Ways of thinking about Economic Growth

Papers from MED's Economic Growth Seminar Series

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Paper Authors:

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- Arthur Grimes (Motu Economic and Public Policy Research, and University of Waikato)
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Abstract

The Ministry of Economic Development ran a series of seminars about economic growth in 2004. One was an economic history of economic growth in New Zealand, three were on different and sometimes contradictory conceptual ways of thinking about economic growth – endogenous growth theory, Austrian economics, and structuralist-evolutionary theory of economic growth. The final seminar outlined the lessons from the previous four seminars and drew conclusions. The papers are non-technical and non-mathematical, and are designed for an audience with only limited knowledge of economics. This Occasional Paper brings the papers produced for the five seminars together as a resource for those interested in different ways of thinking about economic growth and development. It is intended as a companion to MED Occasional Paper 08/08.

JEL Classification **O31, O32, O38, B52**

Keywords: economic growth, economic development, productivity, innovation, entrepreneur, endogenous growth, Austrian economics

Executive Summary

Introduction

In February and March 2004, the Ministry of Economic Development ran a series of seminars to provide training in the different – and sometimes contradictory - ways that different economists have of thinking about economic growth and economic policy. Each paper within this Occasional Paper presents the paper prepared by the economist giving the associated seminar.

The purpose of the seminar series was to expose analysts to a range of ways of thinking about the processes underlying economic growth. This purpose implicitly admits that there is no single "right" model, or way of thinking, about the factors driving growth. The growth process is context dependent, reflecting each country's institutions, endowments, individuals, firms, geography, and interactions with others beyond the country.

The presentation is non-technical and non-mathematical, so it should be accessible to someone without much economics training.

The reason that there are different ways of thinking about economic growth is that the economy is a complex system, and part of a broader and more complex world-wide socio-economic system. As a result, to understand a particular economic phenomenon, we must abstract from irrelevant details, so we can better focus on issues that are most relevant to the phenomenon that we are interested in. That is, any way of viewing the economy that is tractable and useful is inevitably a simplification or a "model" of the real system that we are dealing with.

In this sense, none of the views of economic growth presented here are "right", but they all help us form a richer view of how the economy behaves and how economic growth occurs.

This set of papers is being published now to form a companion piece to MED Occasional Paper 08/08 which outlines how the editor thinks about economic growth and policy for influencing economic growth.

Paper 1: The Development of the New Zealand Economy
Author: Brian Easton (Economic and Social Trust of New Zealand)

This paper outlines the economic change and development of the New Zealand economy from its first settlement to the present day. Economic change is not just about increases in material output, but a variety of other changes including in the mix of sectoral outputs, the products consumed, the production technologies used, the way the economy and society is organised, and the way people live.

There have been major changes to the structure of Gross Domestic Product (GDP), including a substantial reduction of the share of agriculture in GDP over the last 80 years, a diminution of the manufacturing sector for about 20 years, and an expansion of the service sector. Likewise relative prices across sectors have changed. To understand economic development, we must understand these changes in structure, not just the change in aggregate GDP.

Over the period from 1861 to 2003, the average growth of per capita GDP has been about 1.6 percent per annum, a doubling of output per person every 44 years. There were rapid expansions in the 1890s and early 1900s, and rapid growth from 1935 to 1945. Since the Second World War, there appear to have been five stages in the development of the New Zealand economy relative to the OECD. These are an upswing from 1954/5 to 1966/7; a step down from 1966/7 to 1977/8; an upswing from 1977/8 to 1984/5, a step down from 1984/5 to 1993/4; and an upswing from 1993/4 that as at March 2004 was still continuing.

The step-downs were due to a couple of shocks. The first step down was caused by a 40 percent fall in the export price of wool in December 1966. In 1966 wool made up over 30 percent of export revenue. So agriculture, the single biggest tradeable sector, took a major reduction in its profitability, while capital and skills which had been sunk into the sector became valueless. As a result, the economy in the 1970s went through a spectacular export diversification. When growth returned to OECD levels, the level of GDP had fallen 18% relative to the OECD.

The second step down was from 1985 to 1993, and GDP per capita actually fell for 6 years – the worst historically recorded experience. What caused this? There is a left wing view that the stagnation was due to the general liberalisation, but it offers no account of why liberalisation should generate stagnation. A middle view is that poor policy sequencing led to a financial liberalisation which distorted the economy, leading to a temporary economic boom, and then the crash of 1987. The right wing view claims that there was going to be a severe contraction or even an economic crash in the 1980s and that the liberalisation may have been associated with the stagnation but it prevented a far more serious occurrence. Regrettably there is no evidence of this possible crash.

Over this period from 1985 to 1993, New Zealand had an inferior economic performance compared to the OECD. Most of all, New Zealand had a poor export performance (despite some Think Big exports).

Why did exporting do so badly in the late 1980s and early 1990s? Crucial to any sector's performance is its profitability. A good proxy for export profitability is the real

exchange rate – or rather its inverse. The higher the exchange rate the lower the profitability of the export sector.

New Zealand had a leap in real exchange rate in the late 1980s. The New Zealand government had no view on what the exchange rate should be and thought the market would set the appropriate rate. It did not appreciate that its macroeconomic stance tended to push the real exchange rate up. The government was running a large budget deficit in the 1980s, which meant that the economy had to suck in overseas savings, and that tends to push up the exchange rate. An even greater influence may have been the disinflationary policies implemented by the Reserve Bank.

A high – 'overvalued' – exchange rate means that the profitability of exporting (and import substituting) was compromised. As a result various parts of these sectors expand more slowly, contract or even close down.

The liberalisation which took place after 1984 did not lead to the stagnation, but the poor quality macroeconomic management of the period did.

A key lesson from this paper is the need to think sectorally. Different sectors grow at different rates. Sectors that grow faster than the economy as a whole (say around seven percent per annum) and are big enough to drag the rest of the economy along with them are the key sectors in economic growth.

Growing tradeable sectors at these sorts of rates seems to be the only broad growth and development strategy available to New Zealand. That is the lesson of the 'step-downs' of the post-war era, for on both occasions poor economic performance was associated with a poorly functioning exportable sector. The first occasion – from 1966 into the 1970s – was through an event over which New Zealand had little control. However, the second occasion has all the hallmarks of our own fault. We ignored the key requirement for successful growth of an industry: that it has to be profitable.

Paper 2: Endogenous Growth Models
Author: David Mare (Motu Economic and Public Policy Research)

This paper provides a non-technical overview of some key strands of the endogenous growth theory (EGT) literature, providing references to key articles and texts.

The starting point for the survey, as for EGT itself, is the neoclassical growth model. In this, the primary focus is on the growth of productive inputs (labour and capital). To this model, EGT adds a more developed treatment of the process of innovation. As we will show, modelling the process of innovation is not as straightforward as it might seem, and in general requires some tricky technical methods to generate defensible models.

These models are unavoidably complex, so the discussion focuses on the common-sense intuition about innovation that the models endeavour to capture. Essentially, the models assume that something can grow without bound, but in a way that does not generate explosive growth, and in a way which can be sustained in a market economy. Such assumptions are necessary to combat the "ever present threat of diminishing returns".

Key points that this paper makes are that:

- Accumulation of capital and labour, as well as innovation, matter for growth.
- Diminishing returns can extinguish growth.
- Models are only as good as their assumptions.
- All growth models assume that *something* can grow without bound.
- Ideas and knowledge are obvious candidates for sources of spillovers and scale effects necessary for ongoing growth.
- EGT is important because of modelling methods as well as because of specific growth insights.
- Modelling a mechanism doesn't make it true.
    - It may or may not occur.
    - It may or may not be as strong as in the model.
- Changes in the level of GDP, rather than unbounded growth effects, may be good enough to explain observed growth.

Paper 3: Austrian Economics
Author: Frederic Sautet (Mercatus Centre, George Mason University)

Austrian economists understand economics as a multidisciplinary research programme, which sees the economic problem as a problem of coordination of individuals' plans under radical uncertainty. In this context, institutions, culture, anthropology, law, history and political economy are fundamental to understanding the nature of the socio-economic system.

This paper provides a brief view of growth and social change taken from the perspective of the entrepreneurial process and Austrian economics in order to establish the following chain of argument:

- Economic performance (i.e. growth) depends on capital accumulation.
- Capital accumulation is the result of entrepreneurial profit discoveries.
- Entrepreneurship is a function of the institutional makeup of a society.
- Institutions (or rules) will foster entrepreneurship if their adverse effects on (a) the noticeability and (b) the exploitability of profit opportunities are limited over time.
- In order to limit the effects on the noticeability and exploitability of profit opportunities, institutions must constrain the government from the possibility of reneging on its commitments.

In his 1974 Nobel Lecture, Hayek warned us against the "scientistic error". This is the view that economists should imitate as closely as possible the procedures that we learn in the physical sciences. Knowledge of physics has helped us develop the practice of engineering and the design of complex machines. The fallacy is the idea that the same should be done with economics: it should inspire the engineering of society.

Because it reduces the noticeability and exploitability of profit opportunities, "interventionism both increases the level of discoordination within the system and makes it more difficult to eliminate this discoordination". What matters is the speed and responsiveness of the market to discoordination situations: the market is an error-correcting mechanism where entrepreneurs tend to spot overlooked opportunities.

What the entrepreneurial understanding of the economic system teaches is that we cannot engineer growth. Growth is the result of a spontaneous order that cannot be designed.

The institutions that foster entrepreneurial incentives are those of a free market system traditionally understood based on the rule of law. These institutions are subsumed under the laws of property, contract and tort in traditional English Common Law (i.e. abstract and general rules), to which one should add the idea of monetary responsibility.

Paper 4: An Evolutionary View of Technology Driven Long-run Growth
Author: Kenneth Carlaw (Associate Professor, Department of Economics, University of British Columbia and the Department of Economics, University of Waikato and UBC)

We live in a world of rapid economic and social change. Any one change typically causes others, which in turn cause others, and so on in a concatenation of linked causes and effects. For example, the invention of the dynamo in 1887 allowed for the practical generation of electricity. The use of electricity allowed a separate power source to be attached to each factory machine (rather than being driven by a single central power source as in the steam-powered factory), allowing production to be reorganised as in Henry Ford's assembly line.

Such change is best understood as an evolutionary, historical process driven by endogenous innovative activity. Indeed, the evolution of technology drives much of the economic, social, and political change that we experience. Consequently, in our research we pay much more attention to technology than is usual. This is in contrast to most growth theorists, who most often focus on economic growth rather than economic change.

A full understanding of the *causes* and *consequences* of long-run economic growth requires an appreciation of the qualitative changes induced by technological innovations. Technological advance has not only increased our incomes many fold; it has also transformed our lives through the invention of new hitherto undreamed of products that are made in new hitherto undreamed of ways.

Humans are technological animals. Through many millions of years of biological evolution, technology has been fundamental in making us the physical beings that we are today. What distinguishes us from all other animals is our routine use of a wide range of tools and our ability to invent new tools consciously and persistently in the face of environmental challenges and also driven by our own latent curiosity.

New technologies largely result from activities of profit motivated agents, making technological change significantly endogenous to the economic system. Furthermore, scientific and technological knowledge is cumulative. Today's knowledge could not have been discovered or invented in the absence of many earlier discoveries and inventions. To understand where the system is today, we need to know where it has been in the past. In the study of innovation and economic growth, we need explanations that contain an arrow of time, explanations in which past history does exert an influence on the present—*explanations and theories in which history matters*.

Paper 5: Conclusions
Author: Arthur Grimes (Motu Economic and Public Policy Research, and University of Waikato)

Each of the preceding contributions emphasises the importance of knowledge creation in the presence of uncertainty; they also emphasise the role that the profit motive plays in guiding the knowledge creation process. Policies that reduce the ability to spot unexploited profit opportunities, and/or reduce the returns from doing so, can be detrimental to growth outcomes.

Many policies will impact on the profit search process. For instance, bankruptcy penalties that are imposed on those who take risks but fail need to be carefully balanced so as to create incentives for responsible behaviour without unduly discouraging risk-taking. Policies that support those who would not take risks (unless underwritten externally) may also water down the search for opportunities with the highest profit prospects. The profit search process may be affected by policies that affect firm scale decisions and/or a firm's (or investor's) choice of activity.

While the previous contributions provide cautions for policy, they also provide insights about types of policy that may assist the growth process. Policies that assist the knowledge creation process by raising capability and/or by raising the rewards to knowledge creation are consistent with key elements of each of the approaches. These policies may include promotion of educational attainment and promotion of research activities by tertiary and similar institutions. Broad-based promotion of research and development, and of staff training, in private sector firms is likely to facilitate the profit search, investment and thence growth. Support for investment in capital equipment embodying new technologies may also facilitate the profit search since staff are likely to "learn-by-doing" through using the new equipment, taking this knowledge beyond the boundaries of an individual firm.

These types of policies are, in the main, broad-based. Knowledge that underlies development of new projects and sectors is inevitably fleeting. By the time it is processed centrally and then disseminated it is often out-of-date. Those with the incentives to obtain and process the information are generally best placed to decide whether and how to make use of it. Support for the generic profit-search process is a key role that policy can play in order to assist the achievement of higher rates of sustainable economic growth.

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Ways of Thinking about Economic Growth

Introduction:
Author: Roger Procter (Ministry of Economic Development)

In February and March 2004, the Ministry of Economic Development ran a series of seminars on a number of different ways that economists have of thinking about economic growth. Each paper of this Occasional Paper presents the paper associated with one of the seminars. The presentation in this Occasional Paper is non-technical and non-mathematical, so it should be accessible to someone without much economics training.

The purpose of the seminar series was to expose analysts to a range of ways of thinking about the processes underlying economic growth. This purpose implicitly admits that there is no single "right" model, or way of thinking, about the factors driving growth. The growth process is context dependent, reflecting each country's institutions, endowments, individuals, firms, geography, and interactions with others beyond the country. The reason that there are different ways of thinking about economic growth is that the economy is a complex system, and part of a broader and even more complex world-wide socio-economic system. For example, what you and I choose to do tomorrow will have a (probably minute) impact on how the economy behaves. As a result, to understand a particular economic phenomenon, we must abstract from irrelevant details, so we can better focus on issues that are most relevant to the phenomenon that we are interested in. That is, any way of viewing the economy that is tractable and useful is inevitably a simplification or a "model" of the real system that we are dealing with. As the famous industrial statistician, George Box, is supposed to have said, 'all models are wrong, some are useful'.

In this sense, none of the views of economic growth presented here are "right", but they are all useful. Each is useful in different circumstances. By understanding them all, we can form a richer view of how the economy behaves and how economic growth occurs. This allows us to form a judgement about which is most useful to the policy problem we have at hand.

This set of papers is being published now to form a companion piece to MED Occasional Paper 08/08 which outlines how the editor thinks about economic growth and policy for influencing economic growth.

The first paper, by Brian Easton, presents an historical overview of the New Zealand economy outlining key developments from the perspective of economic growth. The following three papers present three different models of, or ways of thinking about, economic growth. In the final paper Arthur Grimes summarises how he interprets these four papers. In the companion MED Occasional Paper 08/08, I have outlined how I think about economic growth and policy for influencing economic growth.

1. The Development of the New Zealand Economy: Author: Brian Easton (Economic and Social Trust of New Zealand)

This paper is a reduced (by over half) version of the paper for presentation to the Ministry of Economic Development Seminar Series: 25 February, 2004. The longer version is at http://www.eastonbh.ac.nz/?p=509.

Between them, Santayana and Marx famously said those who do not learn the lessons of history, are doomed to repeat them: the first time is tragedy, the second time it is farce. The New Zealand economic debate is woefully ahistorical, with little reference to our economic history. Future historians will look at some of our recent tragedies and think them quite farcical.

Mindful that the invitation to speak came from a ministry for development, and not just for growth, I will begin with a political economy account of the past, which emphasises that economic change is not just about increases in material output, but a variety of other changes including the mix of sectoral outputs, the products consumed, the production technologies used, the way the economy and society is organised, the way people live. I then describe the main outlines of aggregate economic output through time. Focussing on recent times, I shall look at New Zealand's aggregate performance compared to other countries, and finish with a quick summary of my own explanatory account of what happened, together with an indication of the policy implications.

1.1. The Political Economy of New Zealand's Economy Development

Political economy can be described through the metaphor of tectonic plates. The geologists' tectonic plates are great slabs of rock which shift about – pushing, crushing, and overriding one another. In a similar manner the economists' tectonic plates are systems of economic organisation, which over time change as new ideas and circumstances create new ways of organising the economy, while old organisations disappear subducted by the overriding new. The conflict between the political economy plates leads to political and social change.

The first such plate in New Zealand – the beginnings of an economy – began about 750 years ago when the first Polynesians reached these shores. They came from a very different tropical environment, to one rich in protein food sources from birds and the sea. Unfamiliar with the new environment and with inappropriate organisational forms, they exploited the available resources in unsustainable ways. The term for this unsustainable political economy based upon exhausting the resources is 'quarry'. In the depleted environment, any surviving communities have to develop a new sustainable tectonic plate. This led to a new political economy – the 'Classic Maori.' It was a closed economy without interaction with the rest of the world.

This changed just over 200 years ago with first the explorers and then the sealers and whalers. Just as those early Polynesians did not understand the environment they had come to, neither did the early Europeans. They quarried the natural resources too: whales, seal, timber, kauri gum, gold, other minerals, even soil was

washed to the sea. So the first European political economy in New Zealand was what the French described as a "colony of exploitation" rather than a "colony of permanence". It is a world in which the visitor comes, exploits, and moves on.

But from 1882 new technologies transformed New Zealand: refrigeration, the steamer and telegraph came from offshore, while the grasslands revolution was largely indigenous. Over the next 80 years the political economy was based on producing grass, processing it into wool, meat, and dairy products, and selling them overseas in return for the desired imports.

This pastoral dominance ended in 1966 when the premium prices that farmers got for wool collapsed, never to return (except temporarily in the 1972-3 commodity boom), while meat and dairy prices were under pressure. The response was diversification – into horticulture, timber, fish, some minerals, tourism, and a little general manufacturing mainly to Australia.

Again the new political economy, which was based on the sustainable exploitation of primary resources, led to changes in the way New Zealand was governed and how New Zealanders lived. The story could be illustrated in many ways, but time allows only the example of the more market element of the 1984 economic reforms because the greater diversity of the export sector meant decentralisation of the economic mechanism became necessary.

Today there may be a new plate arising – that appears to be the intention of the Government's Growth and Innovation Strategy which I discuss at the end.

1.2. Changing Sectors

The political economy of tectonic plates is a qualitative story, which reminds us that development is not simply about a single aggregate output. Here are some few quantitative indicators which support this aggregate story.

Industry Composition

There have been major changes to the structure of GDP, particularly a substantial reduction of the share of agriculture in GDP over the 80 years, a diminution of the manufacturing sector for about 20 years, with the service sector expanding but not uniformly.

