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Calm after the Storm?:

Supply-side contributions to New Zealand's GDP volatility decline

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Abstract

The variance of New Zealand's real GDP has declined since the mid-1980s. To investigate why, this paper decomposes the variance of chain-weighted estimates of production-based real GDP growth into sector shares, sector growth rate variances and co-variances. The principal explanation for the decline in GDP volatility is a fall in the sum of sector variances driven by a decline in the Services and Manufacturing sector production growth variances. Sector co-variances have had a dominant influence on the profile of GDP volatility and this influence has not diminished. Despite marked changes in sector shares, notably increases in Services and Primary sector shares and a decrease in the share of Manufacturing, this has not been a significant factor influencing the decline in GDP volatility. We postulate that policy interventions such as "Think Big", regulatory interventions during the early 1980s, and the introduction of GST are key explanations for the higher volatility until the mid 1980s. Cessation of these interventions, deregulation and possibly changes in inventory management methods are important reasons why GDP volatility has fallen since then.

***JEL classification*:** E23 Production, E32 Business Fluctuations, Cycles, L6 Industry Studies

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"The world does not always remain the same. Carefully documenting how it has changed, or is changing, is an important task for economists." Benjamin Friedman (2001)

I. Introduction

I.1 Background and motivation

There is mounting international evidence that growth and business cycles in many developed economies have been through a transition to significantly lower volatility. McConnell and Perez-Quiros (2000), Kim and Nelson (1999) and Shaghil, Levin and Wilson (2001) for example, provide compelling evidence of a structural break in the variance of U.S. real GDP growth in the first quarter of 1984. The extent of this change is highlighted by McConnell, Mosser and Perez-Quiros (1999) who observe that "in the period since 1984, the volatility of quarterly real GDP growth has been only half that of the preceding twenty-five years" (page 1).

The decline in GDP volatility is evidently not restricted to the U.S. The variance of GDP for Canada, the United Kingdom and Australia also declined sharply in the mid 1980s (see Blanchard and Simon, 2001 and Simon, 2001). There is also evidence to suggest that the variance of New Zealand's real GDP growth may have declined after the mid 1980s (Hall, Kim and Buckle, 1998 and Reserve Bank of New Zealand, 2000).

Although considerable attention has been focussed on the mid 1980s as a possible turning point in the transition to less volatile GDP, Blanchard and Simon argue that this period is just one stage of a decline in GDP volatility that has been taking place over several decades. They conclude that, in the G-7 countries[1] other than Japan, output volatility since the 1950s is characterised by a steady downward trend that was interrupted in the 1970s and 1980s when inflation was high, and returned to trend in the late 1980s and 1990s. This feature also seems to be evident in the long-run behaviour of Australian real GDP (Simon, 2001 and Gruen and Stevens, 2000).

This debate is reminiscent of an earlier debate concerning the stabilization of the post-war U.S economy relative to the pre-war period (see for instance Burns, 1960; Bailey, 1978; de Long and Summers, 1986). The claims made in that earlier debate were questioned by Romer (1986a, 1986b, 1991) and Watson (1994) who doubted the

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1 The G-7 countries are: Canada, France, Germany, Italy, Japan, United Kingdom, and United States.

comparability of the data between the two periods and the reliability of pre-war reference dates relative to their post-war counterparts. The quality and comparability of GDP data over time may yet prove to be part of the explanation for the long-term decline in the volatility of GDP in many G-7 countries observed by Blanchard and Simon (2001) and Simon (2001). However, they seem less likely to be as serious in the identification of a structural break observed in many countries during the mid 1980s. Furthermore the procedures adopted in the current debate tend to allow the data, rather than an unrelated historical event, to determine the timing of any break in volatility.

Attention has also been turning toward understanding why real GDP volatility has declined in these countries since the mid 1980s. Some of this work has focussed on identifying the proximate causes of changes in GDP volatility by examining the change in the volatility of components of demand for real GDP. For example, Blanchard and Simon have decomposed demand for U.S. real GDP and evaluated the behaviour of these components over time. They conclude that the volatility of government spending was very high during the Korean War years and fell rapidly during the 1950s and has remained low ever since; that most of the trend decline in GDP volatility can be traced to a decline in the volatility of private consumption and investment demand throughout the period since the 1950s; and the sharp decline since the mid 1980s is due to inventory investment which has become counter-cyclical leading to a decline in the variance of output relative to sales.

Changes in the volatility of durables sales and inventory investment have also been identified as key explanations for the sudden decline in U.S. GDP volatility by Kahn, McConnell, Perez-Quiros (1999), McConnell, Mosser and Perez-Quiros (1999), McConnell and Perez-Quiros (2000) and Warnock and Warnock (2000). Improvements in inventory management techniques have therefore been identified as a potentially important cause of the decline in GDP volatility. These techniques include 'just-in-time' inventory management that has allowed firms to operate on lower inventory volumes thereby reducing the durables share of GDP and their contribution to volatility,

There is also a widely-held view that many developed economies have learned how to use discretionary macroeconomic policies in a way that reduces instability. In particular, a view has emerged that monetary policy should be the predominant stabilization tool for developed economies, whereas the focus of interest for fiscal policy should be issues of sustainability and inter-temporal equity rather than short-run stabilization (see for example Taylor, 2000b and Allsopp and Vines, 2000). This view has been reinforced by a growing body of literature evaluating the extent to which changes in the conduct of monetary policy could have resulted in a more stabilizing influence on real GDP (see for example Clarida, Gali and Gertler, 1999 and 2000, and Taylor, 2000b). For example, Taylor (2000a) considers that Federal Reserve monetary policy since the 1970s is the most probable cause of the decline in GDP volatility in the U.S.

Other suggestions include fewer and smaller supply side shocks (Taylor, 2000a; Blanchard and Simon, 2001; Simon, 2001), deregulation, globalisation and the gradual breakdown in trade barriers enabling firms to minimize risk and achieve steadier growth

by exporting their products to a broader range of countries[2] (McConnell, Mosser and Perez-Quiros, 1999), and the shift to a more service-oriented economy that is less cyclically volatile[3] (Taylor, 2000a and Warnock and Warnock, 2000).

Zarnowitz (1999), on the other hand, takes a sceptical view of the relevance of many of these suggested explanations. He argues that if there has been a change in volatility of the business cycle it is more likely to have arisen, not from changes in exogenous shocks, but instead from the endogenous interplay of profits, investment, expectations and financial markets.

Identifying whether real GDP volatility has changed and understanding why it has changed are important for several reasons. From a research perspective, linear models for output growth over periods that span a break in volatility may be misspecified. From a policy perspective, a reduction in the variance of output fluctuations should alter the interpretation policy makers place on a particular realization of quarterly GDP growth. What may have been viewed as a moderate fluctuation in activity prior to the break may now be viewed as more severe.

It is also important to understand whether a decline in GDP volatility is a permanent or transient feature of an economy. It may be the consequence of permanent structural changes in which case it may be enduring, or it may reflect the fact that an economy has been subjected to less severe exogenous shocks. Structural changes that could influence GDP volatility are changes in the way policy responds to and influences economic activity or in the way the microstructure of the economy responds to other exogenous shocks.

I.2 Methodology and key conclusions

Determining whether real GDP volatility has actually declined and identifying the reasons for a decline are therefore important from both a policy and an economic modelling perspective. The purpose of this paper is to document changes in New Zealand's real GDP volatility and to uncover reasons why a change has occurred. There have been several approaches adopted in the aforementioned overseas studies.

These approaches include:
(i) applying a Markov switching process to document the timing of a change in total GDP volatility and to determine whether any change is due to a narrowing of the high and low growth rates or the variance of growth rates (McConnell and Perez-Quiros, 2000; Kim and Nelson, 1999);
(ii) examining the times series properties of aggregate real GDP and to attempt to identify whether there have been changes to the size of exogenous shocks or the dynamic reactions to shocks (Blanchard and Simon, 2001; Simon, 2001);
(iii) examining the behaviour of volatility at different frequency domains (Shaghil, Levin and Wilson (2001); and
(iv) examining some of the components of the demand for real GDP, such as private consumption and investment demand, durables and non-durables demand, etc (McConnell, Mosser and Perez-Quiros, 1999; McConnell and Perez-Quiros, 2000; and

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2 The literature on business cycle co-movement however, finds a limited role for trade in dampening fluctuations of GDP. See Otto, Voss and Willard (2001).

3 This is an idea originally advanced by Arthur Burns (1960) as an explanation for the decline in post-war U.S. GDP volatility.

Warnock and Warnock, 2000; Blanchard and Simon, 2001).

The method used in this paper is closer to the fourth approach of decomposing the components of real GDP. However, the limited availability of suitable demand side data and the likelihood that there have been significant changes to the supply side structure of the New Zealand economy, especially since the mid 1980s, suggests that a different decomposition is warranted. We therefore depart from the methods used in the papers mentioned in (iv) by focussing on the supply side of the economy and explicitly identifying the relative contributions of changes in production sector shares, variances and co-variances. This is achieved by decomposing the growth rates of the supply-side of the economy into these components.

Our approach is to start by recognising that changes in aggregate GDP growth can occur as a result of changes in production sector shares of real GDP (that is, changes in their relative size) and changes in production sector growth rates. From this perspective, changes in the volatility of aggregate GDP growth can occur as a result of any one of three proximate causes: changes in sector shares, changes in the volatility of growth of any one sector, and changes in the correlation between the growth rates of all sectors. We label these three components as follows: sector shares, sector variances, and sector co-variances. To identify the relative importance of each of these three components, we first rearrange industry real output series into five production sectors: *Services*, *Government and community services*, *Manufacturing*, *Primary* and *Construction*.

The key conclusions to emerge from this paper are as follows:

- New Zealand's real GDP has been, on average, about 33 percent less volatile since the mid 1980s. This decline in volatility began in the late 1980s; fell further in the mid 1990s before rising again in the late 1990s.
- There have been marked differences between sector growth rates and consequently there have been changes in sector shares. The *Primary* and *Services* sectors have been the fastest growing sectors and the sectors with rising shares of GDP. *Manufacturing*, *Government and community services*, and *Construction* have been the slowest growing sectors and these have experienced falling shares.
- Despite changes in sector shares, the contribution of changing shares to changes in total GDP volatility has not been significant. The scale of the changes in sector shares is small by comparison to the variance of sector growth rates. But other factors are also apparent. The impact of the rise in the share of *Services*, a sector with declining volatility, has been offset by the fall in the share of *Manufacturing*, also a sector with declining volatility, and the rise in the share of the relatively volatile *Primary* sector.
- The decline in real GDP volatility was due primarily to a fall in the sum of sector variances.
- Two sectors were key contributors to the decline in sector variances: *Services* (specifically the *Finance and real estate* and *Wholesale trade* industries) and *Manufacturing* (specifically the *Machinery and equipment manufacturing* and *Other food manufacturing* industries). There was no obvious change in the behaviour of the relatively volatile *Primary* and *Construction* sectors, although the volatility of *Government and community services* increased during the late 1990s.
- Throughout the sample period, changes in sector co-variances have been the

main factor determining the profile of aggregate real GDP volatility. This influence has not diminished and its relative significance has increased.

Is lower volatility likely to be a permanent feature of the New Zealand economy? The answer to that question will depend, in large part, on the reasons why the sum of sector variances has declined and why the co-variance between sectors changes over time. Although this issue warrants further research, we postulate that the industry evidence presented in this paper suggests that particular policy interventions during the early 1980s such as "Think Big", a comprehensive price, wage and interest rate freeze, and the introduction of GST during the mid 1980s explain much of the relatively high volatility during that period.

Cessation of these abrupt policy interventions, and responses to deregulation of many parts of the *Finance and real estate* industry, and the impact of more widespread deregulation on the behaviour of the *Wholesale trade* industry and industries in the *Manufacturing* sector seem to be plausible reasons for the decline in real GDP volatility since the mid 1980s. To the extent that fiscal and regulatory policy interventions have become less abrupt, and that the regulatory and industry changes are permanent features, the New Zealand economy may indeed have entered a period of calm following the relatively stormy years prior to the late 1980s. There is no apparent diminution of supply shocks, and the timing and industry specific nature of the decline in sector variances suggests that formal inflation targeting has not been the principal cause of the decline in New Zealand's GDP volatility since the mid 1980s.

II. Production data and the composition of sectors

To avoid the 'Romer and Watson critiques', an inquiry of this nature requires data prepared on a consistent basis to avoid changes in data compilation methods influencing the interpretation of the performance of GDP and each sector. The frequency and industry availability of real GDP data are also important considerations. There are several alternative New Zealand constant price GDP data series available. They vary by the time period they span, by industry composition and by frequency of coverage. There are also significant differences in the methods used to construct indices of real GDP.

Statistics New Zealand (1998) has prepared quarterly real output data for 23 industries on an SNA basis since the September quarter 1977 (1977:3). Until recently, these series were derived on a fixed weights basis. Statistics New Zealand (2001) released upgraded national accounts at the end of 2000 and in June 2001 it introduced a number of important changes, including moving from fixed weight to chain linked derivation of constant price data and the introduction of the System of National Accounts 93 (SNA 93) and the Australian New Zealand Standard Industrial Classification (ANSIC) definitions and classifications.

The new SNA 93 chain series are now New Zealand's official data series and replace the previous official series, which were based on SNA 68, New Zealand Standard Industrial Classification (NZSIC), and fixed weights. The new chain series for production industries are available from the June quarter of 1987 onwards. The fixed series for production industries are available from September 1977.

Statistics New Zealand (SNZ) intends to eventually back date the chain series to the same beginning dates as the fixed series but no deadline for this has been set. A

calibrated quarterly chain linked series for real GDP and the production sector components of real GDP was therefore constructed to provide a longer time span, one that spanned the period prior to the mid 1980s when other countries were evidently experiencing a decline in volatility. The construction of these series is described in Haugh (2001).

The calibrated series are SNZ's new quarterly chain series from June 1987 onwards appended to a calibrated chain series for the period back to September 1977. The latter is derived by exploiting the statistical relationship between the period of overlapping chain and fixed series (1987:2 to 2000:2). This statistical relationship is then used to derive series for each SNA93 based ANSIC production sector and for total real GDP from 1977:3 to 1987:1, which are intended to approximate the chain-linked series for this period. These calibrated series are then combined with the respective 1987:2 to 2000:4 chain-linked series available from SNZ to form consistent time-series data for each sector over the period 1977:3 to 2000:4.

At a broad level, the industry classifications of the fixed and chain series are similar, but there are some differences. Therefore, in order to create comparable fixed and chain series from an industry classification perspective, a number of minor transformations were made and these are also described in Haugh (2001).

Figure 1 highlights the importance of using data prepared on a consistent basis. This figure plots the quarterly growth rate of real seasonally adjusted GDP from June 1935 to December 2000. The vertical lines divide the time series into three periods. These periods identify the available indexes of New Zealand quarterly real GDP. From 1935 to 1954 the series is interpolated from the Statistics New Zealand annual nominal series and deflated by the CPI. From 1955 to June 1977 the series is interpolated from the Statistics New Zealand annual real GDP series. These are the only available quarterly series prior to September 1977. From September 1977 to December 2000 the series is the calibrated real seasonally adjusted GDP series used throughout this paper.

Figure 1 illustrates clear breaks in the pattern of quarterly growth rates that coincide with the vertical lines that identify changes in the method of constructing the three quarterly real GDP series. The period prior to the mid 1950s does appear to be considerably more volatile than subsequent years. One might infer from these data that, just as Blanchard and Simon concluded for many of the G-7 countries, there has been a secular decline in New Zealand's real GDP volatility during the post-war years, notably after 1950. However, differences in coverage, data collection methods and the reliance on interpolation methods to derive quarterly estimates prior to 1977:3 mean that comparisons of the volatility of real GDP pre and post 1977 would be tenuous.

The focus of this paper is therefore the period since 1977:3, the period covered by the calibrated chain-linked series described in Haugh (2001). Calibrated real output series were also derived for five production sectors as well as for total real GDP. The five sectors are: *Services, Government and community services, Manufacturing, Primary*, and *Construction*. The allocation of industries to the five sectors is described in Table 1. The composition of our five sectors is easily identifiable and is consistent with United Nations SNA classifications and therefore enhances the opportunity for

meaningful international comparisons[4].

III. A decomposition of real GDP growth and its variance

The calibrated chain series for real GDP provides a conceptually consistent database from which to understand how the New Zealand macro-economy has been evolving. This series is used to estimate changes in the relative importance of sectors (changing sector shares), their growth rates, growth rate volatility, and the contributions of changes in sector shares, sector variances and sector co-variances to changes in quarterly real GDP volatility. To guide this analysis, it is instructive to identify the components that make up each growth and variance series.

Let Y_t denote the time series of seasonally adjusted GDP *levels* and $X_{1,t}, X_{2,t}, ..., X_{p,t}$ denote its component level production sector series so that

$$(1) \qquad Y_t = X_{1,t} + X_{2,t} + ... + X_{p,t} + E_t = \sum_{j=1}^{p} X_{j,t} + E_t$$

where the error term E_t principally accounts for the difference between seasonally adjusted GDP, Y_t, and the seasonally adjusted components, $X_{j,t}$, but also other factors (see Haugh, 2001 for further details).

Thus,

$$\frac{Y_t - Y_{t-1}}{Y_{t-1}} = \sum_{j=1}^{p} \frac{X_{j,t-1}}{Y_{t-1}} \bullet \frac{X_{j,t} - X_{j,t-1}}{X_{j,t-1}} + \frac{E_t - E_{t-1}}{Y_{t-1}}$$

and so, to a good approximation[5],

$$(2) \qquad \Delta \log Y_t = S_t + e_t$$

where

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4 Our preference was to allocate industries to sectors on the basis of the type of production activity while also reducing the number of categories to a manageable size. There are several other allocation rules we could have adopted to assign each of the 23 industries to a sector. They could have been grouped on the basis of common statistical behaviour. However, a simple statistical rule could mean that the same allocation decision may not be appropriate across all time periods. Therefore, this type of allocation procedure would not have assisted us with the type of questions we are interested in. Another allocation procedure could be to classify industries according to whether production outputs are internationally tradeable or non-tradeable. However, in practice this type of allocation is not very precise, especially at the industry level. Furthermore, the appropriate allocation can change if overseas consumer preferences, transport costs and real exchange rates change.