Table 1: Industry Shares in Nominal GDP

Year Ended March	1920	1930	1939	1953	1960	1970	1980	1990	1999
Agriculture	29.8	26.2	23.2	22.1	18.0	11.7	10.1	6.1	5.2
Other primary industries			2.9	3.9	4.3	4.3	5.1	7.1	6.8
Manufacturing	21.6	23.7	21.7	21.1	21.8	22.5	23.3	19.2	16.6
Construction	4.0	6.6	8.0	7.1	7.2	5.7	4.6	4.2	3.9
Wholesale and retail trade, hotels etc			15.2	16.4	18.7	20.7	20.0	17.7	18.3
Transport and communication			5.8	8.5	7.4	8.0	7.9	7.6	7.1
Financial and business services			7.7	7.3	8.2	9.1	9.6	14.2	16.3
Other services			16.0	13.6	14.4	18.0	19.4	23.4	25.7

Deflators

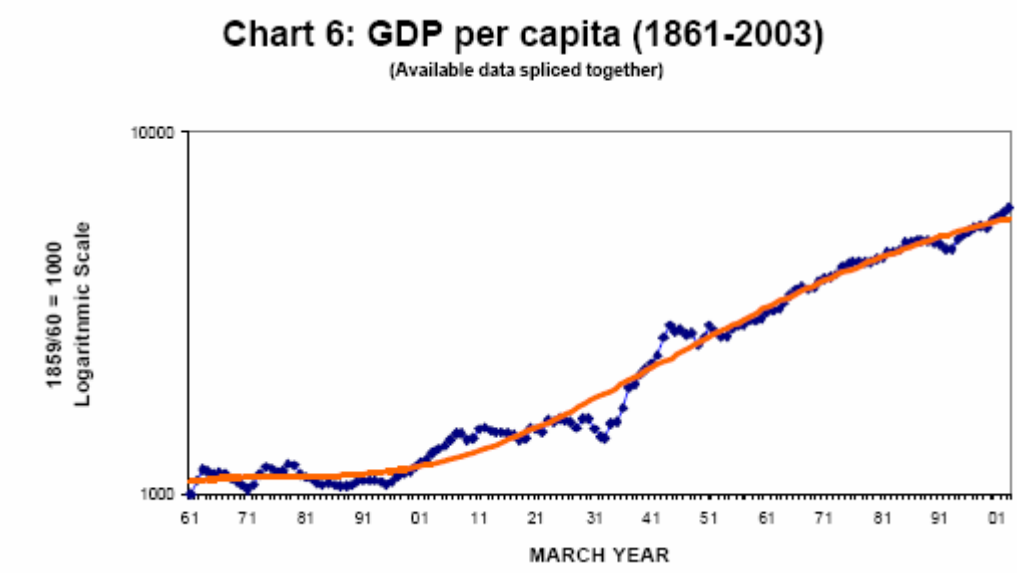
Changing industry composition, means changing relative prices. This is nicely illustrated by comparing the Consumer Price Index (CPI) with the GDP price deflator (GDEF). The CPI covers what consumers spend, including production in New Zealand, and imports of consumer goods. GDEF covers only what is produced in New Zealand, including for export and what goes into investment as well as consumption, but it excludes imports. The difference (*shown in a graph in the full version of this paper*) is salutary. Aggregates operate on the basis that there is only a single product. Two such key prices diverging so markedly reminds us that an economy is about many products. The lesson is that the economist concerned with the growth of the economy cannot just look at aggregate GDP. Sectors are important; prices are important; and profitability and other factor prices are important.

1.3. The Course of GDP

This section, which looks at past periods of growth, is omitted.

1.4. The Long Run: 1861-2003

I have cobbled together the various GDP series, to give a 142 year run from March year 1861 to 2003, always using the better quality data. Chart 6, which uses a logarithmic or ratio scale, shows the stagnations in GDP per capita in the nineteenth century, and from the around 1908 to 1935, in the late 1940s to the early 1950s, and in the late 1980s and early 1990s. Remembering in a logarithmic scale graph,



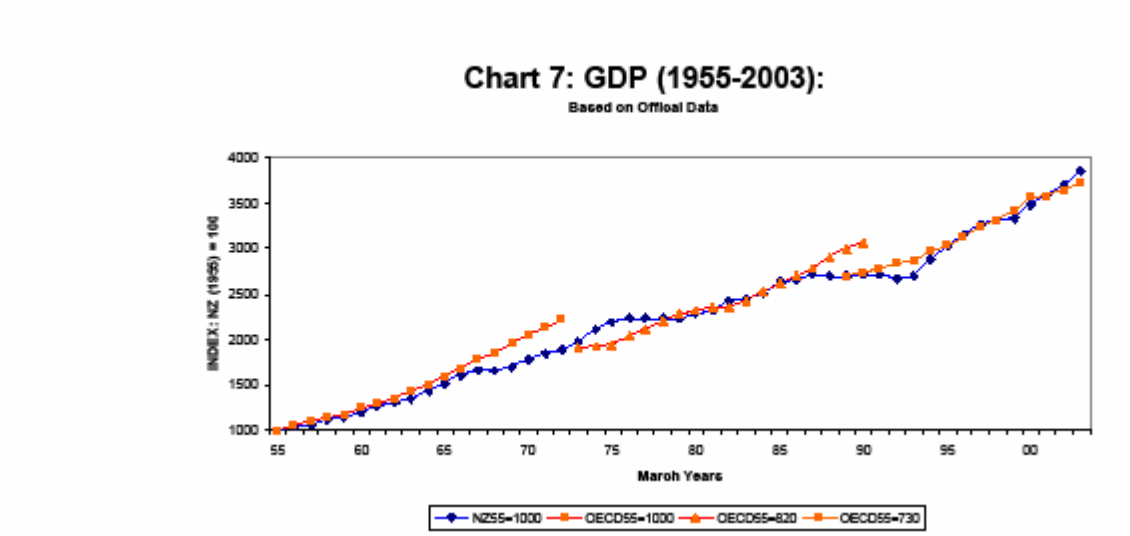
steeper means faster, we observe that there were rapid expansions in the 1890s and early 1900s, and the rapid growth from 1935 to 1945, plus a steady growth, with the odd hiccough from the 1950s to the early 1980s. In summary the last hundred years have seen an average growth of per capita GDP of about 1.6 percent per annum., a doubling of output per person every 44 years.

Chart 6 also shows a trend line based upon a fourth order polynomial. It recognises the nineteenth century stagnation, but sees a strong upward trend in the twentieth. However notice that the trend bends down late in the twentieth century from about

1985. It may reflect the stagnation of the following years, an interpretation supported by that the fact GDP levels have been above trend in the past few years. Alternately it may indicate a slowing of the long run growth rate for New Zealand.

1.5. The Post-war Era

We can get an insight into exactly what happened by looking at the following graph of NZ GDP from 1954/5. I have omitted the earlier years when New Zealand grew slowly relative to those OECD economies severely damaged by the war, but so did the other war-ravaged economies. Chart 7 shows the path of New Zealand volume GDP from March year 1955, where it is indexed to 1000.



Over this New Zealand GDP path Chart 7 superimposes three OECD GDP paths. The first, on the left of the Chart, is set so that OECD GDP is set at the same 1000 in the March 1955 year. The middle path has the OECD GDP set at 820 in the March 1955 year, that is, 18 percent lower than the first OECD path. The third path, on the right, has the OECD GDP set at 730 in the March 1955 year or 11 percent lower than the middle path.

So the slowing down we saw in that long term trend was not continuous, but due to a couple of periods when shocks – which I discuss below – lowered the level of GDP relative to the OECD, rather like dropping a step or two on the ladder. Indeed in two thirds of the years – perhaps more – the New Zealand economy grew at much the same rate as the rest of the OECD. The Chart suggests five stages in the development of the New Zealand post-war economy relative to the OECD, although as usual the endpoints may not be precisely those chosen here.

1954/5 to 1966/7: Upswing

1966/7 to 1977/8: A Step-down

Then, in 1966 New Zealand suffered a shock which put it on a slower growth path for about ten years. The next section explains that the event was the collapse in the wool price at the end of 1966.

1977/8 to 1984/5: Upswing

In the following seven years, the economy broadly followed the OECD growth path again, but at a relative level that was 18 percent lower than the path of the 1950s and early 1960s.

1984/5 to 1993/4: Step-down

Then from 1985 New Zealand underwent another period of stagnation, through to 1993.

1993/4 - ? :Upswing

Since 1994 the economy has been growing at broadly the same rate as the rest of the OECD.

The new growth path is 11 percent below the path of the late 1970s and early 1980s. It is fatuous to say, as no less than the OECD did recently, that the New Zealand reforms are paying off. It is true that we appear to have returned to a growth rate comparable with the rest of the OECD but the reforms will not have 'paid off', until New Zealand is above the 1977/8-1984/5 track.

1.6. The 1966 External Shock

In December 1966 the export price of wool fell about 40 percent. Except for a brief flurry during the 1971-1972 world commodity boom, it never recovered relative to import prices. In 1966 wool made up over 30 percent of export revenue. Add meat, and exports from sheep farming came to half of the total. So the single biggest tradeable sector took a major reduction in its profitability, while capital and skills which had been sunk into the sector became valueless.

The immediate effect of such a shock was that the economy contracted. In 1967, there was – as there had been in the 1932 – a devaluation to share the burden of the commodity price downturn across the entire economy, rather than concentrating it in a leading sector. But instead of clinging to the weakened sector, as happened in the 1930s, the New Zealand economy in the 1970s went through an export diversification – into horticulture, forestry, fishing, mining, general manufactures, and tourism. The external diversification was spectacular. No other OECD economy compared. Even so the economy slowed down. When New Zealand recommenced upon its traditional growth path it was at a level some 18 percent below the previous one.

1.7. Explanation for the Slow New Zealand per capita GDP Growth

Among the explanations I have investigated and given some credence to are:

Post-war Catchup
Systematic Measurement Errors
Population Growth
The Convergence Effect
Terms of Trade

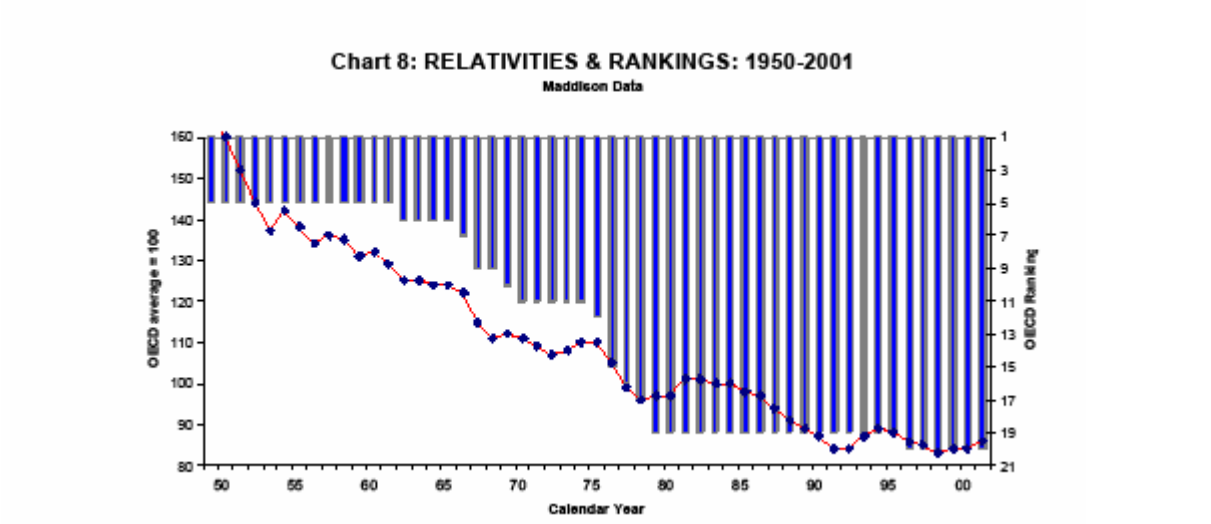
All seem to have slowed per capita New Zealand GDP growth in the post-war era to some extent. But none – except the terms of trade – explain the transition from the pre 1966 track to the post 1977 one, or the magnitude of the difference between the two paths.

1.8. Non-Explanations for the Slow New Zealand per capita GDP Growth

There are some popular explanations which hardly conform to any known scientific methodology.

Excessive Intervention: It was popular to argue in the 1980s that the New Zealand economic mechanism had been too dependent upon centralist interventions, which slowed down the economic growth rate. The policy prescription was that a major economic liberalisation, shifting the mechanisms to more-market, would accelerate economic growth. The evidence of the 1990s is that it did not. But here we evaluate the theory from an early 1980s perspective.

There was no attempt to demonstrate the connectedness of the proposition, or to measure it. In particular, was New Zealand more intervened in than the countries with which any comparison was (implicitly) being made? Additionally the account was ahistorical: it is not obvious interventions intensified in 1966. Moreover the period of fastest growth – from 1935 to 1945 – was a time when the economic mechanism was highly interventionist, much more so than it was in the 1970s.



Size of the Economy

The same problems apply here as apply to the market mechanism thesis described under heading 1.8 above.

Distance

The same non sequiturs apply. Indeed, if distance was an inhibition, one would have thought that the continued and remarkable reductions in the cost of distance in the post-war era ought to have speeded up New Zealand's economic growth rate.

1.9. Some Errors of Method

A therefore B

There is a tendency to connect unrelated facts, without any analytic account of how they are connected, or empirical verification. It is typically associated with the ignoring of facts which contradict the connection and alternative theories which might prove more robust.

Too Late a Period

Check before the period which begins the analysis that something did not just happen earlier.

Tautologies are Not Explanations

Relativities Not Rankings

Much of the New Zealand discussion has been in terms of its ranking measured by GDP per capita among OECD countries. Whatever the mathematical distaste for using an inferior measure, rankings have also misled researchers. Chart 8 shows both OECD relativities and rankings. Not only does the ranking pattern not closely follow the relativity, but for the first 15 years New Zealand hardly changed its ranking, although its relativity fell dramatically. The same applies to the last twenty years, when only Ireland passed New Zealand. Even so, New Zealand's GDP per capita fell from about the OECD average to just above 83 percent. A regrettable result from the focus on rankings has been the focus on the 1970s when New Zealand dropped nine placings, ignoring the problems of the post 1984 period. The earlier period is easily explained in terms of the 1966 terms of trade crash. The later period is more complicated to explain.

1.10. What Happened After 1984?

The graphs show that GDP broadly stagnated from 1985 to 1993. Indeed there appears to be six years in sequence when GDP per capita fell. There was no similar experience in the post-war era, or indeed in any known pre-war era. There is no obvious external shock in the mid 1980s of sufficient magnitude to explain all the stagnation. I looked at the third oil shock (in 1985 when the real price of oil fell) and the hike in real interest rates. While both impacted unfavourably on the New Zealand economy, neither seems to have been sufficient to explain the stagnation.

There is a left wing view that the stagnation was due to the general liberalisation, but it offers no account of why liberalisation should generate stagnation. Australia went through a similar – albeit less extreme – liberalisation, but it did not experience a stagnation.

A middle view is that poor policy sequencing lead to a financial liberalisation which distorted the economy, leading to a temporary economic boom, and then the crash of

1987 (which seems to have been the most severe of all the sharemarket crashes in the OECD).

The right wing view claims that there was going to be a severe contraction or even an economic crash in the 1980s and that the liberalisation may have been associated with the stagnation but it prevented a far more serious occurrence. Regrettably there is no evidence of this possible crash. The one attempt to predict the medium term course of the economy in 1985 by Bryan Philpott contradicts the conclusion that the policies of the 1980s and 1990s made no contribution to the stagnation.

Rather than look for an external shock, we look for an internal shock which impacted on the external sector. That there was a problem in the external sector is evident from the following table which compares New Zealand's economic performance with that of Australia's and the entire OECD's over the 1985 to 1998 period.

As the table shows, New Zealand's economic performance was inferior to the rest, with poor GDP growth, poor productivity growth and high unemployment growth, despite the most favourable terms of trade boost. The one success was the dramatic reduction in inflation. Most of all, New Zealand had a poor export performance – worse than its import growth.

Economic Performance: Average 1985-1998 (% p.a.)

	New Zealand	**Australia**	**Ireland**	**OECD***
Inflation: Private Consumption Deflator	4.6	4.1	2.6	5.5
Employment Growth	0.8	1.9	2.2	1.2
GDP Volume Growth	1.7	3.1	6.0	2.7
Labour Productivity Growth	0.9	1.2	3.8	1.5
Export Volume Growth	3.9	7.1	11.7	6.9
Import Volume Growth	5.3	6.6	9.8	7.2
Current Account Deficit (% of GDP)	3.7	4.8	-0.8	0.2

The import growth is not surprising, given that border and internal protection had been reduced, although without the import substitution of the 'Think Big' major projects it would have been even higher. Similarly the poor growth of the export sector is better than one might expect because it is boosted by some Think Big exports, and by the horticultural and forestry exports from plantings before 1985.

Here is the same table for the 1978 to 1985 period when the New Zealand economy grew much better. Indeed the whole economic performance was much better, except for inflation. In particular export growth was higher: more comparable to the rest of the OECD.

Why did exporting do so badly in the late 1980s and early 1990s? Crucial to any sector's performance is its profitability. A good proxy for export profitability is the real exchange rate – or rather its inverse. The higher the exchange rate the lower the profitability of the export sector.

Economic Performance: Average 1985-1998 (% p.a.)

	New Zealand	Australia	Ireland	OECD*
Inflation: Private Consumption Deflator	4.6	4.1	2.6	5.5
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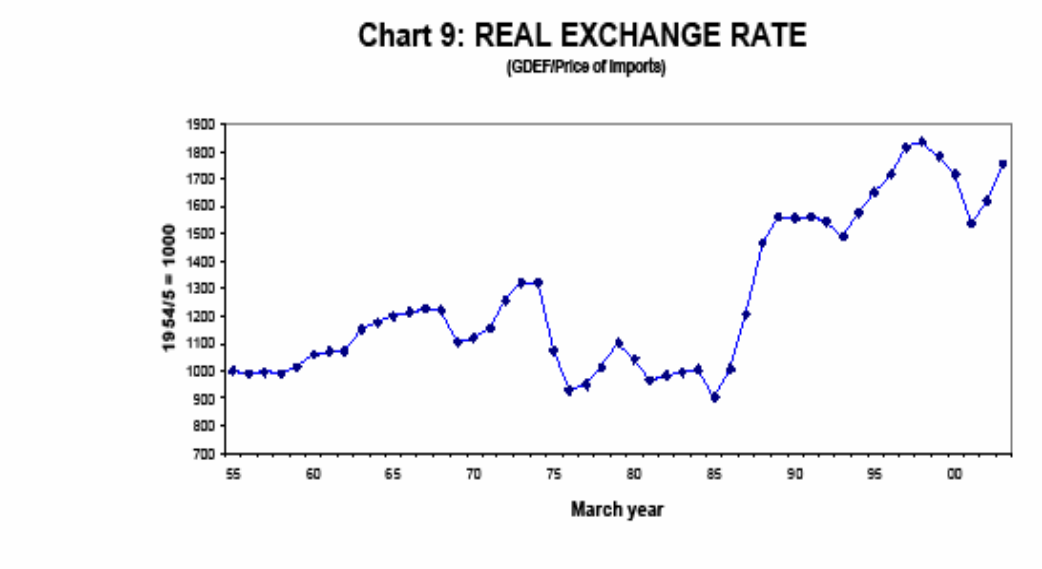
Chart 9 shows a leap in real exchange rate the late 1980s. The New Zealand government had no view on what the exchange rate should be and thought the market would set the appropriate rate. It did not appreciate that its macroeconomic stance tended to push the real exchange rate up. The government was running a large budget deficit in the 1980s, which meant that the economy had to suck in overseas savings, and that tends to push up the exchange rate. An even greater influence may have been the disinflation. The Reserve Bank targeted the Consumer Price Index, which being a measure of expenditure rather than production, has a large import – and therefore exchange rate – component. The easy way to depress the CPI was to hike the exchange rate.



A high – ‘overvalued’ – exchange rate means that the profitability of exporting (and import substituting) was compromised. This has two effects. First, some parts of the tradeable sector contract and close down. This is most evident in the import substituting industries. Second, other parts of the tradeable sector would cease to expand: the mechanism is that the fall in profitability means there are fewer attractive investment opportunities, while sales are not generating the cash flow to fund the investment. Of course, this slowdown would phase in. The medium term outcome would be that the tradeable sector would slow down.

Eventually, the tradeable sector adjusts to the high real exchange rate, by eliminating all its activities which are unprofitable below that rate, at which point it begins expanding again, apparently at roughly the same rate as had occurred before the exchange rate hike. So economic theory says a step-up in the level of the real exchange rate will lead to step-down in the level of GDP with a lag, a transition path of a period of slow GDP growth or even stagnation. That is exactly what happened in practice after 1985. The liberalisation which took place after 1984 did not lead to the stagnation, but the poor quality macroeconomic management of the period did.

1.11. The Importance of Thinking Sectorally

There are many lessons in this paper. Here I want to focus on the importance of thinking sectorally. Suppose we wanted to think about the possibility of an annual GDP growth rate of 4 percent per annum. Those trapped in the aggregate GDP paradigm would write down a mathematical tautology, perhaps leading to a level of total factor productivity growth that had to be obtained. In contrast, a sectorally focussed approach recognises that different sectors grow at different rates. Let me group sectors into four.

The first sector category, perhaps called the tens, are sectors which are likely to grow at 10 percent per annum or more in volume terms. Typically these are very dynamic industries perhaps responding to a new technology or fashion. But ‘tens’ are small industries. As their rapid growth makes them larger, they tend to slow down to join the second category.

The second sector category (sevens), are those which grow faster than the economy as a whole – say around seven percent per annum. Because they are big enough and fast enough to drag the rest of the economy along with them they are the key sectors in economic growth.

The third sector category (fours), are those sectors which grow about the same rate as the economy as a whole. They are not unimportant and can be quite dynamic. But they are not economic drivers.

In the final sector category (ones), are those which grow markedly below average. Not all sectors can grow above average. ‘One’ industries often have productivity growth with demand stagnation. How do we shift their underutilised resources into the ‘sevens’?

What are the characteristics of ‘sevens’? A possibility unavailable in New Zealand is the ‘bootstrapping seven’, a domestically oriented sector which can drag the entire economy along.

Import substitution might seem to be a bootstrapper but, like exporting, it is displacing overseas producers. The most common ‘seven’ is a tradable industry – in today’s circumstances an exporter. In the post-war era, OECD exports and imports grew faster than output. I will come back to why they did shortly. But there is a second reason why a small economy like New Zealand is likely to have ‘sevens’ in the export sector. As a general rule, New Zealand is only a small exporter relative to market size so it can expand its share of the market without severely disrupting competitors. Thus its export sectors can grow faster than the domestic sector and, in doing so, drag the rest of the economy onto a faster growth path.

Tradeables as sevens seems to be the only broad growth and development strategy available to New Zealand. That is the lesson of the ‘step-downs’ of the post-war era, for on both occasions the poor economic performance was associated with a poorly functioning exportable sector. While the first occasion – from 1966 into the 1970s – was through an event over which New Zealand had little control, the second step-down has all the hallmarks of our own fault, when we ignored that the key requirement for successful growth in an industry is that it has to be profitable.

1.12. The Next Political Economy?

To finish with a little speculation about the future New Zealand political economy; while it has transformed from one dominated by the pastoral sector into a more diversified one, there is still an underpinning resource base for most of the major industries: tourism, dairy products, meat products, forestry, horticulture, fish products, wool minerals and energy.

If I have understood the Growth and Innovation Strategy aright, the government wants to accelerate the roles of human capital and creativity. To understand how this fits into the international trading pattern – I am now no longer describing the government’s strategy but interpreting and extending it – recall that exports grow faster than output. Now there is nothing inherent about exports that means that their income elasticity of demand should be substantially greater than unity. What seems to be causing the rapid growth is the patterns of the location of production.

Today, about a quarter of the world’s trade is in oil, a quarter in primary products, and a quarter in general manufactures which are traded according to the rules of comparative advantage. The final quarter of world trade involves intra-industry trades, which occur when the two countries trade broadly the same goods or services – say the French buying Volkswagens and Germans buying Renaults. There was negligible intra-industry trade immediately after the war, so this is the fast rising part of international trade.

Intra-industry trade is governed by the rules of competitive advantage not comparative advantage. This theory is a recent one. It is based upon products which are similar but can be differentiated by the market, it involves economies of scale in production and other advanced technologies, and it is driven by the falling costs of distance.

New Zealand has probably the poorest intra-industry trade record in the rich OECD. An issue is whether New Zealand can get into intra-industry trade – exporting pharmaceuticals to Europe, software to the US, films to Hollywood, while, of course,

also importing pharmaceuticals from Europe, software from the US, films from Hollywood. A way of interpreting the ‘innovation’ part of the Growth and Innovation Strategy is it aims to create industries involved in intra-industry trade which are tens, and grow them strongly enough to become the sevens. This upwelling of a new political economy tectonic plate need not subduct the diversified resource plate. There may be synergies between them – to mix metaphors.

Whether we are economic theorists or practical policymakers we are feeling our way about the significance of competitive advantage and intra-industry trade. Much of my research program over the next few years is trying to understand it. So I conclude with the more fundamental message which has pervaded this paper.

Economic development is different from economic growth. It is not simply about increases in aggregate output, but about the changes in the mix of sectoral outputs, the products consumed, the production technologies used, the way the economy and society is organised and the way people live.

2. What Do Endogenous Growth Models Contribute?: Author: David Mare (Motu Economic and Public Policy Research)

2.1. Introduction

This paper provides a non-technical overview of some key strands of the endogenous growth theory (EGT) literature, providing references to key articles and texts[1]. The intended audience is policy analysts who want to understand the intuition behind EGT models. The paper should be accessible to someone without much economics training.

The starting point for the survey, as for EGT itself, is the neoclassical growth model. Whereas the primary focus of the neoclassical growth model is on the growth of productive inputs, EGT adds to this a more developed treatment of the process of innovation. As we will show, modelling the process of innovation is not as straightforward as it might seem, and in general requires some tricky technical methods to generate defensible models.

We will explain why the modelling is unavoidably complex, and focus on the common-sense intuition about innovation that the models endeavour to capture. Essentially, the models assume that something can grow without bound, but in a way that does not generate explosive growth, and which can be sustained in a market economy. Such assumptions are necessary to combat the "ever present threat of diminishing returns". (Aghion and Howitt (1998, p4))

2.2. Precursors to Endogenous Growth Theory

Understanding economic growth has long been a central concern in economics. At the risk of vastly oversimplifying the rich insights about economic growth gained over more than two centuries of economic thought, I will focus on three generic ingredients – factor accumulation, diminishing returns, and new discoveries.

Adam Smith's Wealth of Nations (Smith (1776)) is arguably concerned primarily with economic growth, or, in Smith's words, the 'progress of opulence'. Given that Smith was writing during the industrial revolution it is perhaps not surprising that he emphasised the rising ratio of capital to labour as a key ingredient in economic growth. The growth of inputs such as capital was making a strong contribution to the growth of output, so Smith could understand a lot about eighteenth century growth by looking at the processes by which capital was accumulated, through deliberate savings ('parsimony'). More generally, increasing the quantity of inputs (factors of production) will (usually) lead to an increase in the quantity of outputs, so studying factor accumulation is a key strand in attempts to explain economic growth.

[1] Aghion and Howitt (1998) provides an extremely useful broad treatment of EGT. I understand that Jones (2002) also provides an excellent treatment of EGT. Unfortunately, I was not able to view a copy while preparing this paper. A useful discussion of general EGT issues appears in the symposium on new growth theory published in the Fall 1994 issue of the Journal of Economic Perspectives, which includes Romer (1994), Gene M Grossman and Helpman (1994), Solow (1994), and Pack (1994).

The second ingredient of economic thinking about growth that I wish to emphasise is that of diminishing returns, which relates to the link between factor accumulation and output growth. In particular, diminishing returns captures the idea that doubling the amount of capital will in general lead to less than a doubling of output. The idea was discussed in detail by Ricardo (1821), although appears earlier in the work of Turgot.[2] Ricardo focused on the case of agricultural (corn) production, where land was in fixed supply, and adding more capital or labour forced activity onto less fertile land, leading to less than proportional increases in output as inputs grew. The more general version of the 'law' of diminishing returns, which has been incorporated into many subsequent economic models, applies the same principle to any set of factors where one is in relatively fixed supply. This point will be picked up again in the discussion of the neoclassical growth model in the next section.

The third element from the growth theory literature that I want to focus on is what I will refer to as 'discovery'. This is a disproportionately large 'catchall' for changes in what is produced, how things are produced, or how they are used. For the purposes of this paper, I will keep the definition of 'discovery' very general. It covers a wide range of phenomena, some of which have acquired more specific usages in the literature, and is intended to include the discovery of new markets, processes, products, and ideas; innovation, invention, technical change, technological shifts, research, development, invention, etc. It may seem a little strange to clump such a wide range of concepts under a single heading, especially as the list includes a variety of forces that many people would identify as obvious potential drivers of growth. This treatment reflects the way that economic growth has been approached in the literature, at least in the mainstream (neoclassical) economics literature.

Neoclassical growth models

The accumulation of productive factors and the existence of diminishing returns have found modern expression in neoclassical production theory in the form of a production function. The production function summarises the amount of output that can be produced with various combinations of inputs. The most commonly used form of the production function models output as depending on just two inputs – capital and labour, according to a particularly convenient mathematical form (the Cobb-Douglas production function).[3] It is commonly assumed that the production function is 'constant returns to scale'. This means that a doubling of all inputs will lead to a doubling of output. However, decreasing returns to scale apply to an input if other inputs do not increase. For instance, if the amount of capital is increased without any increase in labour, each subsequent addition of capital will yield smaller and smaller increments to output.

The neoclassical growth model uses such a production function to examine how output grows as inputs are accumulated. The key insights can be gained by assuming that the amount of labour input is fixed, and that capital can be accumulated by saving a fixed proportion of output each period and investing it in

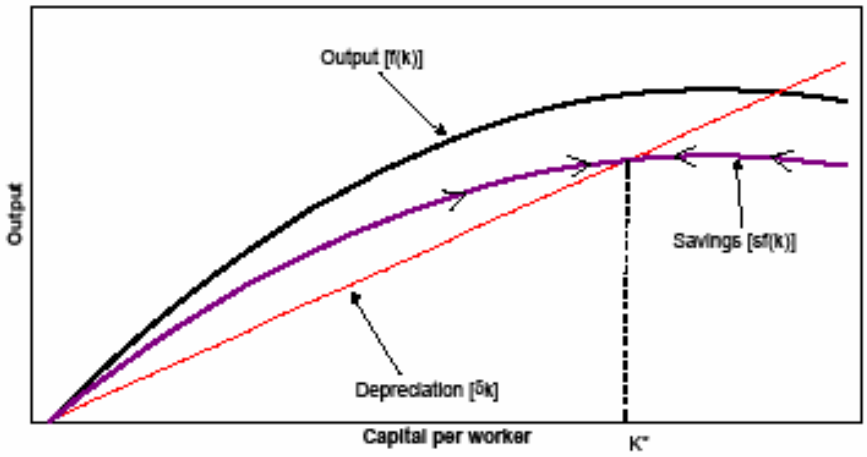
[2] See Cannan (1892).

[3] In the past there has been considerable debate within the economics literature about the validity of specifying an aggregate production function, or even whether the concept of 'aggregate capital stock' has any sensible meaning. The mainstream consensus is that, while it is hard to justify theoretically, it is a sufficiently useful abstraction that can provide many useful insights.

new capital.[4] The model is summarised in Figure 1. The upper line shows the amount of output that is produced with different levels of capital.[5] It curves as it does because of diminishing returns – the growth in output as capital increases gets less and less. Savings are shown as a fixed proportion of output. The straight line captures the amount of saving that is required just to keep up with capital depreciation. If capital per worker is less than the amount shown as *K**, savings exceed depreciation, and some saving is available to increase capital. Over time, capital will increase, and we will move from left to right, as shown by the arrowheads on the savings curve. To the right of *K**, savings are insufficient to meet depreciation, and capital decreases. In the long run, capital per worker will end up fixed at *K**.

The clear implication from this model is that in the long run, growth stops. Moreover, growth gets slower as we approach *K** from below. Not only does the amount of investment decline, but the output generated by an additional dollar of investment also gets smaller. The neoclassical growth model so far is a model of no growth, at least in the long run.

Figure 1: The Neoclassical Growth Model



Growth accounting

One common application of the concept of an aggregate neoclassical production function is in 'growth accounting'. Growth accounting endeavours to identify how much of observed output growth is due to changes in inputs and how much is due to other factors. We start with an estimated production function and knowledge of the quantity of inputs at two points in time. From this we can predict how much growth there would be as a result of the change in inputs. In practice, this generally predicts less growth than actually occurs, and the residual is labelled as 'total factor

[4] The Cass-Koopmans-Ramsey model endogenises the savings rate in an intertemporal utility maximisation model. See Aghion and Howitt (1998, s1.2) or Blanchard and Fischer (1989).
[5] Capital is shown as capital per worker, but since we have assumed that labour input is fixed, the difference is immaterial. If we use a Cobb-Douglas production function, the illustrated relationships hold for the ratio of capital to labour, which is what the graph shows.

productivity (TFP) growth', or sometimes as the 'Solow residual'. TFP thus captures the impact of all of the phenomena referred to above as 'discovery', as well as any errors in the specification of the production function. It is a summary of everything that the model does *not* capture, and has been referred to as a 'measure of ignorance'.[6]

The fact that the neoclassical growth model and growth accounting do a poor job of explaining the forces that cause growth does not negate the insights that can be gained. Young (1995), for instance, examined the growth performance of East Asian economies, and concluded that much of the impressive growth performance can be attributed to factor accumulation (savings, education, labour force participation), with TFP growth playing a minor role.

2.3. EGT – Modelling Discovery

Endogenous growth theory is a collective term applied to a fairly diverse set of theories that model the process of discovery. It is for this reason that Aghion and Howitt (1998) repeatedly refer to the field as "endogenous *innovation* growth theory". As with the analysis of factor accumulation, the analysis of discovery has a long history within economics. Smith, for instance, thought of it as a consequence of the division of labour, itself a consequence of the size of markets: "*This great increase of the quantity of work which, in consequence of the division of labour, the same number of people are capable of performing, is owing to three different circumstances; first to the increase of dexterity in every particular workman; secondly, to the saving of the time which is commonly lost in passing from one species of work to another; and lastly, to the invention of a great number of machines which facilitate and abridge labour, and enable one man to do the work of many."* Smith (1776) (Bk1, Ch1, s1.1.5). Rae (1834) appears to be the first to have argued for 'invention' as the primary source of economic growth. [7]

The renewed emphasis on these issues, evidenced by the development of EGT, reflects in part dissatisfaction with the lack of attention paid to the process of discovery within the neoclassical growth framework. Assuming growth in productivity, as is done in the neoclassical growth model, is sufficient to generate sustained growth in output but it is not very informative about what is driving growth or whether policy can influence it.

In reality, the conclusions of EGT models are also dependent on assumed growth relationships. Cameron (2003) points out that, "to generate permanent growth . . . A model must contain a fundamental linearity in a differential equation". What this means is that something within the model must be assumed to grow without limit. For neoclassical growth, the assumption is that productivity grows exogenously (ie: by assumption, and not as an outcome of the model).

What makes endogenous growth theories *endogenous* is that growth is a consequence of scale and accumulation. As we have seen, in the neoclassical model, accumulation leads to diminishing returns. EGT (generally) incorporates that relationship, but adds another relationship. Instead of assuming that growth is

[6] The phrase is attributed to Abramowitz, as cited in Aghion and Howitt (1998, p.66)
[7] Brewer (1996?).

determined exogenously, EGT theorists posit a mechanism that generates a positive relationship between scale and productivity. The impact of the posited mechanism is to offset, and in most cases outweigh, the impact of diminishing returns.

The most direct way to incorporate this sort of positive feedback mechanism in the neoclassical growth model is to assume that productivity depends on capital per worker. With an appropriate characterisation of this mechanism, the modelled growth in productivity can exactly offset the effects of decreasing returns, making the output curve in Figure 1 a straight line. Both capital and output can grow forever, and the rate of growth is determined by savings and investment. Such models are often referred to as 'y=*Ak'* models', or just '*Ak* models' because of the implied linear relationship between capital per worker and output.

A range of stories has been proposed to justify such an assumption. Arrow (1962) for instance proposed that a firm can make more productive use of capital when the aggregate stock of capital is higher because people learn collectively through experience. He termed this effect 'learning by doing'. Other writers have incorporated additional inputs into production functions – inputs that can, like capital, be accumulated (e.g. aggregate human capital, 'technical knowledge'). By assuming that output can double when these inputs are doubled (i.e. even if labour is fixed), their models are also able to generate sustained growth, and are thus a type of *Ak* model.

There are many different ways of incorporating the necessary positive feedbacks in EGT models, each with its own more or less plausible story to support it. When looking at particular EGT models, it may not be immediately obvious which assumption is the crucial one, especially to the untrained eye. It is not that theorists are trying to deceive – tracing the implications of different (assumed) sources of growth in differently structured models is the way that they gain insights into the mechanics of growth. It also enables them to check the consistency of various stories about growth, both internally, and with observed patterns.

Two common ways that EGT incorporates the assumption of growth are in the form of spillovers, and by the assumption of increasing returns. Spillovers occur when the accumulation of an input has an unintended (and unrewarded) positive effect on productivity. We have already seen an example of this, in the 'learning by doing' approach of Arrow (1962). As capital is accumulated, productivity rises to offset diminishing returns. One feature of models that assume spillovers is that there is underprovision of the input that is the source of the spillover. In the Arrow model, the capital stock is too low – if people took into account the positive effect that investment has on productivity, they would do more of it. Similarly, if we assume that productivity increases as human capital is accumulated, an implication of the resulting model would be that subsidies to human capital could increase growth.