5 The approximation is $\log W_t - \log W_{t-1} = \frac{W_t - W_{t-1}}{W_{t-1}}$, provided the right hand side is small in magnitude.

$$S_t = \sum_{j=1}^{p} p_{j,t-1} \Delta \log X_{j,t} \; ; \quad t = 1,2,.....,T$$

Here, e_t represents the error arising from E_t and, to a lesser degree, approximation error and p_{jt} is the *share* or proportion of GDP represented by the component $X_{j,t}$ such that

(3) $$p_{jt} = X_{jt} / Y_t \; ; \qquad j = 1,2,..., p; t = 1,2,....,T$$

Moreover,

$$\Delta \log Y_t = \log Y_t - \log Y_{t-1}$$

represents the (continuously compounded) *growth rates* of Y_t with similar interpretations for the $\Delta \log X_{j,t}$,

Typically, the share, $p_{j,t}$, will evolve smoothly over time by comparison with the individual growth rates $\Delta \log X_{j,t}$. The latter have been chosen in preference to $(X_{j,t} - X_{j,t-1}) / X_{j,t-1}$ since these are continuously compounded rates, which are the common measures of growth used in the literature.

The *mean* and *variance* of $\Delta \log Y_t$ are given by

(4) $$E(\Delta \log Y_t) = E(S_t) + E(e_t)$$

(5) $$Var(\Delta \log Y_t) = Var(S_t) + 2Cov(S_t, e_t) + Var(e_t)$$

where the *mean* and *variance* of S_t are given by

(6) $$E(S_t) = \sum_{j=1}^{p} p_{j,t-1} E(\Delta \log X_{j,t})$$

and

(7) $$Var(S_t) = \sum_{j=1}^{p} p^2_{j,t-1} Var(\Delta \log X_{j,t}) + 2 \sum_{j<k} p_{j,t-1} p_{k,t-1} Cov(\Delta \log X_{j,t}, \Delta \log X_{k,t})$$

These approximate decompositions assume that the $p_{j,t}$ are smooth by comparison to the $\Delta \log X_{j,t}$. This assumption, validated later in the paper, effectively eliminates terms involving the variability of $p_{j,t}$.

The structural decomposition (2) and the mean and variance decompositions (4) to (7) provide a simple framework to analyse the growth rates of the components $X_{j,t}$ and their contribution to the growth rate of aggregate GDP Y_t, and to identify the contribution of sector shares, the variances of the components $X_{j,t}$, and the co-variances of the components $X_{j,t}$ to the volatility of aggregate real GDP.

The remainder of the paper is structured as follows. Section IV examines the contributions of each component of expressions (4) and (6) to total real GDP growth while Section V examines the contributions of each component of expressions (5) and (7) to the variance of total real GDP growth.

IV. Sector contributions to real GDP growth

In this section we consider the contribution of each production sector to real GDP growth, both in their own terms and moderated by their share of total GDP. The contribution of $E(e_t)$ to the mean growth rate of GDP is negligible (it oscillates around a mean quarterly growth rate of 0.03 percent with a mean deviation of 0.36 percent).

IV.1 Sector growth rates

As a first glance, Figure 2 shows the quarterly growth rates for seasonally adjusted real GDP and the five production sectors from 1977 to the December quarter 2000. All charts in Figure 2 are drawn to a common scale and therefore provide an illustration of the relative volatility of the growth rates of each sector. For instance, the *Construction* sector appears to be the most volatile sector followed by the *Primary* sector. It is difficult however using the actual quarterly growth rates to discern changes in the pattern of volatility over time, apart from perhaps the *Government and community services* sector, which displays a rise in the variability of quarterly growth during the mid and late 1990s. For this reason we use a moving average measure of quarterly growth rates, variances and co-variances throughout the remainder of the paper.

An 11-quarter moving window was used throughout the paper to derive centred moving average real GDP growth rates, growth variances and co-variances. Experiments with shorter (7-quarter) and longer (15-quarter) windows suggest that our conclusions are robust to the choice of window length[6].

Centred moving average quarterly growth rates for the five aggregated production sectors and total real GDP are displayed in Figure 3, together with their mean growth rates for the sample period 1977:3 to 2000:4. Figure 3 therefore shows the moving

6 In their decomposition of the demand-side of U.S. real GDP, Blanchard and Simon (2001) used a 20-quarter moving window. Our preference was for a window length that minimized noise but did not average over cycles.

average values of the components ($\Delta \log X_{j,t}$) of $\Delta \log Y_t$ in expressions (4) and (6).

The relative mean growth rates and the patterns of quarterly growth displayed in Figure 3 explain the changing sector shares revealed in Figure 4. They also provide some initial insights concerning the contributions of each sector to total GDP growth, the growth variance of each sector, whether the variances have changed over time, and whether sector growth rates are correlated. These are issues we examine in more detail in the following sections, but some initial observations are warranted at this point.

The *Primary* and *Services* sectors have experienced the highest average growth rates over the last 25 years. The average quarterly growth rates were 0.8 percent for *Primary* and 0.6 percent for *Services*. *Government and community services* grew by 0.5 percent per quarter; *Manufacturing* by a mere 0.3 percent and *Construction* averaged only 0.2 percent. But there are marked changes in the pattern of growth rates over time.

Total real GDP appears to have moved through three phases over the last 25 years. The first phase in the late 1970s and early 1980s appears to have been one of relatively volatile positive average growth; the second phase from the mid 1980s to 1990 one of steadily declining growth; the third phase one of higher average and perhaps less volatile growth during the 1990s.

The emergence of these phases appears to be determined largely by the *Services* sector, the *Manufacturing* sector (although with lower average growth in each phase) and *Construction*. Although the smallest sector, *Construction* displays the largest swings in growth rates.

The *Government and community services* sector moved through a phase of modest average growth in the first phase to low average growth in the second phase. This sector displayed a rise in average growth during the third phase and seems to be more volatile but also more closely correlated with the *Services*, *Manufacturing*, and *Construction* sectors in the third phase (as illustrated by Figure 6).

Primary is the fastest growing sector and the contrasting sector. Average growth and volatility appears not to have changed markedly over the last 25 years. This sector displays a more consistent cyclical pattern and doesn't always match the phases displayed by the other sectors, although the correlation of the *Primary* sector growth rate with the growth rates of the other sectors may have increased during the second half of the 1990s.

IV.2 Sector shares

The disparate growth rates observed in Section IV.1 generated changes in sector shares over time. Figure 4 shows how the shares for the five production sectors have changed since 1977. That is, Figure 4 shows the component $p_{j,t}$ (where $j = 1,2,...,5; t = 1,2,....,T$) of expressions (4) to (7) for each *j* and *t* since 1977:3.

Figure 5 shows the time varying share of total GDP of some of the components of these five sectors that have experienced significant variation in their shares: *Communications*, *Finance and real estate and business services*, *Transport and storage*, *Combined wholesale trade* (components of the *Services* sector), *Agriculture*,

Forestry and logging (components of the *Primary* sector), *Other food manufacturing*, *Textiles*, *Non-metallic mineral products*, *Machinery and equipment manufacturing* (components of the *Manufacturing* sector).

It is immediately apparent from Figure 4 that the sectoral make-up of the New Zealand economy has changed markedly over the last 25 years, especially since the mid 1980s. The *Services* and *Primary* sectors have increased their shares, while the shares for the *Government and community services*, *Manufacturing*, and *Construction* sectors have declined.

The *Primary* sector share of total GDP increased continuously during the last 25 years, from around 7 percent of GDP in 1977 to around 9 percent by 2001. This was driven mainly by increases in the shares of *Agriculture* and *Forestry and logging*, as illustrated by Figure 5.

In contrast, *Services*, *Manufacturing* and *Construction* display sharp breaks in their sector shares of total GDP during the mid to late 1980s, years when major economic reforms were introduced in New Zealand. The *Services* share increased sharply after 1985 and has maintained a steadily increasing share in subsequent years. In just 15 years, the *Services* share has jumped from around 48 percent to 52 percent of GDP.

In marked contrast, the *Manufacturing* share declined sharply after 1985 and its share has generally continued to decline subsequently, apart from a brief rally during the early 1990s. During the last 15 years, the share of *Manufacturing* has fallen from around 18 percent to 14 percent. The share of the *Construction* sector fell sharply in 1989 from around 5 percent to 4 percent and remains at about 4 percent of GDP.

The *Government and community services* share of GDP declined steadily during the late 1970s to the mid 1980s from around 17 percent to below 16 percent. It recovered somewhat during the early 1990s and has subsequently hovered around 16 percent of GDP.

IV.2.1 Services sector shares

The rise of the *Services* share of GDP was driven by increases in the shares of the *Communications*, *Finance and real estate and business services*, and *Transport and storage* industries. This was partially offset by a fall in the share of the *Combined wholesale trade* industry, which includes *Accommodation and restaurants*, *Retail trade* and *Wholesale trade*.

Advances in information and communications technology have resulted in the *Communications* industry experiencing the fastest mean growth of all industries over the full sample period. The *Communications* industry has grown at an average rate of approximately 2.1 percent per quarter from 1977 to 2000, resulting in its share of GDP rising from 1.2 percent in 1977 to 5 percent in 2000.