One of the most significant advances made by EGT is to find a way to model increasing returns. In fact, the appeal of EGT is arguably as much a result of its having generated useful modelling methods for general equilibrium theorists as it is a result of the insights it provides into growth. The main problems with modelling increasing returns are first that it can easily lead to explosive growth, which is plainly unrealistic, and second, that it is in general inconsistent with a competitive equilibrium. For instance, in the Arrow (1962) model, if capital were paid according

to what it contributed to output, the price of capital would be bid up until it absorbed the full value of output – there would be nothing left to reward labour inputs. In the case of spillovers, the positive feedback is assumed to be unintentional, and thus does not need to be rewarded. To model increasing returns without assuming this sort of spillover, some theorists incorporate 'monopolistic competition' in the model, using a particularly convenient functional form introduced by Dixit and Stiglitz (1977). An example of this approach is discussed briefly below, when outlining the key elements of the Romer (1990) model. Being able to write down models that incorporate both increasing returns and a competitive equilibrium is an important step in delivering on the EGT "vision of perpetual change and innovation through competition" Aghion and Howitt (1998, p2)

Both spillovers and increasing returns provide appealing 'commonsense' stories to underpin growth models, especially when applied to the accumulation of knowledge. Marshall went as far as to assert a law of increasing returns, capturing scale effects in the development of new production methods: " . . . *while the part which nature plays in production shows a tendency to diminishing return, the part which man plays shows a tendency to increasing return. The law of increasing return may be worded thus:—An increase of labour and capital leads generally to improved organization, which increases the efficiency of the work of labour and capital.*" Marshall (1920) (Bk4, Ch XIII, Para IV.XIII.11)

It is understandable that so many EGT models emphasise knowledge, research or ideas as sources of growth. There is one property of ideas that make arguments of spillovers or increasing returns seem particularly plausible and palatable. My knowing an idea does not in any way stop you knowing it. Economists refer to this property by saying that ideas are 'non-rivalrous'. It seems natural to accept that my accumulation of ideas can 'spill over' and increase your productivity. Many EGT models also assume that ideas are 'partially excludable' meaning that I am able to capture some of the benefits from my ideas (eg: through intellectual property rights, patents, etc). Without this assumption, there would be little incentive for me to invest the time and energy in seeking out new ideas.

2.4. Some Endogenous Growth Examples

The themes that we have identified in EGT models (assumed scale mechanism, spillovers, increasing returns) are perhaps best illustrated with reference to some examples of specific influential models. In this section we will provide a very brief outline and discussion of four particular approaches, each emphasising a particular type or feature of innovation. The approached are horizontal innovation (expanding the range of products); vertical innovation (improving existing products); heterogeneous innovation (research vs learning by doing) and 'lumpy' innovation (general purpose technologies).

<u>Horizontal innovation – Romer (1990)</u>

Romer's 1990 article contains what is probably the most influential early model of endogenous growth. It is a model of 'horizontal' innovation, which means that innovation takes the form of developing new varieties of goods. The intuitive summary that follows does not do full justice to what is a carefully constructed and

clever model, but will hopefully serve to illustrate the key assumptions and mechanisms.

The model has three sectors. The first is the research sector, which employs labour and produces research outputs (referred to as designs, blueprints, or licenses). The licenses to use the designs are sold to the intermediate goods sector, which produces inputs for the production of a final good. The final goods sector combines labour inputs and the intermediate goods to produce a final output.

Spillovers are assumed in the research sector, on the basis that the knowledge embodied in designs is non-rival. Once a design is developed, all other researchers can see it, and can more readily develop additional designs. The growth in research outputs is thus positively related to the stock of designs, which grows over time. The strength of this effect is even greater when there are more researchers. As well as being non-rival, the knowledge embodied in the designs is also partially excludable. Designs can be licensed (patented) so that the research sector can sell to the intermediate goods sector the right to exclusive use of each design.

When the intermediate goods sector buys a licence, it has a monopoly in the use of each design. This gives it some market power, and enables it to earn a monopoly rent. These rents are, however, all captured by the research sector in the price that is paid for licenses. There is a source of increasing returns within the intermediate goods sector that adds to the effect increasing returns due to research spillovers. As the number of licences (and hence intermediate goods) increases, more firms (varieties of intermediate goods) enter, with the same marginal product as the other firms. Growth is thus insulated from decreasing returns. Such an increasing returns relationship may arise as a result of greater specialisation which, as Adam Smith has noted, is limited by the extent of the market.

The final goods sector combines the intermediate inputs with the labour input that is not being used in the research sector to create a final good for consumption.

For the model as a whole, the growth rate depends on the size of the research sector, both in terms of how much labour is used there, and how large is the stock of accumulated designs. The applicability of these insights is, however, dependent on the set of assumptions and functional forms that is incorporated in the model. To turn the implications of the Romer (1990) model (that increased research effort raises growth) into a policy prescription is only valid if the assumptions of the model are valid. Recall that these assumptions include research spillovers that are sufficiently strong to overcome diminishing returns in the research sector, excludability that generates monopoly power for intermediate goods producers, and a characterisation of research outputs with licences for intermediate goods that enter into final goods production.

Vertical Innovation (Aghion & Howitt)

A second strand of EGT models a different pattern of innovation – one in which innovation takes the form of improvements in existing products. Innovation thus creates new products or technologies, as well as destroying the value of old products or technologies by making them redundant. The models are referred to as ‘vertical innovation’ or ‘quality ladder’ models. The approach is much closer in spirit to the

process of ‘creative destruction’, which is how Schumpeter famously characterised technical progress:

“The fundamental impulse that keeps the capitalist engine in motion comes from the new consumers’ goods, the new methods of production or transportation, the new markets, the new forms of industrial organisation that capitalist enterprise creates. [The process] incessantly revolutionizes from within, incessantly destroying the old one, incessantly creating a new one. The process of Creative Destruction is the essential fact about capitalism” Schumpeter (1947, pp. 82-3)

Aghion and Howitt (1992) introduced the seminal model in this vein, which they also summarise in Aghion and Howitt (1998, Chap2). Unlike the model in Romer (1990), the Aghion and Howitt (1998) version of this model abstracts completely from capital accumulation. There is, however, still a spillover in the research sector, this time modelled as a positive relationship between research employment and the rate at which new innovations are made. There are also monopoly rents generated in the intermediate goods sector, although this time they are only partially captured by the research sector.

The merits of expanding the research sector are less clear in this model than in the Romer model. Here it is possible to have too much research. Innovations are more productive than the designs that they replace, but there is a negative impact that must be taken into account – the innovation destroys the value of an existing design by superseding it. This is referred to as a ‘business-stealing’ effect. Furthermore, product market competition is unambiguously bad because it reduces the monopoly rents which provide the rewards for research.

Jones and Williams (1999) examine a model that incorporates elements of both horizontal and vertical innovation. They argue based on empirical evidence, that in practice the net real world effect of the various forces is to yield an underprovision of research in the real world.

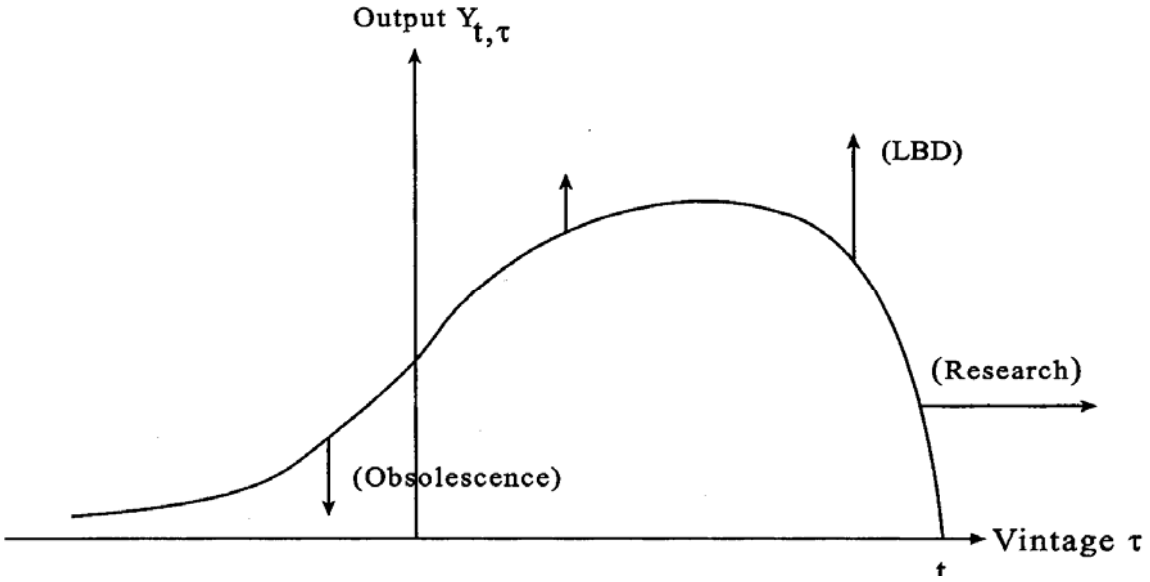
<u>Heterogeneous (two-stage) innovation</u>

Some EGT models relax the assumption that research is homogeneous, by acknowledging the distinction between fundamental research and more applied development activities. They start with the fact that *“[f]undamental and secondary research are complementary activities; in order to exploit fully the fundamental knowledge generated by R&D, a firm must put that knowledge into practice and resolve the unexpected problems and opportunities that only experience can reveal.”* Aghion and Howitt (1998, p. 173)

In these models, growth is enhanced by the right mix of fundamental and secondary research, and the age of intermediate goods becomes important. Fundamental research produces new intermediate goods that have the potential to be more productive than the previously developed intermediate goods. The value of the research output is, however, zero, until there is a secondary innovation that applies the new knowledge. Secondary innovations are achieved as a result of learning by doing. The general knowledge that is built up by the combined effect of fundamental and secondary innovations increases the value of subsequent research of both types.

Figure 2 summarises the process graphically. The rightmost edge of the curve (the 'cutting edge') represents the most recent vintage of research output, which contributes nothing to output. To the left of this are previous periods' research outputs, which now make a positive contribution to output as a result of learning by doing (LBD). For old enough research outputs, the contribution to output is smaller (because recent innovations are better) and eventually obsolescence outweighs the improvements available from learning by doing.

Figure 2: Two-stage Innovation



Adding a second type of research to EGT models introduces new issues and dynamics, and allow us to analyse a wider range of questions about patterns of growth. For instance, two-stage innovation models outline the nature of educational policy choices about the relative emphasis to be put on fundamental as opposed to applied research. Young (1992) draws a link between the rate of sectoral change and the negative impact that rapid sectoral change can have on the contribution of learning by doing to output growth.

Lumpy innovation (General Purpose Technologies)

The final strand of EGT that we will discuss relates to the fact that in most countries, growth is uneven, and appears to occur in spurts, albeit sometimes over extended periods. Aghion and Howitt (1998, Chapter 8) provides a good discussion of EGT insights into growth and cycles.

The positive scale effects that are built into EGT models would have the effect of magnifying the growth impact of temporary fluctuations. A temporary increase in output, by raising scale, would increase productivity, generating a more sustained increase in output growth. This line of reasoning has been pursued in the related field of 'real business cycle' theory.

Fluctuations in growth are an implication of the vertical innovation models outlined above. The prospect of high research effort next period raises the likelihood that current research will be rendered obsolete, and reduces current research efforts.

A more significant and direct treatment of uneven growth comes from the modelling of the impact of 'general purpose technologies' (GPT). GPTs are innovations that have the potential to improve technologies in many sectors. Commonly cited examples of GPTs are computers, the steam engine, and electric dynamos. Because of the potential applicability to a wide range of firms, the appearance of GPTs raises the return to applied research (learning by doing) across the economy, at the same time as it renders many current methods obsolete. There can be a decline in growth while the system adapts to a new range of technologies. Cyclical downturns under this sort of model reflect a transition to a new, more productive, set of technologies.

2.5. Discussion

The range of issues to which EGT has been applied go well beyond what we have covered in the brief outlines above. Aghion and Howitt (1998) discuss applications to sustainable development, market structure, inequality, education, and trade. The introduction to their book is brimming with excitement and confidence about the potential for EGT to shed light on many important growth-related questions in economics.

The stories that EGT theorists tell are often intuitively appealing, and there is much anecdotal and empirical support for the existence of forces such as knowledge spillovers, returns to specialisation, and monopoly rents from new ideas. Whether or not these operate in exactly the way that they are portrayed in growth models, or with enough force to completely outweigh diminishing returns is less well established. It may be an obvious point, but it should be borne in mind that writing down a model to illustrate the operation or implications of a particular mechanism says nothing about whether the mechanism operates in the real world, or operates in the way that is modelled. Models are only as good as their assumptions, and there is a risk that a model's conclusions are little more than a rephrasing of some underlying assumptions. Models should be examined critically, especially when the underlying story is an appealing one.

The idea of endogenous growth so captures the imagination that growth theorists often just insert favourable assumptions in an unearned way; and then when they put in their thumb and pull out the very plum they have inserted, there is a tendency to think that something has been proved. Solow (1994, p. 53)

The true test of the theories comes when implications of the model are compared with observed patterns. Cautious reviews of the empirical findings in the literature can be found in Temple (2001) and Gemmell (1999), both of which also summarise the problems of drawing causal inferences from the existing studies. Chapter 12 of Aghion and Howitt (1998) discusses and rebuts some of the main macroeconomic evidence against EGT as an explanation of sustained growth.

Jones (1995) presents a generalised version of the Romer (1990) model, relaxing the strong assumption about the strength of spillovers in the research sector. By comparing key predictions of his model with observed patterns, he concludes that it is unlikely that research spillovers are strong enough to generate sustained growth in output. They do, however, lead to a higher level of output, even though diminishing returns eventually extinguish the long run growth impact of spillovers. Growth rates will, of course need to be higher to reach the new steady-state income level. This

transition, although temporary, may be prolonged. (In the theoretical model, growth rates get closer and closer to zero, but take forever to reach zero!) Jones (1998)[8] provides a more detailed discussion of growth with or without scale effects.

Identifying and analysing the mechanisms by which technological change occurs is a key contribution of the EGT literature, and arguments over whether growth effects are permanent or last only decades may be of less relevance. Temple (1999, p. 152) sums up the issues as follows:

Either growth is endogenous, or it is exogenous and level effects are large. Given the presence of large level effects, distinguishing between exogenous and endogenous growth models is not as pressing as it might seem. The important point is that policy can have a major impact on a country's level of welfare. As pointed out earlier, the debate on whether policy affects the long run growth rate or just the steady state level of income is almost impossible to resolve, and not much of practical importance will turn on it.

Aghion and Howitt (1998) discuss the implications of particular EGT models for a range of policy issues, including the design of institutions and policies - regulation, subsidies and intellectual property rights. I am not familiar enough with all of the relevant literatures to judge which policy implications are particular to the specific assumptions and models that are used, and which are general insights. It seems that many apparently strong results are subsequently weakened or even reversed as a result of relatively small changes in assumptions or model specification. I am sure that the ongoing debate can shed light on policy choices in many areas. Distilling the insights in any particular policy area would, however, require a careful examination of the relevant literature, which is beyond the scope of the current paper.

When applying the insights of EGT to policy issues in New Zealand, we should not ignore the fact that New Zealand is a small open economy. Most of the discussion so far has abstracted from national boundaries, and has said nothing about implications for international differences.

Chapter 11 of Aghion and Howitt (1998) discusses the implications of combining EGT with trade theory for international flows of final goods, intermediate inputs and ideas. The analysis raises questions about the presumption in favour of free trade. Arguments can be made for industry and trade policies to encourage specialisation in sectors where there are spillovers.

Free flows of intermediate goods, or of research designs, also raise the possibilities of imitation, and of differences across countries in the relative importance of fundamental as opposed to secondary (learning by doing) innovation. Some models, such as those presented by Gene Grossman and Helpman (1991, Chs 11&12) assume that developed countries ("the north") have an advantage in fundamental research and that for less developed countries ("the south"), growth is achieved by developing secondary innovations and imitating innovations from the North.

It seems plausible in a general model of learning by doing that the scope for secondary innovation within any particular country depends on the global amount of

[8] A version of this paper was published as Jones (1999)

fundamental research. This opens the possibility of small open economies such as New Zealand relying on international fundamental, and possibly even secondary, research efforts at least in some sectors. With smaller scale, scale and spillover effects may be harder to achieve, and we would need to weigh up the costs of devoting resources to less productive research against the costs of being slightly behind the 'cutting edge'.

Overall, the impact of EGT has been great - in increasing attention on the determinants and dynamics of discovery; in introducing new modelling approaches, and in providing a richer understanding of growth issues than is available from the earlier neoclassical literature. It has forced researchers to think rigorously about what is required to generate sustained growth, and to formalise a wide range of appealing potential explanations of growth and innovation. I am sure that EGT researchers would acknowledge that their job is not finished. Aghion and Howitt (1998, pp 65-67) catalogue several of the major shortcomings and limitations of EGT. These include the ability to fully account for: long term structural shifts; heterogeneous knowledge; learning and experimentation; institutions and transactions costs; and the political economy of innovation. Most of the subsequent discussions in their book present what they variously refer to as "first efforts" or "preliminary attempts" to fill these gaps. Only history will tell whether or at what point the growth of endogenous growth theory will succumb to diminishing returns.

Key points

I will close with a list of the key insights about the contribution of EGT that I have tried to convey in the paper.

- Factor accumulation and innovation both matter for growth.
- Diminishing returns can extinguish growth.
- Models are only as good as their assumptions.
- All growth models assume that *something* can grow without bound.
- Ideas and knowledge are obvious candidates for sources of spillovers and scale effects (due to non-rivalry and partial excludability).
- EGT is important because of modelling methods as well as because of specific growth insights.
- Modelling a mechanism doesn't make it true.
    - It may or may not occur.
    - It may or may not be as strong as in the model.
- Level effects may be good enough.

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3. Entrepreneurship, Institutions and Economic Growth: Author: Frederic Sautet (Mercatus Centre, George Mason University)

The recognition of the insuperable limits to his knowledge ought indeed to teach the student of society a lesson of humility which should guard him against becoming an accomplice in men's fatal striving to control society – a striving which makes him not only a tyrant over his fellows, but which may well make him the destroyer of a civilization which no brain has designed but which has grown from the free efforts of millions of individuals.

F. A. Hayek

Little else is requisite to carry a state to the highest degree of opulence from the lowest barbarism, but peace, easy taxes, and a tolerable administration of justice; all the rest being brought about by the natural course of things.

Adam Smith

3.1. Introduction

Austrian economists understand economics as a multidisciplinary research programme, which sees the economic problem as a problem of coordination of individuals' plans under radical uncertainty. In this context, institutions, culture, anthropology, law, history and political economy are fundamental to understanding the nature of the social order.