The *Finance and real estate and business services* industry had a large jump in its share in the mid 1980s from around 15 percent of GDP to around 18 percent of GDP. This is likely to be associated with widespread financial reforms that occurred during the mid to late 1980s. These reforms included deregulation of foreign exchange trading, abolition of credit growth guidelines and removal of interest rate controls in 1984, the end of reserve ratio requirements, sector lending priorities and restrictions on ownership of financial institutions in 1985 (Silverstone, Bollard and Lattimore, 1996,

Figure 1 and Appendix to "Introduction"). These changes generated significant changes in the structure of the financial sector and market shares (Harper and Karacaoglu, 1987).

The *Transport and storage* sector has also increased its share from 3.8 percent to 5.1 percent of GDP. This may reflect the impact of deregulation of the transport industry, which had been previously regulated to benefit government-owned rail at the expense of road transportation. In particular, between 1983 and 1986 quantity restrictions on road and rail carriage and quantity licensing of trucking were removed (Silverstone, Bollard and Lattimore, 1996, Figure 1 and Appendix to "Introduction"), moves that are considered to have increased the flow of transport activity (Guria, 1987). These changes were followed by the opening up of the domestic aviation industry in 1987, corporatisation of ports in 1987 and deregulation of the taxi industry in 1990 (Silverstone, Bollard and Lattimore, 1996, Figure 1 and Appendix to "Introduction").

The *Combined wholesale trade* category fell from 18 percent of GDP in 1977 to around 15 percent in the mid 1980s. In contrast to other industries, the wholesale trade share has remained relatively constant ever since then. The components of *Combined wholesale trade* that caused this decline are unknown because disaggregated data on the components is only known from June 1986. Since that time the components *Accommodation and restaurants*, *Retail trade* and the remainder of the wholesale trade industry, have all remained reasonably stable.

IV.2.2 Manufacturing sector shares

The rise in the share of *Services* is mirrored by an equally dramatic fall in the share of *Manufacturing* during the mid to late 1980s. This downward trend was further exacerbated during the late 1990s, after a moderate recovery in the early 1990s. The decline in the share of *Manufacturing* was initially associated with a sharp appreciation of the real exchange rate during the mid to late 1980s, the phase-out of import licensing requirements between 1983 and 1989, the phase-out of export performance tax incentives between 1984 and 1987, and the reduction of import tariffs on the basis of the "Swiss formula" from an average of 28 percent to 5 percent between 1986 and 1996 (Silverstone, Bollard and Lattimore, 1996, Figure 1 and Appendix to "Introduction").

This decline in the relative performance of the *Manufacturing* sector raises questions that go beyond the scope of this paper, but the work of Hazledine and Murphy (1996) suggest that by the early 1990s there had been little improvement in allocative efficiency in manufacturing following economic liberalisation, apart from improvements in the primary processing industries. Not surprisingly, they suggested that the *Manufacturing* sector was initially adversely affected by the removal of trade protection.

Manufacturing industries that have had a declining share of GDP include *Other food manufacturing, Textiles*, *Non-metallic mineral products*, and *Machinery and equipment manufacturing*. The share of the *Basic metals* industry has remained constant while *Wood and paper products* and *Petroleum, chemicals and plastics* have increased their shares. The rise in the *Wood and paper products* industry coincides with increases in *Forestry and logging* (included in the primary sector). The decline in the *Textiles* industry, an industry which had traditionally been subjected to relatively very high levels of effective protection prior to the late 1980s (see Lattimore and Wooding, 1996), is likely to reflect the impact of the removal of high levels of effective border protection. Also notable in the Manufacturing sector is the declining share of the *Machinery and*

equipment manufacturing industry, an industry in which some of the most advanced manufacturing technology could be expected to be found.

IV.3 Sector contributions to GDP growth

This section brings together the components of total GDP growth examined in the previous two sections and described by expressions (4) and (6): the sector shares, $p_{j,t}$, and sector growth rates, $\Delta \log X_{j,t}$. Note that the contributions measured here are the proximate contributions to total GDP growth and do not reflect the importance of a sector in terms of initiating or under-pinning growth in other sectors.

Over the full sample period, real GDP grew by an average of approximately 0.5 percent per quarter. The *Services* sector accounted for over half of this growth, contributing an average of 0.3 percentage points to total GDP per quarter. This reflects its substantial and rising share of GDP and the fact that it was the second fastest growing sector (after the primary sector). *Government and community services* was the second highest contributor with an average of 0.08 percentage points. The much smaller *Primary* sector was the fastest growing sector contributing 0.07 percentage points to overall growth per quarter. The larger but relatively slow growing *Manufacturing* sector meant it contributed less to overall growth than the Primary sector, at an average of 0.05 percentage points per quarter. The contribution of the *Construction* sector was close to zero.

However, there have been substantial variations about these average contributions to growth. This is illustrated by Figure 6 which shows the share weighted contributions of each sectors quarterly real output growth rate to total real GDP growth in each quarter. Figure 6 illustrates the importance of the contributions of *Services* and *Manufacturing* in determining the three phases of GDP growth. Although *Construction* displays a similar pattern, its small size means that it contributes less to total GDP. The contribution of the *Government and community services* sector increased during the third phase. At least until the early 1990s, growth in the *Primary* sector tended to be less synchronised with the other four sectors. During the late 1990s sector growth became more synchronised.

V. Sector contributions to real GDP volatility

Volatility of New Zealand total GDP, as measured by its 11 quarters centred moving standard deviation, has declined over the period 1977 to 2000. Figure 7 shows that the standard deviation of the quarterly growth rate for total GDP declined in the late 1980s, fell further in the mid 1990s, before rising again more recently to a level similar to that which prevailed at the beginning of the 1990s. Between 1977 and the late 1980s, the average standard deviation of the quarterly growth rate for total GDP was around 1.2 percent. Since the late 1980s, the standard deviation has averaged about 0.8 percent, a fall of about 33 percent.

There are several potential proximate causes of this fall in GDP volatility. GDP is an aggregate of component production sectors. Therefore its volatility is a function of the share of each sector, the variance of the growth of each sector, and the co-variance between the growth rates of each sector. This relationship is set out in expression (7) with the impact of the error term shown in expression (5). We now turn to examine the relative importance of these factors.

V.1 Sector volatility

The behaviour of the variances of each sector is illustrated by their 11-quarter centred moving standard deviations shown in Figure 7. These plots show noticeable falls in *Manufacturing* and *Services* sector production variances during the mid and late 1980s respectively. By contrast, the variances of production in the *Primary* and *Construction* sectors remained relatively constant over the sample period. There was a noticeable increase in the variance of the *Government and community services* sector in the mid 1990s.

The influence of these changes on total GDP volatility depends on the share of the sector in total GDP. Figure 4 shows that these shares have changed markedly. Each sector's moving standard deviations weighted by their share in GDP is plotted in Figure 8. The largest contributions[7] to the change in total GDP volatility have come from the *Services* and *Manufacturing* sectors. Although the *Construction* sector was only around 4 percent of GDP by the end of 2000, its high variance means that its influence on total volatility as measured by its weighted standard deviation is only slightly below the *Manufacturing* sector, which constitutes around 14 percent of GDP. The *Primary* sector at around only 10 percent of GDP has similar and sometimes a higher weighted standard deviation than the *Manufacturing* sector and even the *Services* sector, which accounts for around 50 percent of GDP. Since the 1980s, the Services sector, despite its relatively large size, does not appear to influence overall aggregate GDP volatility much more than the other much smaller sectors.

V.1.1 Services sector volatility

Overall the standard deviation of the *Services* sector fell from around 1.2 percent prior to the mid 1980s to around 0.8 percent in the post mid 1980s period, a fall of approximately 33 percent. Figure 9 shows a breakdown of the Service industries weighted by their share of GDP.

Figure 9 illustrates that the *Combined wholesale trad*e industry, which includes wholesale trade, retail trade and accommodation, restaurants and cafes, appears to be largely responsible for the fall in Services sector volatility during the late 1980s. The large spike around 1986 is associated with the introduction of the 10 percent Goods and Services Tax (GST) in October of that year. Seasonally adjusted real output increased by 5 percent in the September quarter immediately preceding the introduction of GST. It fell by 6 percent in the subsequent quarter. The spike around 1989 is associated with the introduction of an additional 2.5 percent GST rate in that year.

Furthermore, there appears to have been a more gradual underlying decline in the volatility of production in the *Combined wholesale trad*e industry during the late 1980s. The reasons for this are unclear, but this industry has experienced declining inventory to sales ratios since the mid 1980s and may have benefited from improvements in inventory management techniques (see Buckle, 2000, Table 1).

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7 Contribution is used loosely here. The sum of these weighted standard deviations will not sum to the standard deviation of GDP as the sum of weighted growth rates would unless the sector series are all independent.

The *Finance and real estate and business services* industry also contributed to the fall in *Services* sector volatility, although this appears to be because of a large spike in volatility during the early 1980s rather than a trend change. This was associated with comprehensive price, wage and interest rate regulations which imposed varying degrees of limitations on price, wage and interest rate changes between June 1982 and July 1984 (Boston, 1984, Chapter 9), thereby placing greater pressure on quantities to adjust. Since the removal of those regulations, production in the *Finance and real estate and business services* industry has been relatively more stable. However, as with the *Combined wholesale trad*e industry, there is a spike associated with the introduction of GST in October 1986, and volatility in the *Finance and real estate and business services* industry appears to have increased again in the mid to late 1990s.