This paper provides a brief view of growth and social change taken from the perspective of the entrepreneurial process and Austrian economics in order to establish the following chain of argument:

- Economic performance (i.e. growth) depends on capital accumulation.
- Capital accumulation is the result of entrepreneurial profit discoveries.
- Entrepreneurship is a function of the institutional makeup of a society.
- Institutions (or rules) will foster entrepreneurship if their effects on (a) the noticeability and (b) the exploitability of profit opportunities are limited over time.

In order to limit the effects on the noticeability and exploitability of profit opportunities, institutions must constrain the government in its possibility to renege on its commitments.

3.2. A bit of Crusoe economics…

Economics was born out of the recognition that individuals use scarce means in order to achieve ends that are most of the time mutually exclusive. Thus the very

fact of the relative scarcity of means and the impossibility to achieve all ends simultaneously both at the individual level (e.g. I cannot be in Paris and Wellington at the same time) and at the collective level (e.g. we cannot all live in the same house) implies that there will be a limited number of ends that we can achieve in our lives.

Growth has to do with being able to gradually reduce the relative scarcity of means in order to achieve more ends. An illustration using "Crusoe economics" will help understand this claim.

As in the story, assume that Crusoe is alone on his island. His goal is to capture fish in order to eat. At this stage he only has his bare hands to go fishing and thus it may take hours before he can catch any fish. If he could use something to help him catch a fish, he could improve his chances. Assume that he finds some thin vines in the forest and decides to make a net. A net will improve his chances of catching fish for a given unit of time. The net is what allows Crusoe to reduce the scarcity of means in order to achieve the end of fishing (and eating).

Capital goods can reduce the relative scarcity of means to allow us to achieve more ends and thus satisfy more needs while sacrificing fewer alternatives in the process.

By using a net, Crusoe improves his chances of catching more fish per unit of time and thus he will have more time to spend pursuing other alternatives.[9]

It is because Crusoe is able to use better means that he sacrifices fewer alternatives to achieve his ends. The means that are used in order to achieve ends are called "capital goods". The process of using better means to gradually reduce relative scarcity is called "capital accumulation".[10]

Capital goods are akin to a time machine, they are "stored-up" labour, land and time. By storing up labour, land and time, they get us closer to the achievement of the end sought after. They are intermediate way stations on the road to the attainment of one's own end and the consumer's goods into which they are transformed (e.g the net is turned into fish over time). Capital goods allow us to free up resources (e.g time) to achieve more ends than we would have done otherwise.

What separates rich countries, nations, regions and communities from poor ones is the level, structure and quality of capital accumulated which transports individuals in time. Poor countries are poor in terms of capital accumulation. The basic question to understand growth is thus: what makes the process of capital accumulation possible?

3.3. Subjectivism and capital goods

Attempting to provide a response to the above question involves knowing the principles that underlie the economic approach. One of the principles that the Austrian approach holds is methodological subjectivism. This refers to the idea that individuals perceive and experience reality and that one cannot objectively know (i.e.

[9] Just as means change over time, ends will change too. New alternatives are discovered as former ends are being satisfied.

[10] This term may be misleading, as it may convey the idea that what matters is, strictly speaking, "accumulating" capital when the issue is the type and structure of capital.

as an external observer) this inner experience. Utility, for instance, is a subjective phenomenon and there is no objective measure of utility that one could establish.[11] The objectivity of economic theory lies in the recognition of the subjective dimension of human action.

A first implication of methodological subjectivism is that capital goods are heterogeneous. The use of aggregates such as "capital", "output", etc overlooks the issue of subjective value and perceptions. What matters to the economist is the perspective of the acting individual who values capital goods.

Capital accumulation is therefore accumulation of capital goods that are useful to individuals in the circumstances in which they are placed and with respect to the ends they want to achieve. In the Austrian approach, capital accumulation does not refer to some aggregate notion of capital. Every capital good is thus specific to the end that an individual wants to pursue in the circumstances in which he finds himself. If circumstances change and an individual realises that he can use his capital goods to pursue other ends, then he will reallocate his portfolio of assets to these new specific ends.

A second implication of methodological subjectivism is that there are no "natural resources". Methodological subjectivism implies that any resource is a resource because it is valued as such by the human mind. It is only with regard to ends that individuals want to pursue that means will come to be valued. In other words, by valuing means with respect to the ends that they can help achieve, the human mind introduces information in the natural world. Thus so-called natural resources are resources in so far as they have been recognised and valued by the human mind as potential means. They are not resources by virtue of some intrinsic property they might have. This stands in contrast to some popular explanations of economic growth, which consider natural resources as a given.

3.4. Crusoe, capital accumulation and entrepreneurship

There are thus two issues that are necessary for capital accumulation to take place:

(a) One must save in order to accumulate;

(b) Capital accumulation is not an automatic process.

With regard to (a). To make a net Crusoe needs his labour, time, thin vines, etc. Crusoe has to set aside these resources in order to make a capital good that will be helpful to achieve his end (eating fish) in a better way. Instead, he could have spent his time catching fish with his bare hands or resting on the beach. In other words, accumulation is possible only if the means used to achieve ends are not consumed immediately but are set aside for greater consumption later.

With regard to (b), the decision to save resources in order to make a capital good is not an automatic process for Crusoe. It involves two steps:

[11] The full realisation of this principle led Lionel Robbins in the 1920s to reaffirm that utility was subjective and could neither be objectively measured nor compared among individuals.

- The discovery and recognition that another way of doing things is possible. This is the "eureka": Crusoe realises that vines can be used to make a net. This step involves sheer human creativity and ingenuity;

- Associated with the first step is the judgment that Crusoe must make between pursuing this new possibility and doing what he already knows (e.g using his bare hands). Crusoe will only set aside resources to make a net if he believes that it will help him achieve his end in a better way. Thus in the investment into making a capital good is a judgement of relative success with regard to the alternatives (i.e. a sufficient return on investment). This success is not guaranteed a priori: it is a judgement about the future.

The discovery and the judgement of future conditions are what constitute the *entrepreneurial function* in human action. In a monetary economy, the phenomena of discovery and judgement are guided by the existence of pure profit (see below).

The issues of savings and capital accumulation have been explored in neoclassical economics for a long time. However entrepreneurship has been largely ignored because neoclassical economics does not allow for the phenomenon of discovery. The contention of the entrepreneurial approach is that at the most essential level, neoclassical economics is not in a position to explain the phenomenon of growth.

Neoclassical economics operates in a "closed universe". In this paradigm, genuine novelty (and therefore change) is excluded. This has been recognised by some neoclassical economists such as Kenneth Arrow: "Subtle observation is not needed to see that we have had great changes in our technological knowledge. The need for economic analysis is to explain steady or even accelerating rates of growth in advanced economies. Neoclassical economics without increased knowledge should lead to diminishing rates of growth, even apart from Malthusian considerations and exhaustible resources. While dissemination of existing information can certainly account for some gains in productivity, it is clearly necessary for sustained growth to have information new to the entire system, not merely learned from others. Where does this new knowledge come from?" (Arrow 1994: 7)

What has neoclassical economics resorted to in order to explain new knowledge? Neoclassical economics has only posited growth in order to explain growth. This is true of the work of Solow (1956), which posits the unknown factor, and this is also true of endogenous growth theories where one resorts to externalities and increasing returns.

Crusoe economics is rich in explanations to understand human action. It shows that:

a) In order to improve his lot, Crusoe must produce capital goods.

b) These capital goods are the result of discoveries and judgments about the future: this is the entrepreneurial function.

c) Judgements about the future imply uncertainty (e.g the vines may not resist to water as much as he hoped).

d) Crusoe's time preference will be revealed by his decision to save resources in order to build the net (i.e. the forgone consumption of leisure must be compensated by more consumption in the future than would have otherwise taken place): advancing the means of production is the capitalist function.

e) In the absence of an objective measure of utility, it is difficult for an external observer to measure the growth that may result from the use of the net, as one must assume an objective measuring rod: catching fish or time at the beach.

3.5. Entrepreneurship and the market process view in a nutshell

First of all, the market process view recognizes that not all states of the future can be known (even probabilistically speaking) and that action takes place within the radical uncertainty of the future. This means that the present state of the world does not determine its future. A corollary of this proposition is that genuine change exists.

An open-ended world means that equilibrium can never be achieved as there are always unnoticed opportunities for profit. From this perspective, the economic problem is a problem of coordination of individual plans. Thus what matters to understand the market system is what lies outside a situation of (hypothetical) equilibrium where all the plans mesh (Kirzner 1973).

The entrepreneurial function is this human capacity of imagining what the future may be like by discovering opportunities for profit. In a world in disequilibrium, price discrepancies overlooked by other participants exist and arbitrages are possible. Most price discrepancies are inter-temporal, that is, if discovered they lead to arbitrages over time. In inter-temporal arbitrages, an entrepreneur discovers a profit opportunity based on the fact that current prices of inputs are, seen from the future state of the market, too low. Pure profit represents the difference between the price at which the output will be sold in the future and the current inputs prices taking into account the opportunity cost of capital.

The market is in a constant state of flux and the future is radically uncertain. Therefore, there is no profit that is certain; every entrepreneurial discovery is speculative until the profits are realized. However, entrepreneurial discoveries occur because entrepreneurs are guided by the existence of pure profits. Profits act as a compass that guides entrepreneurial activity towards the most desired outcomes. Profits act as a lure that awakens entrepreneurial senses.

The nature of knowledge is important to the context in which discoveries take place. Knowledge can be explicit or tacit and will depend on the local circumstances of time and place (Hayek 1948). While knowledge plays an important role, there is nothing deterministic about entrepreneurial discovery, which is why they are discoveries. Entrepreneurs are alert to profit opportunities but do not necessarily discover them (Kirzner 1973).

One doesn't invest in entrepreneurship, as it is not a resource that is deployed to achieve some ends. By their very nature, discoveries are costless; there is no resource that is given up in the act of discovery.

Austrian economics stipulates that the true human dimension in human action is the possibility of creation. Ultimately, entrepreneurship is about the introduction of radical novelty in the universe. It is the possibility for human beings to be, as Thomas Aquinas explained in the Summa, second causes.

Schumpeter's distinction between invention and innovation (Schumpeter, 1947) is important as it shows the role of profit in signalling which inventions are desired by others from those that aren't. Profit guides entrepreneurs towards what is desired by others.

In an open-ended world, monopoly pricing loses its relevance, as the structure of the market does not matter. What is important is entrepreneurial pure profit, which is transient. Also the issues around the optimality of investment and externalities are not seen as economic problems (in the usual sense of the term) but rather as institutional ones (e.g the definition of property rights).

3.6. Shumpeterian creative destruction

In recent years, neo-Schumpeterian theories have become more recognised because of the theory of creative destruction. However, Schumpeter was not the first one to talk about entrepreneurship and technical change. The reason why his theories have had a lot of appeal for many neoclassical economists is because he has tried to reconcile two different approaches. While Schumpeter was educated in Austria and studied under Böhm-Bawerk, he was influenced by Walrasian general equilibrium theory. His understanding of the entrepreneurial role comes not from the recognition of radical uncertainty but from the incompatibility of equilibrium theory with change.

Schumpeter (1939, 1942) starts his inquiry into the nature of economic change with a general equilibrium characterised by an absence of profit and loss and a zero interest rate. In the Walrasian equilibrium, consumers' tastes, technology and resources are given. These are the parameters of the equilibrium, i.e. this is a closed universe. Schumpeter examined each of these in turn.

As Schumpeter assumed that there is no time preference, he cannot assume that economic change would come from a change in the saving rate that would free up resources for production. Similarly, a change in other preferences is unlikely because consumers are passive individuals who merely react to prices and quantities. Resources cannot be the source of change, as land and labour cannot change (or only slowly over long periods of time). Schumpeter endorses this Walrasian assumption. Thus the only possible source of change was technology and this is associated, in Schumpeter's system, with the role of the entrepreneur.

Thus Schumpeter saw the entrepreneur as a "destroyer" of the existing equilibrium; a disruptive force that introduces new technology into the system. In Schumpeter's view, the entrepreneur destroys a state of equilibrium to replace it with another one.

While appealing because it tries to deal with novelty and entrepreneurship, there are many problems with Schumpeter's theory. First of all, Schumpeter neglects to give a rationale for entrepreneurial behaviour. In the absence of profit, it is difficult to see why the entrepreneurial function would take place in a world in equilibrium. This is

the profound difficulty of neoclassical economics that in order to have genuine change, one needs the possibility of pure profit and disequilibrium, which is by assumption ruled out.

Secondly, in Schumpeter's equilibrium model there is no time preference, thus there can be no saving to finance entrepreneurial activity either. This is why Schumpeter saw the role of banks not as financial intermediaries but as credit creators. Moreover, the disruption that entrepreneurs create comes with changes in prices and thus profit and losses may appear. In order to obtain a return to equilibrium, Schumpeter must postulate a type of entrepreneurial activity where the profits realised by the new industry are counter-balanced by the losses made by the old industry. Eventually, the innovative period comes to an end and the economy settles down in a new equilibrium with a higher price level as the result of the inflationary bank credit. In fact, by describing a theory of innovation, Schumpeter described a theory of cycles. This is why entrepreneurial activity only occurs at certain moments and not all the time, as in the market process view where entrepreneurs constantly strive to capture profit opportunities.

While Schumpeter was correct in associating change with the entrepreneurial function, he only focussed on technological change. The real issue is entrepreneurial activity as such (i.e. the discovery of pure profit opportunities); not so much technological change, for the latter is a consequence of the former. Entrepreneurship can be seen as a much broader phenomenon, that of discovering the new means-ends framework under which individuals will operate. This encompasses, for instance, the discovery of deeper preferences that were genuinely unknown to individuals and this does not necessarily relate to technological change. Schumpeter's view is a construct that tries to account for the existence of economic change, inflation and cycles, taking general equilibrium as a point of departure and arrival. It is a dynamic approach to break out of the Walrasian box, not a truly dynamic approach of the market. [12]

3.7. Entrepreneurship and the nature of incentives

Schumpeter's contribution makes one important point, which is to realise that a general theory of the market is also an explanation of the growth process (i.e. of social change). In other words, growth is not an issue in itself (i.e. separated from the rest of market theory). In fact, market process theorists would argue that if one understands market processes, then one also understands growth processes, as the two are inseparable. There is no such thing as "growth economics" separated from

[12] It is probably fair to say that Schumpeter has opened the road to evolutionary economics and other approaches that try to analyse the dynamic aspect of the market system. However, as Rothbard puts it: "To admire Schumpeter, as many economists have done, for his alleged realistic insight into economic history in seeing technological innovation as the source of development and the business cycle is to miss the point entirely. For this conclusion is not an empirical insight on Schumpeter's part; it is logically the only way that he can escape from the Walrasian (or neo-Walrasian) box of his own making; it is the only way for any economic change to take place in his system" (1987: 233).7 In that sense, pure profit is not "necessary" to the existence of the good sold, as it is not imputable to any factor of production used in the production process. That is why it cannot fit in the neoclassical equilibrium framework.

the rest of economic theory; there is only a general theory of markets and empirical differences in the institutional and cultural contexts.

While I gave a brief explanation of what entrepreneurship is about in the Austrian view, I have not provided a response to the above question: what makes capital accumulation possible?

From the above discussion on market processes, one can deduce that Austrian economics sees the entrepreneurial function in human action as the key engine to change and thus growth. Austrian economics understands the entrepreneurial function not as confined within some individuals who start companies, but as a propensity that any individual can display at any moment. The basic question is to understand why while the entrepreneurial function is supposed to be a universal trait of human nature it does not seem to lead to the same results across all places in the world.

Understanding the incentives to entrepreneurship provides an essential clue to the question. Kirzner (1985) makes the distinction between “already perceived alternatives” and “unnoticed opportunities”. In other words, if discovery exists, then there must be a period before the discovery has been made, that is, a period where the opportunity is truly unnoticed and where it is not part of the choice set of the individual.

In the traditional approach, incentives refer to already perceived alternatives, that is, alternatives that are part of the individual’s choice set. What matters to market process theory is to understand the nature of the incentives that will encourage the entrepreneur to notice what was previously overlooked. This type of incentive takes place in an open universe where undiscovered potential courses of action exist. Thus, it does not refer to the inducement to undertake a course of action that has already been perceived but to the inducement to discover a certain course of action.

As we saw above, pure entrepreneurial profit is what is left once all the costs (including interest) to a course of action have been taken into account. Profit is the compass that directs entrepreneurial alertness. The lure for profit is the basic incentive that makes entrepreneurial discoveries possible.

Thus if one could remove pure entrepreneurial profits from the economy, the incentives to provide the goods that already exist would not be changed. However, it would affect the incentive related to the discovery of hitherto unknown courses of action. Pure profit provides an incentive only in the second sense of the term discussed above: it affects the noticeability of undiscovered courses of action.

3.8. Institutions and the generation of knowledge

The primary condition for entrepreneurial discovery is the existence of pure profit. Moreover, what also matters to the existence of entrepreneurship is the possibility to exploit discovered opportunities for profit.

Discovery and exploitation are two sides of the same entrepreneurial coin. If entrepreneurship is the ultimate cause of social change, this means that the issue of growth is basically an institutional problem: the problem of identifying the necessary

institutional conditions for entrepreneurship to take place. In other words, entrepreneurship is a function of the institutional makeup of a society.

One of the main aspects of the competitive market process is its "decentralised" nature. Precisely because information is dispersed, the decentralised aspect of competition allows each individual not only to apply his/her own explicit knowledge to the recognition of the new data in the market, but also his/her own tacit knowledge. Through this process, knowledge that is tacit is used in ways that could not have been effected under a different institutional arrangement since none of this knowledge could have been organised and centralised. Paradoxically, the economic problem finds its root in the decentralised nature of knowledge (i.e. radical ignorance is due to the dispersion of knowledge) but it is also through the decentralised nature of knowledge that it finds its solution (i.e. the entrepreneurial competitive process). *The market system, through the entrepreneurial competitive process, is able to create and disperse knowledge that could not be organised by a single mind.*

This leads us to one of the core issues of market process theory: the influence of institutions on the generation and dispersion of knowledge. The idea is that different patterns of institutions will produce different patterns of knowledge because they will affect the incentives for entrepreneurial discovery in different ways. That is why the differences among institutions are so important. What the theory of entrepreneurial competition teaches us is that the decentralised structure of the market produces knowledge that would be impossible to produce in a different institutional environment. It is not only that the market system marshals knowledge in a more efficient way than any form of government planning; it is essentially that the knowledge produced in the market system would simply not exist under central planning. The entrepreneurial process of competition will tend to solve the Hayekian knowledge problem (i.e. the idea that the knowledge necessary to make individuals' plans dovetail is not possessed by anyone) because it creates knowledge that would not be available otherwise (Hayek 1948).

This claim is valid at the systemic level, e.g the market system versus central planning; but is also valid at more micro levels, where specific institutions, such as the structure of multidivisional firms, can be shown to produce knowledge that would not exist in their absence. Market process theorists thus argue that the superiority of the market system resides in its capacity to produce knowledge that would not be available under different institutions. The versatility of the market system allows individuals to use their explicit and implicit knowledge to turn discovered information into useful knowledge.