The *Electricity, gas and water* and *Transport and storage* industries have contributed relatively little to overall Services sector production volatility, except in the early to mid 1990s. The rise in volatility is associated with a long and sustained period of economic expansion, deregulation of the sectors and, in the case of the *Electricity, gas and water* industry, a drought that led to low lake water storage levels and power shortages in the early 1990s (see M-co, 2001). By the end of the sample period the weighted standard deviations for both industries had subsided again.

In contrast, the *Communications* and *Owner occupied dwellings* industries have contributed very little to the changes in Services sector volatility. *Owner occupied dwellings* produces a stream of housing services from the housing stock. Because the housing stock does not fluctuate significantly, this stream of services is also very stable. The *Communications* industry growth rate has a relatively low standard deviation and has a relatively small, but rapidly rising, share of GDP. Low volatility of this industry is associated with a period of marked technical change, which may be masking cyclical effects.

V.1.2 Manufacturing sector volatility

The average standard deviation of the quarterly growth of *Manufacturing* production fell from around 2.4 percent between 1977 and the early 1980s to around 1.8 percent thereafter. This approximately 25 percent reduction in *Manufacturing* sector volatility is largely due to the occurrence of two large volatility spikes for two industries during the mid to late 1980s.

Figure 10 shows selected manufacturing industry weighted (by share of GDP) standard deviations. Two industries, *Machinery and equipment manufacturing* and *Other food manufacturing* experienced sharp increases in their standard deviations in the 1980s, which subsequently subsided and have not reappeared again.

The sharp increase in the *Machinery and equipment manufacturing* standard deviation occurred in the early to mid 1980s, a period associated with significant investment in large capital projects during the development of the "Think Big" projects (see Silverstone, Bollard and Lattimore, 1996). This spike appears to have been preceded by relative high volatility in the late 1970s. However, the short period of available data makes it difficult to determine whether the spike in the *Machinery and equipment manufacturing* industry is a one-off or is representative of the volatility in this sector prior to 1977.

There is also a spike in the standard deviation of *Other food manufacturing*. This is associated with the introduction of a 10 percent Goods and Services Tax (GST) in October 1986. There is little evidence of a decline in volatility in other manufacturing industries.

V.2 Contributions of sector shares, variances and co-variances

The previous section examined the behaviour of the growth rate variances of the sectors that make up real GDP. As we have stressed, GDP volatility will be determined not only by the variances of each of its component sectors but also by changes in the share of each sector in total GDP and the co-variance between sectors. In this section we evaluate the relative importance of each of the three components that make up expression (7), and examine the impact of the error term (e_t) in section V.3.

We first examine the contribution of changing sector shares. The potential for sector composition changes in the form of changing sector shares, to impact on aggregate GDP volatility was emphasised by Arthur Burns in his often-cited 1960 address to the American Economic Association (Burns, 1960). If a relatively stable sector displaces a more volatile sector, everything else constant, aggregate volatility will fall (and vice versa).

The five sectors in order of volatility from highest to lowest are *Construction, Primary, Manufacturing, Services, and Government and community services.* From 1977 to the end of 2000, the sum of the share changes has been to replace around 3 percentage points of *Manufacturing*, 1 percentage point of *Construction*, 1 of *Government and community services* and 2 percentage points of the unallocated, with about 2 percentage points of *Primary* and nearly 5 percentage points of *Services*. The general pattern therefore, has been for a less volatile *Services* sector to be replacing more volatile sectors including the *Construction* and *Manufacturing* sectors. However, there has also been an increase in the share of the relatively volatile *Primary* sector and a decrease in the relatively stable *Government and community services* sector.

To evaluate the impact of changing shares, actual real GDP volatility (using the actual evolution of sector shares) is compared with GDP volatility simulated by weighting sector variances and co-variances using sample period mean sector shares. That is, we compare the derivation of the expression (7), the variance for S_t, using the actual values for the respective sector shares, $p_{j,t}$, with the derivation of (7) using the sample period mean of the respective sector shares. Figure 11 illustrates the result of this comparison. It is clear that apart from some minor differences during the early 1980s, the change in sector shares has not had a significant impact on the evolution of real GDP volatility[8].

Turning now to the contribution of sector variances and co-variances, it is apparent from Figure 7 that the behaviour of sector variances can change substantially over time and varies across sectors. Hence, even with constant shares, idiosyncratic sector variance behaviour could result in offsetting influences on total real GDP volatility. Similarly, if sector growth rates are independent, the measured co-variances will be

8 This result is consistent with Blanchard and Simon (2001) decomposition of the demand side contributions to changes in U.S real GDP volatility. They concluded "composition effects had little to do with the general pattern of output volatility over the last fifty years" (p 162).

small and would contribute very little to GDP volatility. On the other hand, high dependence between sector growth rates will increase the potential for sector growth rate changes to influence total GDP volatility. Moreover, as the positive correlation between sector growth rates increases, sectors will have a greater tendency to move together leading to larger fluctuations in aggregate GDP and higher GDP volatility.

It turns out that the influence of both the sum of (weighted) sector variances and the sum of (weighted) sector co-variances are important. Figure 12 illustrates the respective contributions of sector variances, co-variances and changing sector shares to the variance of S_t, where S_t is the weighted sum of sector growth rates and excludes the error term e_t which principally accounts for the difference between seasonally adjusted chained weighted GDP, Y_t, and the seasonally adjusted chain weighted components. This diagram is constructed as follows. The plots for sector variances and co-variances are derived by summing the weighted sector variances and co-variances using constant (sample period mean) sector shares. The remaining component is the impact of changing sector shares.

It is clear from Figure 12 that the decline in real GDP volatility in 1987 was associated with a sustained decline in the sum of sector variances and a temporary decline in sector co-variances. The sustained decline in the sum of sector variances was, as discussed in Section V.I, the result of declining *Services* and *Manufacturing* sector variances.

There appears to be no trend decline in the sum of sector co-variances series, which exhibits significant recurring cycles. These cycles in the sum of sector co-variances have been the dominant influence on the profile of total real GDP volatility, especially since the decline in total volatility in the late 1980s. For example, the sharp fall in GDP volatility in the mid 1990s was primarily the result of a temporary fall in the co-variance of growth between the sectors. This suggests that at least for the last 10 to 15 years it has been the interaction between the sectors as opposed to changes in the variance of the sectors that has been the main influence on changes in total real GDP volatility.

The apparent lack of a trend and the cyclical nature of the sum of sector co-variances series suggests that, barring a significant change in weighted sector variances, GDP volatility can be expected to cycle with the degree of correlation between the sectors. Furthermore, if the decline in sector variances is a permanent feature, recurrent cycles in GDP volatility may in future be around a lower trend level of real GDP volatility, provided the co-variance between sector growth rates does not increase significantly.

The decomposition of GDP volatility into sector shares, variances and co-variances has revealed some unexpected results. Despite changes in New Zealand's industrial structure, changes in sector shares have not had a significant influence on the changes in GDP volatility. The main reason for the sustained decline in GDP volatility has been a decline in the sum of sector variances. There has been no significant trend decline in the influence of sector co-variances, which are now the dominant influence on the profile of GDP volatility.

V.3 Contribution of the error term

As noted before, the error e_t is primarily the consequence of aggregation and processing errors that exist in Statistics New Zealand's total series due to seasonal

adjustment and chain weighting procedures (see Haugh, 2001 for details). As expected, e_t oscillates around a mean close to zero with a standard deviation that is small. During the 1990s e_t exhibits little correlation with S_t, but there is some evidence of correlation prior to 1990 which may be an artefact of the introduction of chain linking. However, the net effect of adding this term does not materially affect Figure 12 or our conclusions.

If included, the error term tends to increase the variance of GDP in the 1980s, reduces it slightly around 1990, but makes no material difference thereafter. Moreover, the error term has a similar effect on the profile of the sum of sector variances. Therefore, conclusions drawn from the analysis of expression (7) are unchanged.

VI. Summary, conclusions and future research

Using chain-weighted estimates of production based real GDP, we find that New Zealand's real GDP has become less volatile since the mid 1980s. The average standard deviation of real GDP growth has fallen by about 33 percent since the mid 1980s compared to the average standard deviation for the period from 1977 to the mid 1980s. This decline in volatility coincides with reported reductions in GDP volatility during the mid 1980s in several other developed economies, including Australia, USA and the United Kingdom.

Although most attention has focussed on the break in volatility during the mid 1980s in these countries, Blanchard and Simon argue that this period is just one stage of a steady decline in GDP volatility that has been taking place over several decades. This might also be the case for New Zealand and there is some suggestion from Figure 1 that the 1950s at least was relatively volatile compared to more recent decades. However, we do not have available a sufficiently consistent long-term quarterly real GDP series that would enable a rigorous test of the behaviour of GDP volatility since the 1930s. For this reason we concentrate on the period from 1977.

To understand why New Zealand's real GDP has declined since the mid 1980s, this paper decomposes the variance of real GDP into the contribution of production sector shares, variances and co-variances. This procedure has generated several interesting and unexpected facts about the evolution of the structure of the New Zealand economy, the factors that influence real GDP volatility, and the reasons for the fall in New Zealand's real GDP in the late 1980s. Figure 12 highlights these points by comparing the contributions of sector shares, variances and co-variances to the variance of real GDP in each quarter since 1977.