One issue that is often raised is the "cornerstone hypothesis", that is, the idea that some cultures can be a barrier to the adoption of institutions that foster entrepreneurship and economic change (see Harper 2003 for an analysis of the concept). Culture is often part of that "thick" description of the world that anthropologists and historians like to gather but that most economists reject in favour of "thin" descriptions that can be treated statistically. The legitimacy of a particular institutional makeup is likely to be related to the culture of a people. Whether institutional changes stick or not will depend, among other things, on culture (Boettke 2001a).

However, culture is only part of the story, as Rabushka (1987) and Olson (1996) have argued. If culture was always primordial in the adoption of institutions, one wouldn't have seen the cases of the two Germanys (East and West) and the three Chinas (Mainland China, Hong-Kong and Taiwan). In these cases, peoples with strong similar cultural heritage have adopted different institutional fabrics. Thus while culture is vital to understanding the context in which entrepreneurship occurs, it is not the only cause for adopting institutions.

3.9. Public Choice and Institutional Design

Before addressing the issue of policy, two important issues need to be mentioned. The first one is what Barry Weingast (1995) calls the paradox of government. The second one is the limits of democracy.

The paradox of government is the idea that a government strong enough to establish limits to its powers is usually strong enough to break those very bonds. The basic problem is one of *ex ante* commitment and *ex post* predation. In other words the constitutional constraint that a people must establish is one that will tie the ruler's hands; i.e institutions, which stop the state from reneging on its promises.

As I argued above, in order for entrepreneurship to take place, entrepreneurs must be able to exploit discovered opportunities. If an entrepreneur decides to participate in the economy, once she has entered, the government can benefit from confiscating her profits. Therefore unless the ruler's hands are tied, a non-desirable social outcome will follow: that where entrepreneurs do not enter the market. The temporal dimension of institutions is essential to the success of policy because the most important part of entrepreneurship for economic performance takes place in time. The simple decision tree derived from Boettke (2001b) shows that commitment is most fundamental to entrepreneurial activity (see appendix). Because modern production processes happen through time, unless the institutional structure limits *ex post* expropriation, no entrepreneurship and long-term investments will occur.

This brings us to my second point on the limits of democracy. The market system and entrepreneurial competition can bring huge transitory profits to some actors in the economy and this raises the incentives for public expropriation. The question is whether majoritarian Parliamentary systems are capable of keeping the commitment that governments must make in order to create the institutional strata for entrepreneurship to flourish. Public choice economics argues that there are strong reasons to think that this is not the case because: (a) politicians and bureaucrats do not have the public interest at heart but their own self interest; (b) voters are rationally ignorant; (c) bureaucracies waste resources and finally (d) representative democracy will tend to favour rent seeking by some organised groups at the expense of the rest of the population (the "dispersed costs, concentrated benefits" story).

Bounded rationality and self-interest with guile apply to policy makers as well. Even more so, radical uncertainty is also a fact of reality that governments have to live with. Politicians and policy makers are ignorant of many of the consequences of their own actions in government. Policy failure, that is the existence of a conflict between actual and intended outcome, is a clear possibility. As policy failures create the need for more intervention, the mixed economy becomes a "self-ordering and self-sustaining process embodying a powerful internal dynamic that tends to cycle the

system between relatively free markets, on the one hand, and collectivist central planning and inevitable crisis on the other" (Ikeda 1997: 28). This is the slippery slope problem (Rizzo and Whitman 2003). The issue is one of comparative institutional analysis: which institutions will (a) provide the environment for entrepreneurship and capital accumulation to take place and (b) protect the citizenry against itself (because it is ignorant of both what politicians want to do and of the impact of policies) and against the government (i.e. the slippery slope problem). Weingast (1995) has argued that the best constitutional framework for economic development and performance is what he termed "market-preserving federalism".

3.10. Policy implications

While understanding why some rules are adopted and others are not is essential, it is not the focus of this last section. Here I would like to focus on the above proposition that "entrepreneurship is a function of the institutional makeup of a society".

As we saw above, the fundamental incentives for capital accumulation are twofold:

- Incentives that affect the noticeability of undiscovered courses of action.
- Incentives that affect the exploitability of discovered profit opportunities.

The first type of incentives relate to the rules that affect pure profit. These rules relate primarily to taxation but also to other forms of regulation that may reduce pure profit: regulation of competition that affect the freedom of contract, regulation of trade, industrial policy, regulation of labour, inflation, etc.

The second type of incentives relates to the commitment that governments must make with regard to the consistency of their policies. This means that constitutional constraints should extend into the policy domain:

- Fiscal constitution: to limit taxation and balance the budget.
- Regulatory constitution: to limit industry regulation (including competition law) and to require compensation for regulatory takings.
- Monetary constitution: to have and maintain an independent monetary policy (or a currency board or even free banking).
- Trade constitution: to have and maintain free trade with all countries.

Because it reduces the noticeability and exploitability of profit opportunities, "interventionism both increases the level of discoordination within the system and makes it more difficult to eliminate this discoordination" (Ikeda 1997). What matters is the speed and responsiveness of the market to discoordination situations: the market is an error-correcting mechanism where entrepreneurs tend to spot overlooked opportunities.

The institutions that foster entrepreneurial incentives are those of a free market system traditionally understood based on the rule of law. These institutions are subsumed under the laws of property, contract and tort in traditional English

Common Law (i.e. abstract and general rules), to which one should add the idea of monetary responsibility.[13]

3.11. Conclusions

As I stated in the introduction, I have tried to establish in the paper the following chain of argument:

- Economic performance (i.e. growth) depends on capital accumulation;
- Capital accumulation is the result of entrepreneurial profit discoveries;
- Entrepreneurship is a function of the institutional makeup of a society;
- Institutions (or rules) will foster entrepreneurship if their effects on (a) the noticeability and (b) the exploitability of profit opportunities are small over time;
- In order to limit the effects on the noticeability and exploitability of profit opportunities, institutions must constrain the government in its possibility to renege on its commitments.

In his 1974 Nobel Lecture (Hayek 1989), Hayek warned us against the "scientistic error". This is the view that economists should imitate as closely as possible the procedures that we learn in the physical sciences. Knowledge of physics has helped us develop the practice of engineering and the design of complex machines. The fallacy is the idea that the same should be done with economics: it should inspire the engineering of society.

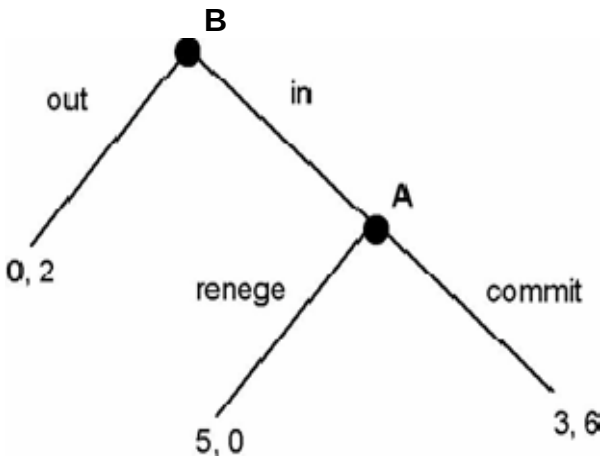
What the entrepreneurial understanding of the economic system teaches is that we cannot engineer growth. Growth is the result of a spontaneous order that cannot be designed. The true use of reason resides in *understanding that much more than what* we can comprehend makes the social order possible. The reliance on general and abstract rules (in the establishment of social orders) is not an abandonment of reason, but rather an essential insight into its limited powers (Hayek 1973). What we can try to do, in spite of the conflicting goals that individuals may have (e.g have the cake and eat it too) is to influence the adoption of an institutional framework that enhances entrepreneurship and capital accumulation (i.e. the competitive process).

[13] Population is also potentially a key to higher economic performance. This relates to the idea that the denser the population, the more opportunities for profit will be available that will deepen the division of labour and increase capital accumulation. As Olson (1996) argues, one can observe that large migration in the past did not depress the wages of natives: "[I]f it is diminishing returns to land and other resources that mainly explain international differences in per capita incomes then large migration from poorer to richer societies will, if other things (like the stock of capital) remain equal, necessarily reduce income differentials" (1996: 10). This is not what we observe. In fact, continues Olson, one observes that "[m]any of the most densely settled countries have high per capita incomes, and many poor countries are sparsely settled" (1996: 12). While one may expect diminishing returns to labour with a growing population, this seems to be a short run phenomenon. Under comparable institutions (and this is an important caveat), the benefits from a growing population (external economies, deeper division of labour and more entrepreneurship) swamp the diminishing returns to labour: "labour is on average more highly paid where it is combined with less land" (1996: 13).

3.12. Appendix

Decision tree with two players: the government A and an entrepreneur B, and two periods. The issue is for the entrepreneur to participate in legal market activity or do something else (such as undeclared work). If the entrepreneur chooses not to participate he only makes 2 and the government makes 0. While if he chooses to participate, his income will depend on the behaviour of the government. If the government commits, then the government will receive 3 and the entrepreneur will make 6. If the government reneges on its promise to commit then the entrepreneur receives nothing and the government gets 5.

The incentives for the government are to renege in the second period, while the incentives for the entrepreneur are not to participate if he anticipates that the government will renege. Post-contract opportunism on the part of the government is what destroys entrepreneurial behaviour and reduces total wealth (5 instead of 9). The rules of the game must provide the right incentives for entrepreneurs to enter the market, discover opportunities for profit and exploit them. Solving the *ex ante* and *ex post* commitment problem is necessary to the flourishing of entrepreneurship.



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4. An Evolutionary View of Technology Driven Long-run Growth:
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4.1. Introduction: Technology as Revolution[14]

We live in a world of rapid economic and social change. Any one change typically causes others, which in turn cause others, and so on in a concatenation of linked causes and effects. For example, the invention of the dynamo in 1887 allowed for the practical generation of electricity. The use of electricity allowed a separate power source to be attached to each factory machine (rather than being driven by a central power source through a system of shafts and belts as in the steam-powered factory). The "unit drive" electric motor allowed the machines in the factory to be rearranged to coincide with the flow of production through the factory. This arrangement allowed Henry Ford to mechanise production with a moving assembly line. In Ford's hands, the assembly line, together with standardized parts (themselves the result of another key invention in the machine tool industry), enabled mass-produced and affordable automobiles. The Model T and its successors transformed America (and later Europe) in myriad ways. It allowed people to move about more quickly and more cheaply. It provided high paying work to many immigrants who could not easily converse in English. It enabled the suburb, the shopping centre, the domestic tourist industry, and the motel. It altered sexual norms (as dating couples were freed from the supervision of parents and chaperones) — to mention only a few of its far-reaching effects.

We argue that such change is best understood as an evolutionary, historical process driven by endogenous innovative activity. Indeed, the evolution of technology drives much of the economic, social, and political change that we experience. Consequently, in our research we pay much more attention to technology than is usual in the writings of most growth theorists who most often focus on economic growth (usually measured by increases in Gross Domestic Product, GDP) rather than economic change. This is understandable since growth in GDP is relatively easy to measure and its cumulative effects are dramatic. However, a full understanding of the *causes* and *consequences* of long-run economic growth requires an appreciation of the qualitative changes induced by technological innovations—a point stressed by Joseph Schumpeter many years ago (Schumpeter (1934 and 1943)). People living at the beginning of the 21st century have measured real consumption that is over ten times as much as the consumption of those living at the beginning of the 20th century.

[14] The material presented in this paper is cursory summarization of a larger body of research presented in Lipsey, R.G., K.I. Carlaw and C.T. Bekar (2005) *Economic Transformations: General Purpose Technologies and Long-Term Economic Growth*.

But this measurement does not capture that fact that they consume completely *new commodities* made with *new techniques*. Technological advance not only increases our incomes; it transforms our lives through the invention of new hitherto undreamed of products that are made in new hitherto undreamed of ways.

Humans are technological animals. Through many millions of years of biological evolution, technology has been fundamental in making us the physical beings that we are today. Through many thousands of years of economic and social evolution, our adaptations to the technologies that we have created have helped to mould and re-mould our economic, social and political institutions and our behavioural patterns.

Homo sapiens share the use of tools with a dozen or so other animals that routinely make use of one or more simple tools. What distinguishes us from all others, however, is our routine use of a wide range of tools and our ability to invent new tools consciously and persistently in the face of environmental challenges and also driven by our own latent curiosity.

New technologies largely result from activities of profit motivated agents making technological change significantly endogenous to the economic system. Furthermore, scientific and technological knowledge is cumulative. Today's knowledge could not have been discovered or invented in the absence of many earlier discoveries and inventions. Thus, growth and technological change is an historical process in which there is a clear arrow of time. Outcomes are not reversible: introducing a shock and then removing it will not return the economy to its original, pre-shock position because the reaction to the shock will typically lead to the accumulation of new knowledge that will affect future outcomes. Since agents' behaviour and choice sets are path dependent, technological change is replete with multiple outcomes, lock-ins, and possible "butterfly effects." To understand where the system is today, we need to know where it has been in the past. In the study of innovation and economic growth, we need explanations that contain an arrow of time, explanations in which past history does exert an influence on the present—*explanations and theories in which history matters*.

4.2. Technology Driven Evolutionary Growth

Evolutionary approaches to understanding technology driven economic growth date back at least to Nelson and Winter's (1982) *Evolutionary Theory of Technological Change*. Their work represented a fundamental departure in approaches to understanding growth. Explanations of economic growth split roughly along the lines of those in the Neoclassical tradition and those in what we call the Structuralist-Evolutionary view. There are several key assumptions on which the two views differ that lead to critically different predictions.

4.3. Neoclassical versus Evolutionary Approaches

In this section, we compare and contrast the specific elements of what we call the canonical versions of the two theories. These are generalisations of the main elements (tastes, technology and technological change, information and motivation of agents, equilibrium, competition, structure and the role of the market) of the two bodies of theory. "Neoclassical" is our collective term for the well-known body of theory based on rational maximizing agents operating under a well-defined

exogenous scarcity constraint with fixed technology and tastes. It has been an extraordinarily successful theory. When dealing with the microeconomic issues surrounding innovation and long run technological change, however, the canonical general equilibrium version of neoclassical economics is largely silent. "Structuralist-Evolutionary" (S-E) is our collective term for the body of theories developed explicitly to analyse long term growth using dynamic evolutionary concepts. Instead of focusing on models of stationary equilibrium states, these theories have sought to model the dynamic processes by which actual technologies evolve under the impact of successive innovations.

Tastes

The treatment of tastes is one of the few places where the neoclassical and S-E views are similar. Few economists in either camp have tried to model explicitly the formation of tastes.[15] It seems, however, that if one is to understand long term growth, one must accept a substantial endogeneity of tastes—an endogeneity that probably also exists over shorter periods of time but is ignored in the interests of obtaining tractable models. Consumers buy many goods that did not exist in the past and it seems to us unreasonable to assume that they have tastes defined over the unknown (although some economists insist that they do). For example, could a medieval peasant in 800 have had tastes defined over the range of electronic devices and communications technologies (e.g., ipods, iphones, email, the Internet, etc.) available to consumers in 2007?

Technology and technological change

Neoclassical growth theories employ the concept of a "black box" aggregate production function, which implies that the process and the structure of technological change are observable only by their results. For example, given quantities of all inputs may be associated with larger quantities of output. Conceptually, this phenomenon is observed by measuring the amount of the change in output that cannot be statistically associated with a change in the inputs. The remaining change is referred to as the Solow residual, or total factor productivity (TFP) growth.[16]

In S–E theories, technology is observed through its embodiment in such things as physical and human capital, infrastructure, the legal system, social norms and practices, etc. Technology has a hierarchical structure of engineering complementarities and technological change is modelled explicitly as evolving endogenously. Also, because S-E theories attempt to incorporate many of the awkward facts surrounding the microeconomics of innovation, they often treat the economic, social and political structure of an economy explicitly. Institutions are seen as co-evolving with technology. The firm is seen as inhabiting a specific point in input space with the possibility of moving to other points but only in real time, at significant cost, and under conditions of uncertainty.

[15] One notable exception in the S-E camp is the research on evolving tastes being done by the Max Planck Institute of Economics, Evolutionary Economics Group, which is directed by Ulrich Witt.

[16] See also Carlaw and Lipsey (2003) and Lipsey and Carlaw (2004)

Information and motivation

In neoclassical models, agents are assumed to have complete information sets, sufficient to allow them to make maximising decisions. This implies that all decisions are made either with perfect foresight or with foresighted rational expectations. For the latter, agents need to know all possible outcomes of their choices and to have well defined probability distributions about the likelihood of each possible outcome. This implies that in situations of less than perfect information agents operate in situations of “risk” rather than “uncertainty.” Agents need not learn from experience since all information that is relevant to their decisions is known by them initially. In this view, two individuals with the same endowments and tastes, faced with the same choice between two alternative courses of action and possessing the same set of relevant information, *are predicted to make the same maximizing choice*.

In S-E theory, innovation is typically seen as endogenously determined by decisions taken by individuals in search of profits. The theory does not endow agents with perfect information or perfect foresight. Instead, agents face uncertainty when making decisions, particularly those decisions associated with innovation. Since innovation means doing something never done before, it is often impossible to enumerate in advance the full set of possible outcomes of a particular line of research. In such situations, agents will be unable to assign probabilities to alternative future states in order to conduct risk analysis. Therefore, groping in a purposeful, profit-seeking manner is the usually assumed behaviour of agents. The key implication of uncertainty is that two individuals with the same endowments and tastes, faced with the same choice between two courses of action, and possessed of the same bounded set of relevant information, *may make different choices*. Given the uncertainty, neither individual’s choice can be said to be *ex ante* irrational, even though it may turn out *ex post* to be inferior to an alternative.

Equilibrium

Much neoclassical theory is Newtonian in conception. Forces balance each other to produce equilibriums that are typically stationary, unique, optimal, and rendered stable by negative feedback. Small perturbations are dampened so that the system returns to its initial equilibrium position. When technology is changing in this view (often characterised as a stock of accumulating knowledge that enters a given production function), the equilibrium concept is either a steady state or a dynamically stationary optimal growth path characterised by a constant growth rate. Many neoclassical economists have been interested in institutions and have modelled many aspects of the economy’s structure such as the location of industry and the internal management of firms. Nevertheless, the general-equilibrium, Arrow-Debreu-type theory on which many of the most influential neoclassical policy prescriptions are based, usually focuses on an equilibrium end state with little or no attention being given to the characteristics of and structure of institutions that experience suggests influence behaviour. Even where such institutions are modelled the equilibrium concept is stationary.

In contrast, the purposeful groping behaviour, endogenous and evolving choice sets, and endogenous and evolving technology of S-E theory imply the absence of a unique, welfare-maximizing equilibrium. The innovation process is replete with non-convexities—such as once-for-all costs of developing and acquiring technological

knowledge, positive feedbacks from current market success to further R&D efforts, and complementary relations among various technologies. S-E models with their uncertainty and non-convexities incorporate path-dependent processes. Some formulations of the resulting behaviour yield punctuated equilibriums: long, stable periods alternating with bursts of change, the timing and substance of which are not predictable in advance. Others yield multiple equilibriums, in which historical accidents determine which equilibrium will be reached or approached at any one time. Still others yield only perpetual change or non-stationary equilibria. Considerations such as these put an arrow of time into S-E theories.