As a result of disparate growth performances, there have been changes in the structure of the New Zealand economy that are reflected in changing sector shares. The shares of *Primary* sector output, a relatively volatile sector, and *Services* sector production, a sector with declining volatility, have increased at the expense of the *Manufacturing* sector, also a sector with declining volatility, the volatile *Construction* sector and the *Government and community services* sector.

Despite changing sector shares, this was not a significant factor contributing to the decline in real GDP volatility after the mid 1980s. The sustained decline in real GDP volatility was due primarily to a fall in the sum of sector variances. The decline in sector variances is explained primarily by two sectors: *Services* (specifically the

Finance and real estate and *Combined wholesale trade* industries) and *Manufacturing* (specifically the *Machinery and equipment manufacturing* and *Other food manufacturing* industries). There was no obvious change in the behaviour of the relatively volatile *Primary* and *Construction* sectors, although the volatility of *Government and community services* increased during the late 1990s.

Throughout the sample period, changes in the sum of sector co-variances has been the main factor determining the profile of GDP volatility. This influence has not diminished and its relative significance has increased since the mid 1980s.

What has caused the sustained decline in the sum of sector variances? The industry evidence presented in this paper suggests that industry, regulatory and fiscal policy interventions during the early and mid 1980s explain most of the relatively high volatility during that period compared to subsequent years. These policy interventions that appear to have been most important in contributing to the relative high volatility of the 1980s include the "Think Big" industrial development strategy, a comprehensive price, wage and interest rate freeze introduced in 1982, and the introduction of the Goods and Services Tax (GST) in 1986 and 1989.

The cessation of these policy interventions, responses to deregulation of many parts of the *Finance and real estate* industry, and the impact of more widespread deregulation on the behaviour of the *Wholesale trade* industry and industries in the *Manufacturing* sector appear to be key reasons for the decline in real GDP volatility since the mid 1980s. Changes in inventory management techniques may have also played an important role in some industries, particularly the *Combined wholesale trade* industry. To the extent that these regulatory and industry changes are permanent features, the New Zealand economy may indeed have entered a period of calm following the relatively stormy years prior to the mid 1980s.

These conclusions contrast with those of some studies that have examined the reasons for the decline in GDP volatility in other developed economies and which have identified reductions in supply shocks and the conduct of monetary policy as key contributors to changes in volatility. Our decomposition methodology may not be the ideal approach for identifying the precise contribution of supply shocks and monetary policy, but we think it nevertheless provides some useful insights concerning their relative importance. In particular, examination of the behaviour of volatility of the *Primary* sector provides no indication of a diminution of climate generated supply shocks. Indeed, climatic factors accentuated volatility in the *Electricity, gas and water* industry during the 1990s.

The timing and industry specific nature of the decline in sector variances suggests that monetary policy and its focus on inflation targeting appears unlikely to be the predominant explanation for the decline in New Zealand's GDP volatility. If monetary policy was the predominant influence, we might expect to see that influence reflected in a change in volatility across several sectors, and in particular in sectors that would be expected to be more sensitive to interest rates, such as the *Construction* sector. Furthermore, although formal inflation targeting has been associated with a fall in the variance of real GDP, the timing of the decline in real GDP volatility predates formal inflation targeting. This conclusion is consistent with Nadal-DeSimone's (2001) dating of a peak in 1987 and decline between 1987 and 1990 in the standard deviation of the cyclical component of New Zealand's real GDP.

For similar reasons, it would be difficult to conclude that changes in the stabilisation

role of fiscal policy have been a significant factor explaining the decline in GDP volatility. Furthermore, the volatility of the *Government and community services* sector increased during the mid and late 1990s. Nevertheless, the contemporary focus of fiscal policy on issues of sustainability and inter-temporal equity may have enhanced the tendency toward less abrupt policy changes during the 1990s. This shift in approach to policy may in fact have been more important than the indirect influences on GDP volatility typically considered arising from the impact of a longer-term focused fiscal strategy on private sector behaviour (see for example Allsopp and Vines, 2000).

This explanation appears to have been largely ignored in the contemporary debate about the reasons for the decline in GDP volatility across so many countries. Furthermore, the switch to less frequent and less abrupt policy interventions that has occurred in many developed countries might provide an important clue to the close timing of the decline in GDP volatility across several developed economies during the 1980s.

Our decomposition of GDP volatility raises other interesting questions that warrant further investigation. Why have the significance of the co-variances held up and their relative significance increased? What drives changes in the sector co-variances? Uncovering the factors that determine the variability of sector co-variances warrants deeper investigation because it is the most important component determining the cyclical variation in GDP volatility. We postulate that shocks that are common to many sectors, such as changes in interest rates, the exchange rate and aggregate demand will tend to raise the sector co-variance and raise GDP volatility. Shocks that are sector specific, such as sector specific climatic shocks and productivity changes, could be expected to have a smaller impact on GDP volatility.

Has deregulation changed the way sectors interact and influence GDP volatility? Preliminary cross-correlation analysis reveals a fall in the correlation between *Services* and *Manufacturing* sector growth rates and a rise in the correlation between the *Primary and Services* sectors since the early 1980s, suggesting either a change in the linkages between these sectors or that the type of shocks that have impacted on these sectors has changed. But this warrants deeper investigation, which could include investigating co-variances between sectors at different lags.

The changes in GDP volatility and the proximate factors contributing to this change raise several other important questions. Clarifying the reasons for such disparate growth rates between the production sectors is important but goes beyond the scope of this paper, which focuses on the volatility of GDP growth. However, the changes in GDP volatility and the proximate causes have potentially important implications for the short-term dynamic behaviour of the New Zealand economy. For example, have there been regime shifts in the dynamics of the New Zealand economy? If so, do they involve changes in growth levels and/or changes in the variance and auto-correlation properties around constant growth levels? What implications do these issues have for the way sectors interact and for the way sectors and total GDP react to climatic, international and fiscal and monetary shocks? These are questions that remain open challenges for future research.

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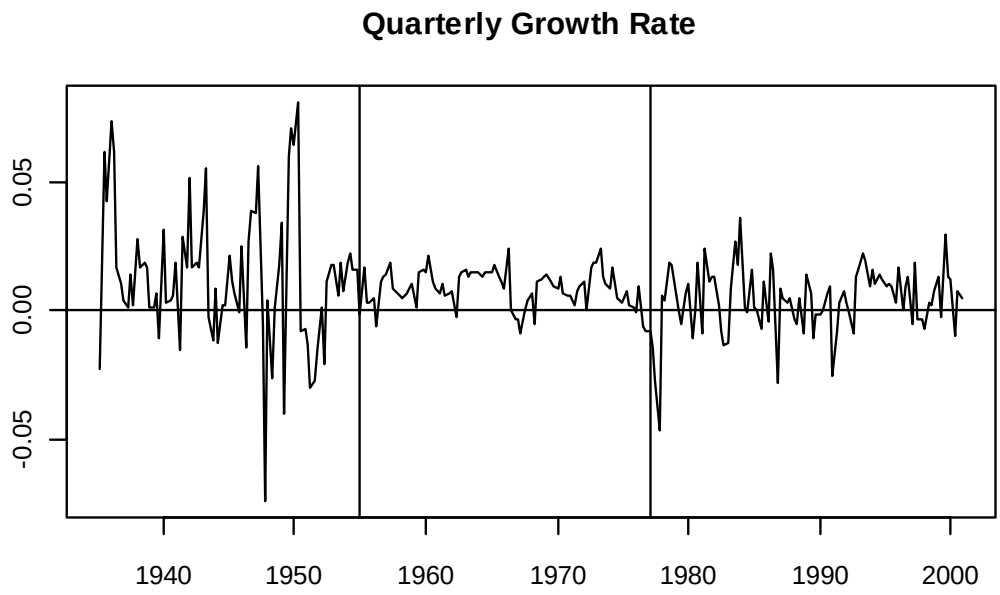
Table 1: Industry composition of the five production sectors

Sector Name	Chain linked Industries included in the Sector
Services	Communications + Electricity, Gas & Water + Combined Wholesale Trade + Transport & Storage + Finance, Insurance, Business Services & Real Estate + Owner Occupied Dwellings
Government and Community Services	Personal and Community Services + Central Govt and Defence + Local Govt Services
Primary	Agriculture + Fishing + Forestry + Primary Food Manufacturing
Manufacturing	Textiles + Wood & Paper Products + Printing & Publishing + Petroleum etc + Non-Metallic Mineral Products Manufacturing + Basic Metals + Machinery & Equipment + Other Manufacturing + Other Food Manufacturing
Construction	Construction

Figure 1: Influence of changing index measures on the profile of New Zealand's quarterly real GDP growth



This plot shows the quarterly growth rate of real seasonally adjusted GDP from June 1935 to December 2000. The vertical lines divide the series into 3 periods that have different data construction methods. From 1935 to 1954 the series is interpolated from the Statistics New Zealand annual nominal series and deflated by the CPI (Source: Reserve Bank of New Zealand). From 1955 to June 1977 the series is interpolated from the Statistics New Zealand annual real GDP series (Source: Reserve Bank of New Zealand). From September 1977 to December 2000 the series is the calibrated real seasonally adjusted GDP series used throughout this paper.