Competition

Neoclassical theory treats competition as the *end state* of the competitive process. There is no ongoing process of rivalrous behaviour. Instead, what is modelled is the static state in which firms are all perfectly adjusted to their stationary environment. In the market structure of perfect competition, firms have no power over the market and so no means to engage in rivalrous behaviour *vis a vis* each other.

S-E theory treats competition as a *process* that takes place in real time. Behaviour takes the form of active struggling of firm against firm each seeking a temporary advantage over the others. In this type of competition, technological innovations are a major tool by which firms strive to gain competitive advantages. However, no such advantages are permanent and so none will show up in a stationary, long run equilibrium.

Structure

The neoclassical view tends to display the world as smooth, subject to incremental alterations, with a featureless technology and homogeneous agents whose behaviour is adequately displayed by that of a single representative for each class of agent. The S-E view tends to display the world as lumpy, subject to discrete alterations, with a structured technology and heterogeneous agents. Institutions are themselves hierarchical. It is the co-evolution of technology and institutions that determine the growth dynamic. Evolution is driven by differences among agents and it is often the outlier, not the median agent, who drives change.

The role of the market (evolutionary selection)

As we have seen, the neoclassical market is one in which suitably informed agents acting to maximize their own objective functions subject to well defined feasibility constraints arrive instantaneously at the optimal market equilibrium. In contrast, the S-E view is one of imperfectly informed agents groping under uncertainty towards outcomes they perceive as better, and thus driving an historical, path dependent process that never settles into a stationary equilibrium but is, instead, continually jostled by new endogenously created innovations. One of the great issues in the economics of long run growth is to explain why the whole economy behaves in a more or less ordered way although the key decisions are made by many unrelated agents.

The neoclassical explanation is that the price system does the coordinating by producing publicly available signals that reflect relative scarcities to which individuals

respond in a self-interested manner and, in the process, produce order in the system. In this view, agents have the all of the relevant information and do the maximising calculations themselves. The markets' function is to generate information in the form of price signals, which is all that the agents require from them. Without them, decentralised decisions of individual agents would not produce the emerging property of an economy that looks as if it had been consciously coordinated.

The S-E approach commonly assumes that agents lack the relevant information that would be required to make optimizing decisions. Furthermore, when operating under uncertainty it is unclear what maximizing behaviour even means. So the market has a much more important coordinating role to play. Agents do the best they can, often forming mistaken expectations about the underlying processes and often being subject to bandwagon thinking, and various other misdirecting influences. Sometimes they get "it" right but often they get "it" wrong. So the job of the market is to direct behaviour towards more value-creating activities by rewarding successes and punishing failures. In this way markets act as the evolutionary selection device, just as survival functions for biological evolution. Those who, by luck or good judgment (or both), get it right are awarded big profits, much larger than the normal return on capital that is all that is needed to direct resources in static perfect competition. Those who get it wrong lose and, if their losses are sufficient, they disappear from the system.

Compared with the static world of neoclassical welfare economics, the problem of coordination is much more complex in an S-E world of continuous change. How does a system that is continually changing and destroying much of what it has, and that is subject to cumulative causation, path dependence and increasing returns to scale and a host of non-linear dynamic structures, produce relative order? Our answer is that first, technologies develop along relatively structured paths shaped by their technical characteristics, and evolutionary history of accumulated knowledge derived from inventing and applying technology; second, when technologies are evolving endogenously, the evolutionary hand of the market is the major selection mechanism for choosing those strategies that will be reinforced by profits and those that will be discouraged by losses; and, third, the uncertainty associated with technological change requires institutions in the private and public sectors to shape behaviour and organize the interactions of agents, which serves to stabilize the system.

4.4. Technology, Structure and Change

One of the most important features of the S-E approach is that it explicitly models the microeconomic features of technology, the structure (including institutions and culture) into which it is introduced and the evolving interaction between these two. In order to discuss the interaction, which is of ultimate interest to those seeking to understand technology driven growth, we need to define technology and its characteristics, as well as define the economic and social structure into which technology integrates. This will allow us to articulate the co-evolutionary processes of technological and structural change.

Technology

Technological knowledge, technology for short, is the idea set specifying all activities that create economic value. It comprises: (1) knowledge about product

technologies, the specifications of everything that is produced; (2) knowledge about process technologies, the specifications of all processes by which goods and services are produced; (3) knowledge about organisational technologies, the specification of how productive activity is organised in productive and administrative units for producing present and future goods and services (which thus includes knowledge about how to conduct R&D).[17]

Technological change runs the whole gamut from continuous, small, incremental changes, through discontinuous radical inventions, to occasional new general purpose technologies (GPTs) that evolve to pervade much of the economy. All types of technology display the three related characteristics of building on accumulated knowledge, emerging in crude form, having few complementarities with other technologies, but subsequently developing a wider range and variety of use.

New knowledge builds upon existing knowledge. One does not invent the dynamo without an understanding of magnetism, conductivity and so on. No society has ever discovered the cam shaft without first discovering the wheel, and since the cam shaft is the key to harnessing rotary motion, no society without the idea of the wheel has managed the generation and harnessing of rotary motion. The nature of knowledge and discovery is inherently historical, and in accumulating knowledge "signposts" (crucial discoveries that enable whole research trajectories) matter.

It is always the case that newly invented technologies emerge in crude form, usually applied to a single activity and usually designed for a single purpose. For example, Newcomen's simple steam engine had the single purpose of pumping water out of ever deepening coal mines in Britain. Then via innovation and diffusion these technologies are refined, applied to more activities and adapted to more uses. Refinements to the steam engine resulted in it being able to withstand pressure up to several atmospheres and deliver vastly more horse power than the original Newcomen engine which ultimately resulted in a vast variety and range of application.

Elements of technological knowledge integrate with other new or existing elements of knowledge. Integrated capital systems are made up of many components. The components themselves consist of many sub-components and these sub-components are made up from sub-sub-components, and so on. An implication of the interrelated structure of capital is that components are complementary to one another, as well as to the integrated capital good itself. These complementary relationships range from the extreme of a component being necessary for the function of a technology to a range of weaker versions where the component merely enhances other components to varying degrees.

GPTs

In our research, a class of technology, general purpose technology (GPT), warrants special comment in the discussion of evolutionary long-run growth. A GPT is a technology that initially has much scope for improvement and eventually comes to be widely used, to have many uses, and to have many spillover effects. Almost every technology one would care to identify possesses at least some of these four

[17] The definition is derived from Lipsey, Bekar and Carlaw (1998).

characteristics we have just identified. However, no one of the above characteristics is sufficient to identify a GPT. A GPT must possess all four of the characteristics in abundance.

The importance of GPTs is found in their capacity to rejuvenate and sustain economic growth over the long run. New GPTs present agents with a whole new research program to develop new process, product and organisational technologies that make use of the new technologies. As long as transforming GPTs continue to be invented, there is no reason why growth cannot proceed into the indefinite future. Scientific and technological history gives no reason to suspect that the flow of new GPTs will dry up. Indeed, several new GPTs can be seen emerging at present, in particular biotechnology and nano-technology, both of which give promise of transforming products, processes and organisations across a wide spectrum of the whole economy.

Structure

Structure is the realisation of technological knowledge; it embodies technological knowledge; all technological knowledge must be embodied in the structure to create economic value. To be useful, the great majority of technologies must be embodied in one way or another. Structure is comprised of the following[18]:

- all physical capital,
- consumers' durables and residential housing,
- people, and all human capital that resides in them and is related to productive activities, including tacit knowledge of how to operate existing value-creating facilities,
- the organisation of production facilities, including labour practices,
- the managerial and financial organisation of firms,
- the geographical location of productive activities,
- industrial concentration,
- all infrastructure,
- all private-sector financial institutions, and financial instruments,
- all public sector institutions, parliament, courts, civil services, regulatory bodies, and other government bodies,
- humans who staff these organisations and whose human capital embodies the knowledge related to the design and operation of public sector institutions, i.e., institutional competence.

The agents who take most of the decisions concerning these elements are firms, governments and households.

Technological and Structural Evolution

A critical dynamic in understanding the process of economic growth, driven by technological change is to understand how the endogenous actions of agents groping under uncertainty and constrained by the characteristics of technology and pre-existing structure generate change in the economic system. As we have noted, everything that is known about the evolution of technology suggests that its course is

[18] This list is derived directly from Lipsey, Carlaw and Bekar (2005, chapter 3).

uncertain. This uncertainty is involved in more than just making some initial technological breakthrough. Most development expenditures are on product, not process, development, largely because new technologies come into the world in *crude form*, after which they are slowly developed as their range of applications is expanded in ways that are impossible to predict in advance. Another cause of uncertainty is that two or more technologies sometimes prove, to everyone's surprise, to be *complementary* and to produce when operating together much more than the sum of the parts when they operate independently. There are also uncertainties about how long a technology will continue to be useful before it is replaced by a superior technology. In addition there is uncertainty about how new technology will interact with pre-existing institutional, legal and cultural structures in a society. Because of such pervasive uncertainties, technologies evolve along trajectories that are path dependent in the sense that what seems a possible, next step depends on the successes and surprises in the previous attempted steps.

Similar comments apply to diffusion, which is a slow, costly and often uncertain business. Just to discover what is current best practice around the world is a daunting task. Even if an agent can identify best practice techniques, this (at most) provides it with a blueprint; learning how to produce what is described in a blueprint successfully implies acquiring all the tacit knowledge that goes with adopting something new. It follows that the existing set of technologies does not provide a freely available pool of knowledge. Learning about technologies in use elsewhere and adapting them to one's own uses is a costly process—typically requiring innovation in its own right—innovation and diffusion shade into each other rather than being clearly distinct activities.

This adaptive learning process applies to all agents operating in all elements of the economic structure. Firms create, search for and adapt best practice techniques to compete with other firms, consumers make choices over ever widening bundles of consumptions seeking to increase their well being and governments adapt existing property right and criminal laws to meet the ever changing technological environment to increase social welfare. In the process, structural and institutional mechanism are adapted to better fit emerging technology. All of these processes are costly in the sense that it takes resources to create learn and adapt. Critically, the coordinating mechanism of the market selects the best strategies of all agents and rejects the worst.

4.5. Policy implications

The two theoretical views of the growth process discussed above lead to two different views of policy.

In the Neoclassical view, maximizing agents equate the expected returns from a marginal unit of expenditure everywhere in the economy, including all lines of R&D. Given all the other standard assumptions, a welfare-maximizing equilibrium exists. Departures from this equilibrium are caused by market failures, which take three general forms; externalities, imperfect information, and non-convexities. The removal of these market failures is the main object of neoclassical microeconomic policy advice. There is nothing in the general models that distinguish one economy from another such as different specific technologies, different institutions and different histories or stages of development, such as an economy that is catching up

technologically or one that is at the technological frontier. As a result, its policy advice is general, applying to all market economies operating at all times. The advice is to remove market imperfections wherever possible.

A further implication of the equilibrium concept in Neoclassical models is that all policy interventions are reversible because historical path dependence is ruled out by the assumptions of this view. A policy intervention could be put in place for a time causing a change in the equilibrium while the policy is in place. And upon its removal the economy would revert to its original equilibrium.

In contrast the S-E view highlights a number of possible, context specific roles for policy intervention at a number of different stages in the path dependent process of complex interrelation between technology and structure.[19] The S-E view sees a role for policy in exploiting the differential and context specific technological complementarities among the various elements of technology and the economic structure. There is a role for policy to strike a balance between innovation and diffusion that is also potentially specific to different classes of technology. There are roles for adapting existing structure to accommodate new technologies and to aid other agents in the economy in overcoming sunk information costs about new technologies and best practice used elsewhere. The over arching view is that inducing economic growth through technological change is good but given the uncertainties that are inherent in the process how much of each kind of change to try to induce must come down to an irreducible element of judgement on the part of the policy maker.

Because of uncertainty, complementarity, the accumulation process that knowledge growth follows and the resulting path dependency, policy decision have the capability of altering the development trajectories of research agendas from minor incremental process in specialized lines of activity to the entire development trajectory of an economy, sometimes with devastating effect.[20] There is a fundamental message here. In the timeless Neoclassical framework a policy mistake (to the extent that such things are possible) can be reversed. In the S-E view a mistake can have lasting effects and may even eventually lead to success because it diverts the system onto a new and fruitful trajectory. Critically, policy makers must understand that they operate

[19] Lipsey and Carlaw (2000) provide details of the myriad possibilities.

[20] The Chinese organized sojourn abroad in the early 15th century provides an excellent example of several of our themes: the power of the state, the restrictions placed on merchants, and opportunities created then lost. The effort began when government shipyards constructed over 2,100 sea-going vessels. During the first thirty years of that century, massive Chinese fleets of hundreds of vessels carrying thousands of men travelled to various ports in Asia. These fleets dwarfed in size and number of vessels anything that Europeans sent out later in that century for their early trade with the east. The main purpose of the expeditions, however, was to take to the barbarians knowledge of Buddhism and of the fame of the emperor. Goods were carried but more for gifts than trade. Once the move had been made, some more conventional, commercially oriented voyages also occurred. But like so many other endeavours in which the Chinese were well ahead of the Europeans, these efforts came to naught. A new emperor came to the throne and those around him scorned commerce and opposed contact with the barbarian world. So, after a period of debate and indecision, all further expeditions were halted, “By 1500, anyone who built a ship of more than two masts was liable to the death penalty, and in 1525 coastal authorities were enjoined to destroy all ocean going ships and to arrest their owners. Finally in 1551, it became a crime to go to sea on a multi-masted ship, even for trade” (Landes: 96).

under the same veil of ignorance about the future as the agents whose behaviour they are seeking to influence. In an ever evolving system “doing nothing” is actually “doing something” because governments and policy makers exist and even the action of doing nothing can have lasting effects on how the system evolves. An understanding of the complex interrelationship between technology and economic structure is, therefore, essential to delivering good policy, but so too are independent assessment mechanisms for policy (i.e., an appropriate selection mechanism), institutional competence, and institutional flexibility. All of these are necessary because, given the uncertainty of the process mistakes will be made.

Having given the requisite warning it is also important to note that institutional structure, legal conventions, societal norms and culture all must evolve along side technological change in order to produce economic growth. Governments play a critical role as the agents of change in much of this evolutionary process.

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5. Approaches to Economic Growth: Implications for Policy Analysis: Author: Arthur Grimes (Motu Economic and Public Policy Research, and University of Waikato)

5.1. Introduction

The purpose of the *Approaches to Economic Growth* series is to expose analysts to a range of ways of thinking about the processes underlying economic growth. This purpose implicitly admits that there is no single "right" model, or way of thinking, about the factors driving growth. The growth process is context dependent, reflecting each country's institutions, endowments, individuals, firms, geography, and interactions with others beyond the country.

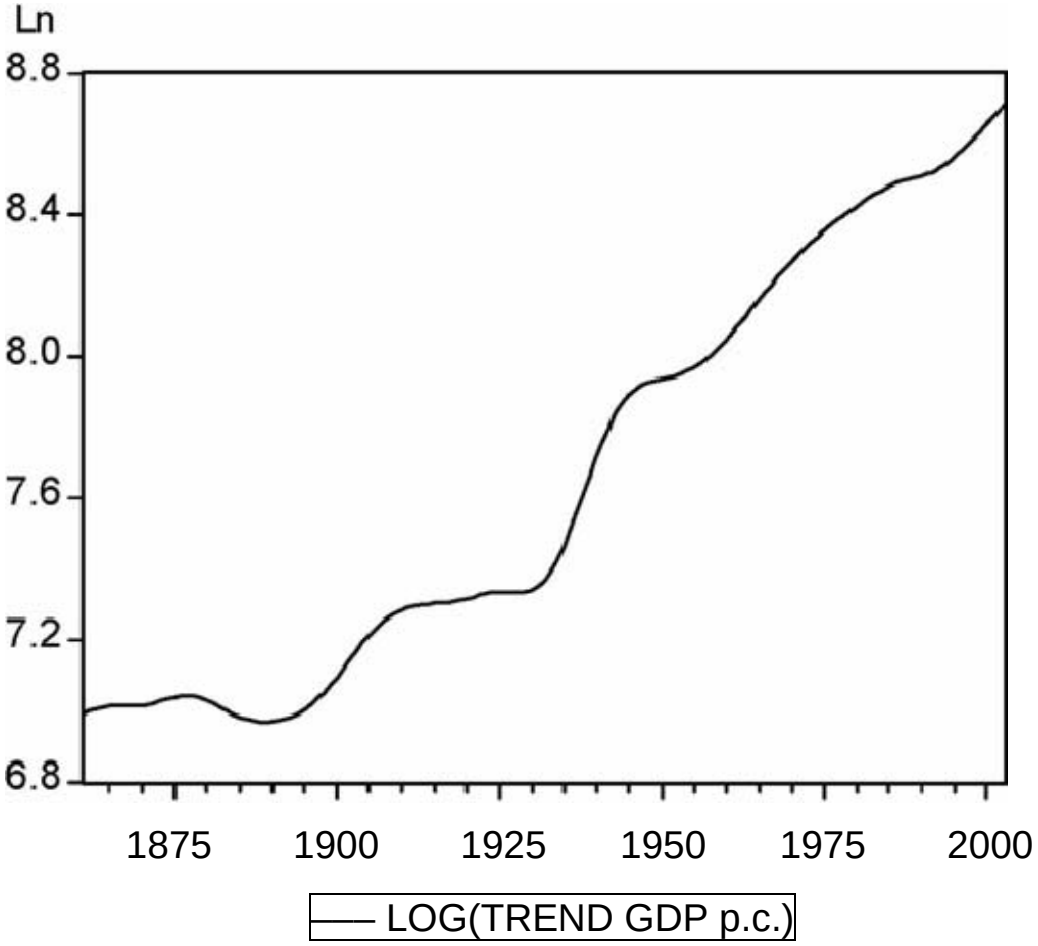
An understanding of different growth approaches is required in order to be able to proffer advice on policies which may assist the growth process. The purpose of this paper is to take insights from earlier presentations and consider their relevance for policy-making that supports sustainable economic growth. The paper suggests how and when it may be appropriate to apply these insights to policy situations. Relevant historical experiences are referred to in line with Santayana's admonition (cited by Brian Easton[21]) that "*those who do not learn the lessons from history are doomed to repeat them*".

Easton's paper is particularly useful in spelling out key historical patterns pertaining to economic growth in New Zealand. His chart 6 depicts the rise in GDP per capita in New Zealand since 1861. Figure 1 uses the Easton data to plot trends in New Zealand per capita GDP over 140 years (the slope of the line represents the trend per capita growth rate).[22]

As Easton discusses, New Zealand's growth rate relative to its OECD peers suffered some key post-war hiccups – notably after the collapse in wool prices in 1966, and during the policy deregulation period of 1984-1991. As indicated by Andrew Coleman in questioning, the latter period may, at least in part, have been a delayed negative reaction to previous events (such as the two oil crises in the 1970s) that policy had sought to hold at bay. As discussed later in this paper, the wool collapse may also have been a delayed reaction to earlier trends that domestic policy had sought to ameliorate.

[21] Brian Easton "The Development of the New Zealand Economy", paper presented to MED seminar series on *Approaches to Economic Growth*, February 2004.
[22] The trend per capita GDP series is calculated using a Hodrick-Prescott filter applied to the raw Easton GDP per capita series with standard filter values applicable to annual data.

Figure 1: Trend New Zealand GDP per Capita[23]



Insights from Previous Papers

The papers by Easton, Maré[24], Carlaw[25] and Sautet[26] : each has important insights for thinking about the economic growth process. Many of the insights are complementary to one another. There are few differences in broad approach, but there are differences in emphasis.

Brian Easton emphasises important process issues of which analysts should take cognisance in considering the growth process. In particular, he emphasises that anyone interested in the growth of the economy cannot look just at aggregate GDP.

[23] Each 0.4 step in the natural logarithmic scale (ln) represents a 50% (actually 49.2%) increase in per capita income over the previous step in the scale.
[24] Dave Maré, "What do Endogenous Growth Models Contribute?", paper presented to MED seminar series on *Approaches to Economic Growth*, March 2004. [Editor's note: This is Section 2 of this paper].
[25] Kenneth Carlaw, "An Evolutionary View of Technology Driven Long-Run Growth", paper presented to MED seminar series on *Approaches to Economic Growth*, March 2004. [Editor's note: This is Section 4 of this paper].
[26] Frédéric Sautet, "Entrepreneurship, Institutions and Economic Growth", paper presented to MED seminar series on *Approaches to Economic Growth*, March 2004. [Editor's note: This is Section 3 of this paper].

GDP is simply an aggregation of developments amongst individuals, firms and sectors. These developments arise as a result of a myriad of forces. Two key forces are developments in (disaggregated) output prices and factor prices (driven by both domestic and international forces). Together, these developments interact with institutional and other forces (domestic and international) to determine profitability of firms. Ultimately, profitability provides a vital incentive for investment and thence for growth.

Frédéric Sautet also emphasises that economic growth cannot be viewed just as an aggregate process. He goes a step further, considering that "sectors" are an artificial aggregation – a product of the statistician's mind rather than a concept meaningful for firms. Within the "Austrian" view of entrepreneurship that he adopts, growth arises as a by-product of the profit-seeking actions of firms and individuals. Institutions affect these actions but are not the instigating force for them; the instigating force is instead individuals' desire to increase their wellbeing ("psychic profits").

This view of the growth process leads Sautet to five propositions. Together, these propositions emphasise that in a constantly changing and uncertain world, the decentralised search for profitable opportunities creates new products, new technologies and new production processes. Economic growth is an accidental (but socially important) by-product of this search for profitable opportunities. Production growth *per se* is not the goal of the (private sector) actors; profits (and other determinants of wellbeing) are the goal of these actors. It is important, therefore that growth-oriented policies support the search for profitable opportunities.

A related policy insight is that institutions and/or policies which stifle this search for profit opportunities will inhibit the creation of new products, new technologies and production processes, and thereby stifle economic growth. Since part of the search process is to discover and then to exploit profit opportunities, policy-makers need to be careful not to limit the degree to which profit opportunities are discoverable by entrepreneurs. Policy must also ensure that once profit opportunities are discovered they can be exploited by the discoverer. [27]

Further, penalties for entrepreneurs who search for profit opportunities, but who fail in that search, must not be so draconian that the profit search is unduly stifled. This observation has implications for insolvency policy.

This "Austrian" view of the growth process has a number of similarities to the "evolutionary" approach to growth. Ken Carlaw notes that "growth is best understood as an evolutionary, historical process driven by endogenous innovative activity." He emphasises that new technologies arise largely as a result of activities of profit motivated agents acting under uncertainty. Even though agents live in an uncertain world, their desire to create profits leads to a search process that, in aggregate, has positive profit – and growth – spin–offs. Carlaw sums up the search process as follows:

[27] The degree to which this argument extends to profits derived from natural monopolies (such as a gas pipeline) is a moot point. Austrians argue that such profit opportunities should not be inhibited; another view is that in these instances "super-profits" do not drive additional innovations and should be curbed on standard monopoly regulation grounds.

> *The job of the market is to direct behaviour towards more value-creating activities by rewarding successes and punishing failures … those who … get it right are awarded big profits, much larger than the normal return on capital … those who get it wrong lose and [may] disappear.*

A number of corollaries flow from Carlaw's approach. First, as implied also by Sautet's analysis, seemingly "excessive" profits on certain activities are required to compensate entrepreneurs for the risky search for profitable opportunities in an uncertain world. Such profits are observed *ex post* – i.e. only after success is confirmed; *ex ante* the expected profit on the search may not be abnormal. This observation is important for thinking about the framing of competition law.

A second corollary of the evolutionary view is that scientific/technological knowledge is often cumulative. Technological advances – including advances that subsequently have extremely widespread impacts (General Purpose Technologies, "GPTs") – enable future technological advances to occur that build on the initial innovation. Often, the potential future innovations are unknown, and unknowable, at the time of the initial innovation. The profit motive (within an uncertain world) helps guide later entrepreneurs to the "Eureka" moments that involve application of earlier advances to new ends.[28] One implication of this corollary is that small countries do not necessarily have to be fully up with the play on advances in basic science. Adaptation of others' advances to new ends may be more appropriate to the scale and opportunities of entrepreneurs in such countries.

A third corollary of the evolutionary approach is that outcomes are not reversible; the arrow of time points only one way. Once a discovery, or a policy innovation, has occurred it is virtually impossible to return to the prior state. A number of lessons for policy analysis flow out of this observation.

One lesson is that care must be taken with regard to encouraging, or possibly even allowing, innovations that embody major irreversibilities and large risks that are not fully internalised by the innovator. Introduction of genetically modified crops to a country may be an example. At the same time, however, an over-precautionary approach can also be damaging. If the innovation is ultimately approved and if domestic entrepreneurs have been denied access to adapting it while entrepreneurs elsewhere have such access, the result may be missed profit and growth opportunities. There is no easy way around this trade-off in designing policy. As emphasised by the evolutionary literature, policy (as well as the profit search) is made in an uncertain world and mistakes will be made. Decisions must be informed as fully as possible, especially where the future (positive and negative) stakes are high; but they cannot await attainment of complete certainty. Waiting for certainty would rule out too many profit opportunities. However, where major negative externalities could arise, a higher threshold than is normal for approval (or encouragement) of innovations is appropriate.

[28] This observation does not deny that advances will also be made as a result of other motives – for instance the "personal glory" motive amongst academics. Even in this case, however, there is often personal profit attached; promotion prospects are enhanced if a publishable (and/or patentable) discovery is made.

There are implications of irreversibility for the policy-making process in other situations as well. One issue is how "experimental" public growth-oriented policies should be. One view is that a (small, distant) country, such as New Zealand, should exhibit an "openness to experimentation in policy" in order to bolster economic development. Some countries appear to have experimented successfully with such policies while other countries (at times including New Zealand) have experimented unsuccessfully with growth policies. Further, from the international and domestic historical record, the fact that a country is different from others – or similar to others – does not appear to be correlated with success or failure of experiments.[29] What counts most for the success of experimental policies are:

(a) quality of *ex ante* analysis (based on problem identification, assessment of alternatives, and cost-benefit analysis of likely outcomes of different alternatives under conditions of uncertainty with agency costs);

(b) ability and willingness to discontinue programmes that were expected *ex ante* to be successful but *ex post* were not; and

(c) luck.

Not much can be done about (c), but conditions (a) and (b) both need to be met for experimentation to be considered. Further, the risk (variance of outcomes) surrounding each policy experiment needs to be considered as well as the expected (mean) return attributable to the experimental policy. Finally, the potential for reversibility (and irreversibility) both of decisions and outcomes needs to be carefully assessed prior to implementation of experimental policy.

Endogenous growth theory (summarised by Dave Maré) emphasises a number of mechanisms that are shared by the Austrian and, especially, the evolutionary approaches. Endogenous growth theory emphasises that knowledge is cumulative, with spillover benefits. New knowledge builds on past knowledge advances, and the benefits of past advances may accrue to unrelated people in future. As well as building on past ideas, new ideas may complement existing (and new) capital, making capital more productive. Thus new ideas can raise the productivity of capital, inducing new investment. Capital accumulation is the result, with benefits to overall living standards. New ideas support the emergence of new intermediate goods (and final goods) and this expansion in the choice of inputs and final products is a vital cog in expanding production opportunities and thence growth.

The spillovers that arise from new ideas – from whatever source – promote an environment in which there are ongoing profit opportunities. According to this approach, the stimulation of new ideas is critical to the growth process. These new ideas do not have to be "fundamental" scientific discoveries. Indeed many of the processes suggested by this approach are adaptive in nature; for example, "learning by doing" (e.g. development of on-the-job skills).

Policy, under this approach, has the role of supporting the discovery of new ideas. This insight has a number of implications, for example, for patent policy. The

[29] Struan Little (2001), *Lessons from the Losers: What the Also-Rans Can Teach Us About Economic Performance*, NZ Treasury, Wellington.

Austrian and evolutionary approaches emphasise that the search for profit opportunities through the discovery of new ideas must be rewarded with expected profits. However, if patent law were perfect in terms of awarding all future profits of a discovery (including indirect profits due to spillovers) to the initial discoverer, the search for new discoveries would be stifled. The reason for this is that there would be no profit opportunity for future entrepreneurs arising from discoveries that are adaptations of past advances. A balance therefore has to be struck between rewarding the initial innovator while at the same time leaving in place incentives for future innovators (building on past innovations) to benefit.

Uncertainty, Knowledge and Profits

Three consistent themes come through the presentations. One is that all decision-making, whether by private entrepreneurs or public policy-makers, is made within a climate of uncertainty. Decision-makers do not know the "true" model of the world and may not even be able to form an accurate probability distribution over potential states of the world. A second theme is that the search for profit opportunities, even within this uncertain world, is a vital ingredient in the growth process. A third theme is that the search for, and the creation of, new knowledge is an important component of the search for profit opportunities.

Even though knowledge is scarce, this scarcity does not logically imply that policy can assist to overcome the scarcity. The particular circumstances will dictate whether such assistance is possible. In some circumstances publicly-provided knowledge provision may be helpful; at other times it may be harmful.

To illustrate these ideas, consider the analogy of the role of publicly-provided advice to prospective speliologists. Advice to novice cave explorers about dangers, recommended equipment etc may help to prevent accidents, thereby promoting overall welfare. However, publicly-provided knowledge dissemination may be counter-productive; prior advice to novice cavers may unnecessarily embolden a potential explorer to go where they would (and should) not otherwise go; or it may persuade them to take a particular route out when the explorer's instincts tell them that an alternative route is preferable.

As with other areas of economic activity, incentives are important. The growth theories, summarised above, emphasise that it is important to have the correct incentives to obtain, process and impart knowledge. The successful pursuit and implementation of knowledge must be rewarded (whether by profits or by glory). Correspondingly, acquisition and use of knowledge that is not driven by a clear incentive process may result in poor outcomes as the knowledge turns out to be inappropriate for the situation. An example of this latter situation may be where a public agency disseminates knowledge to users who place undue emphasis on it; for instance, by regarding the knowledge as providing a profit opportunity when in fact the public nature of the knowledge means that prior profit opportunities have already been exploited.

Another issue in terms of public policy involvement in the knowledge-creation process is the extent to which, and the nature by which, public agencies assist the knowledge creation process. Almost inevitably, through its interaction with tertiary (and other research) institutions, public policy will impact on the nature and the

directions of knowledge creation. R&D and related tax policies will impact on who conducts the search for knowledge, how it is conducted (e.g in response to incentives for different types of knowledge creation) and how much is conducted. In this respect, knowledge creation may be more suited to some types of firms than others. Baumol[30], for instance, argues that there are considerable economies of scale in the process of sustainable knowledge creation; large corporates can afford to undertake an ongoing portfolio of R&D whereas small firms are more opportunistic and piecemeal in their innovation approaches. Care must be taken before public incentives are provided to encourage knowledge creation by some types of firm ahead of others in case the search for knowledge is diverted towards less efficient searchers.

Lessons from History

In accordance with Easton's emphasis on the need to learn from history, it is useful to consider whether New Zealand could have escaped the worst of the adjustment consequences to past shocks. Here we consider the example of the 1966 wool shock. Wool prices collapsed by 40% in December 1966, leading to a prolonged period of New Zealand under-performance compared with other OECD nations in terms of GDP growth per head (documented in Easton's presentation).

It is instructive to examine events leading up to the wool price collapse. The New Zealand Wool Board was established in 1944. Sir John Acland became its Chairman in 1960. In its entry on Sir John Acland, the *Dictionary of New Zealand Biography*, described events under his chairmanship as follows:

> *Wool was experiencing competition from synthetic fibres, and Acland presided over the industry's vigorous response. Woolgrowers accepted greatly increased levies for promotion and research, the Wool Research Organisation of New Zealand was established in 1961, young scientists were sent abroad for training, there was technical help for mills using New Zealand wool and the board stepped into freight arrangements.*
>
> *Acland ensured that New Zealand wool received a fair share of promotion and product development. He travelled widely visiting International Wool Secretariat branches and meeting with trade representatives. The 1960s saw improved wool packing and transport to ship-side, and research that was to lead to scientific measurement and sale by sample. Eventually, the board proposed setting up a corporation to market wool.*

From this account, Acland had a remarkably modern approach to development. He:

- Promoted a wool cluster with joint market promotion and research.
- Ensured there was government facilitation of the cluster (funded through compulsory farmer levies).
- Established a CRI-type research organisation (Wool Research Organisation).

[30] Baumol, William (2002) *The Free-Market Innovation Machine: Analysing the Growth Miracle of Capitalism*, Princeton: Princeton University Press.

- Took actions to promote applied science related to the wool cluster.

- Provided technological assistance to domestic customers (wool mills).

- Established international networks through both trade representatives and international bodies.

- Provided marketing co-ordination of the product.

This policy approach built on New Zealand's natural advantages and resulted in wool comprising over 30% of the country's exports in 1966. This high share of exports (and production) was "despite years of increasing competition from synthetic fibres". From the analysis in the earlier presentations, this concentration on wool arose from a combination of (subsidised) knowledge creation within the wool sector and a concentration of profit opportunities in the wool sector arising from the Wool Board's approach.

The 40% drop in the wool price, on a product then constituting 30% of exports, meant a direct drop of 12% in New Zealand's overall export prices. The resulting terms of trade decline led to major falls in farmer incomes which fed through elsewhere to the economy, retarding growth for a significant number of years. The facilitation of this situation by policy actions and official support – which may have looked sensible prior to 1966 – proved, *ex post*, to be disadvantageous.

It is often easy to look retrospectively and see that policy settings at a particular time were not sensible (in the light of subsequent events). So was this situation possible to foresee? It turns out that there were signs, spotted previously, that indicated not all was right with the then approach to economic policy.

In 1963, Professor Wil Candler (Massey University) wrote a paper in *The Economist* magazine analysing the effects of New Zealand's economic policies on economic growth.[31] He argued that New Zealand provided a model for how to retard economic growth. Key elements responsible for this retardation included:

- *The removal of growth from the political agenda.*
  Promoting and facilitating growth requires hard "pro-growth" decisions to be made at times. By removing per capita growth from the political agenda, these hard decisions can be avoided; growth is the casualty.

- *The "Individual project" argument.*
  Concentration on specific projects diverts policy-makers' sights from the big picture towards publicly visible (but essentially minor) projects. "By claiming to have initiated thirteen new industries in three years, or promising to build a cotton mill (or not to build it), the politicians of New Zealand have managed to create the impression that economic change is synonymous with economic progress."

- *Divorcing decision-making from incentives.*
  Import licensing and public export facilitation divorce production decisions from market-based incentives. "The remuneration of the staffs of these agencies is

[31] Wil Candler, "How to Progress Backward", *The Economist*, 9 March 1963, pp. 874-876.

quite unrelated to the prices received for the product, or to their ability to predict the development of future prices."

- *Disincentives to production & promotion of cottage industry scale.*
  A combination of licensing and taxation of returns from production act to reduce the incentive to increase production. The divorce of major decisions on scale and method of production from those who actually benefit from a right decision results in "the reappearance of cottage-type industrial activity" which may not be appropriate to a modern economy.

Candler would be pleased to see that growth is back on the political agenda. However, his other warnings remain apposite. Policy-makers need to be wary not to concentrate on specific "individual projects" in place of an over-arching growth perspective. Further, there is still a disconnect between explicit incentives facing officials involved with business facilitation and the results of the businesses themselves. Taxation and other disincentives to production still abound; they are inevitable in a modern society, but need to be minimised to the extent possible, consistent with attaining other objectives. Finally, care must be taken to ensure that policy is neutral with respect to the scale of production in New Zealand. If Baumol's hypothesis is correct that sustainable innovation comes mainly from larger corporates, policies that assist small and medium enterprises, but that do not similarly assist larger firms, may be counter-productive to the search for innovation-based profit opportunities that lead to economic growth.

5.2. Concluding Thoughts

Each of the preceding contributions emphasises the importance of knowledge creation in the presence of uncertainty; they also emphasise the role that the profit motive plays in guiding the knowledge creation process. Policies that reduce the ability to spot unexploited profit opportunities, and/or reduce the returns from doing so, can be detrimental to growth outcomes.

Many policies will impact on the profit search process. For instance, bankruptcy penalties that are imposed on those who take risks but fail need to be carefully balanced so as to create incentives for responsible behaviour without unduly discouraging risk-taking. Policies that support those who would not take risks (unless underwritten externally) may also water down the search for opportunities with the highest profit prospects. The profit search process may be affected by policies that affect firm scale decisions and/or a firm's (or investor's) choice of activity.

While the previous contributions provide cautions for policy, they also provide insights about types of policy that may assist the growth process. Policies that assist the knowledge creation process by raising capability and/or by raising the rewards to knowledge creation are consistent with key elements of each of the approaches. These policies may include promotion of educational attainment and promotion of research activities by tertiary and similar institutions. Broad-based promotion of research and development, and of staff training, in private sector firms is likely to facilitate the profit search, investment and thence growth. Support for investment in capital equipment embodying new technologies may also facilitate the profit search since staff are likely to "learn-by-doing" through using the new equipment, taking this knowledge beyond the boundaries of an individual firm.

These types of policies are, in the main, broad-based. Knowledge that underlies development of new projects and sectors is inevitably fleeting. By the time it is processed centrally and then disseminated it is often out-of-date. Those with the incentives to obtain and process the information are generally best placed to decide whether and how to make use of it. Support for the generic profit-search process is a key role that policy can play in order to assist the achievement of higher rates of sustainable economic growth.