Figure 2: GDP and sector quarterly growth rates
(All figures drawn to a common scale)

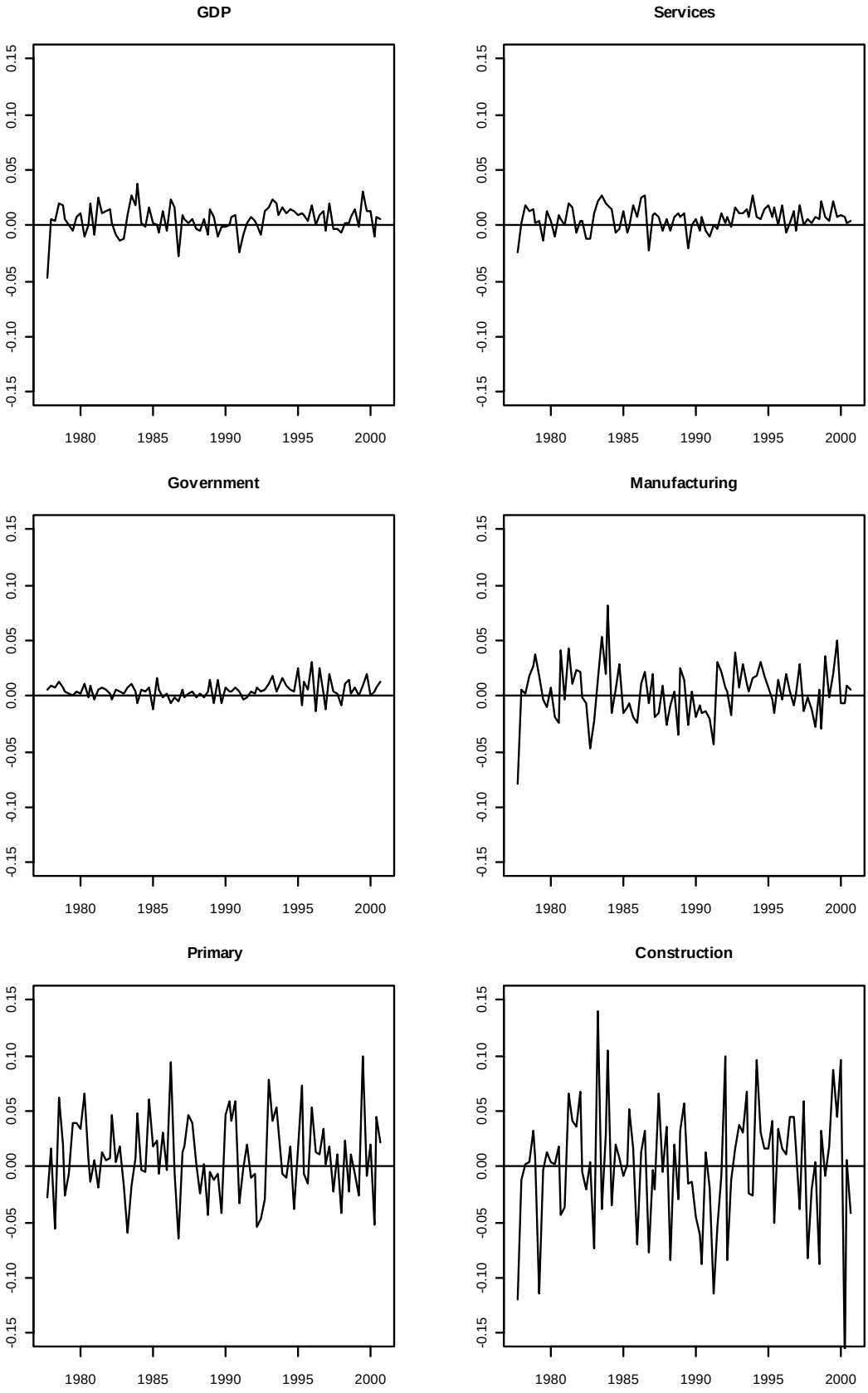


Figure 3: GDP and sector quarterly moving average growth rates
(11 quarters triangular centred moving average. Dotted line = mean.
All figures are drawn to a common scale)

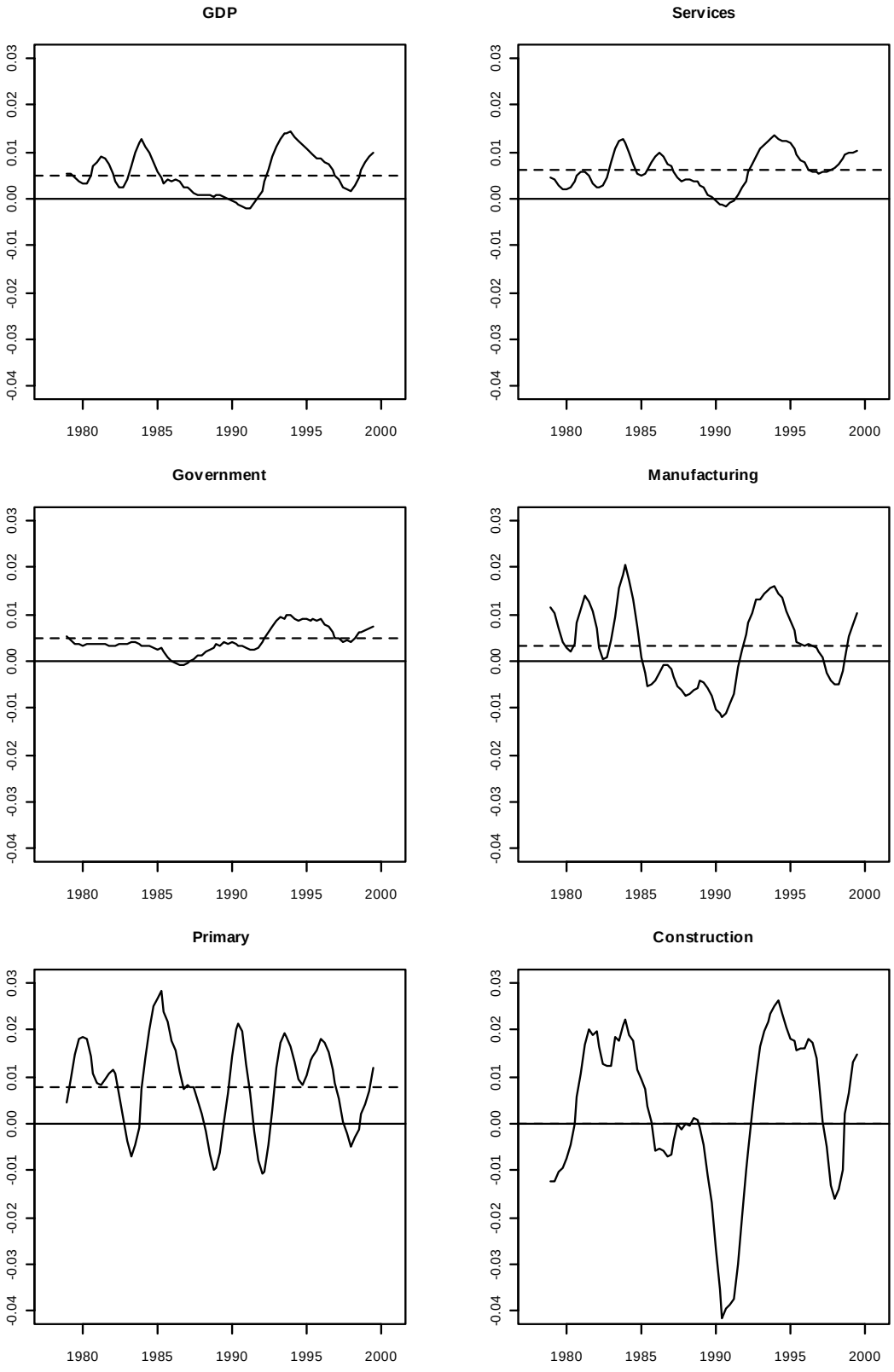


Figure 4: Sector shares of GDP
(All figures are drawn to a common scale)

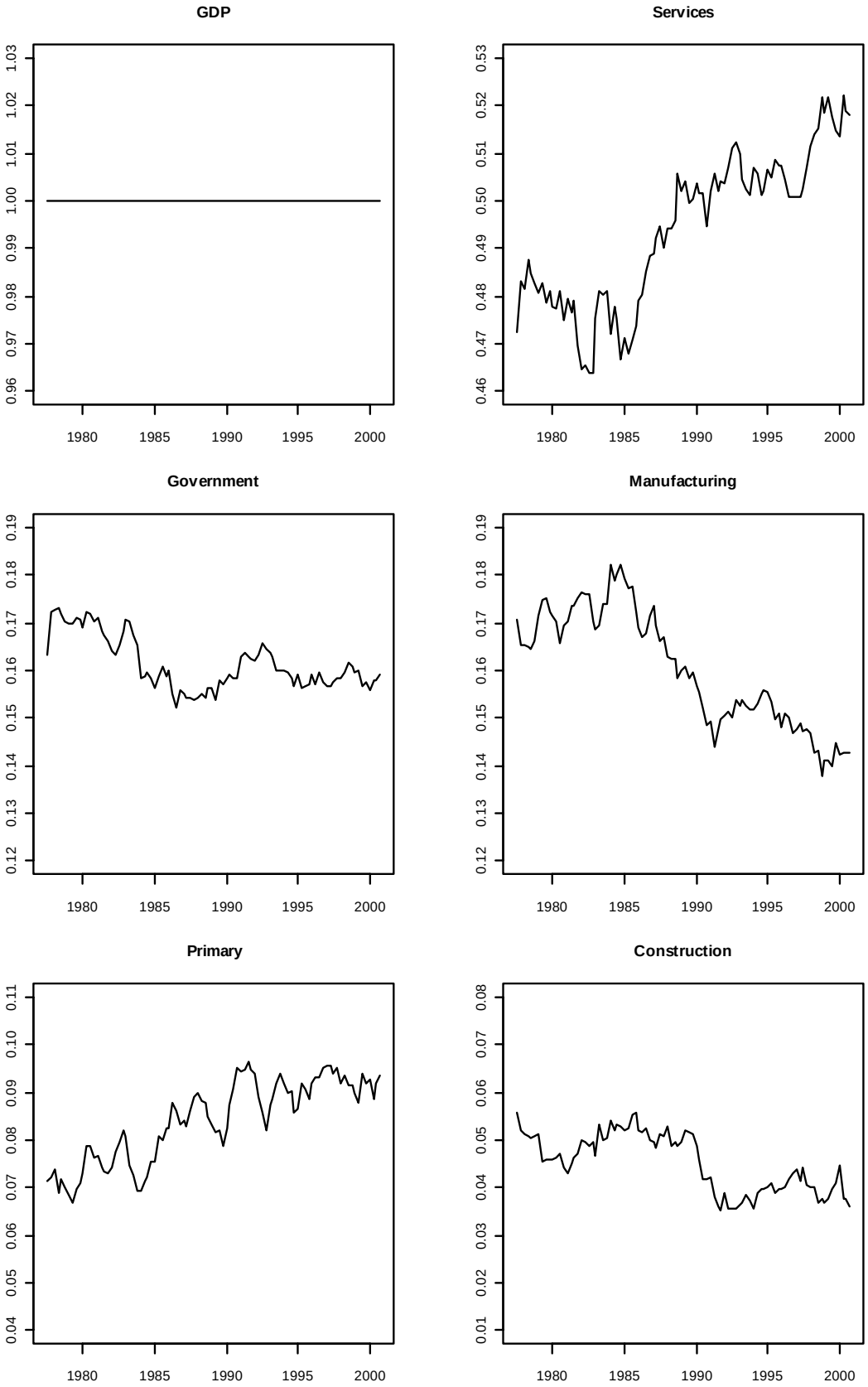


Figure 5: Industry shares of GDP

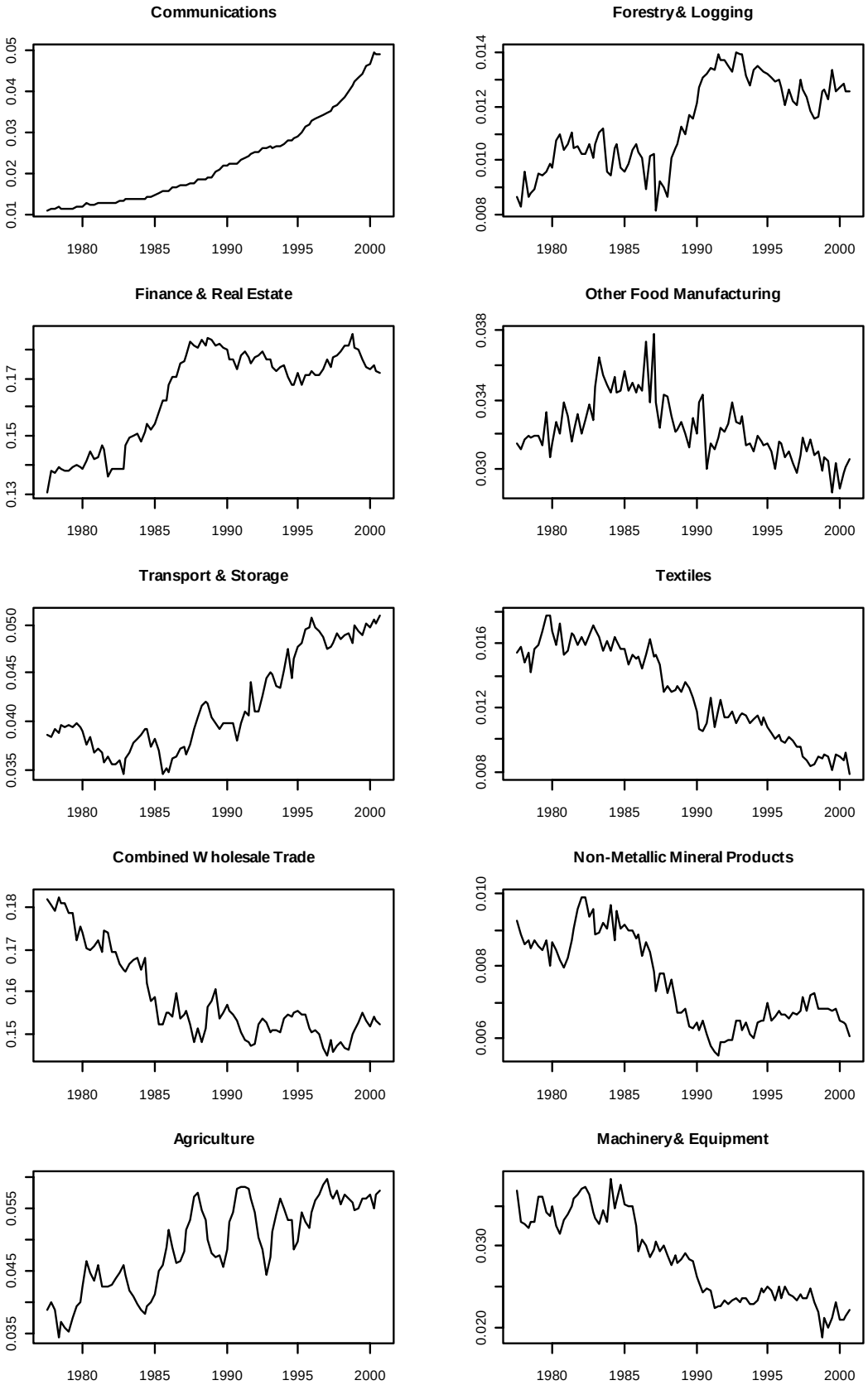
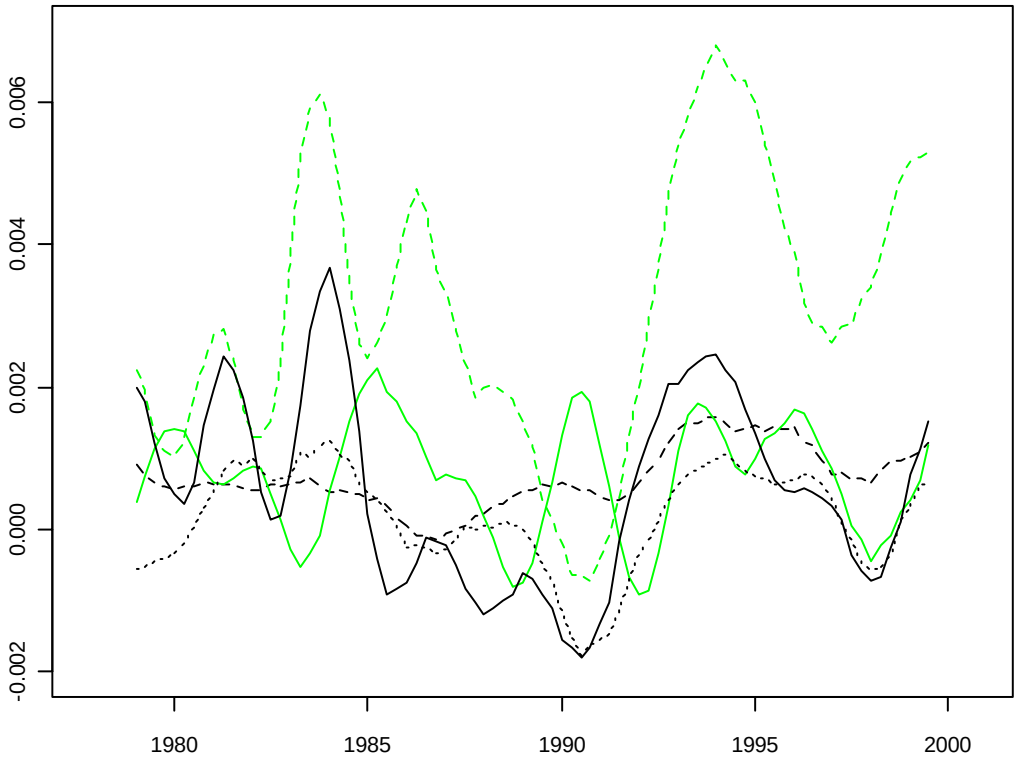


Figure 6: **Sector contributions to quarterly GDP growth**
(Sector growth rates weighted by share of GDP.
11 quarters centred triangular moving average)



The lines are: **dash grey**, Services; **dash black**, Government and community services; **solid grey**, Primary; **solid black**, Manufacturing; and **dotted**, Construction.

A 0.6 percentage point contribution to total GDP growth is equal to 0.006.

Figure 7: GDP and sector standard deviations
(11 quarters centred triangular moving average.
All figures drawn to a common scale)

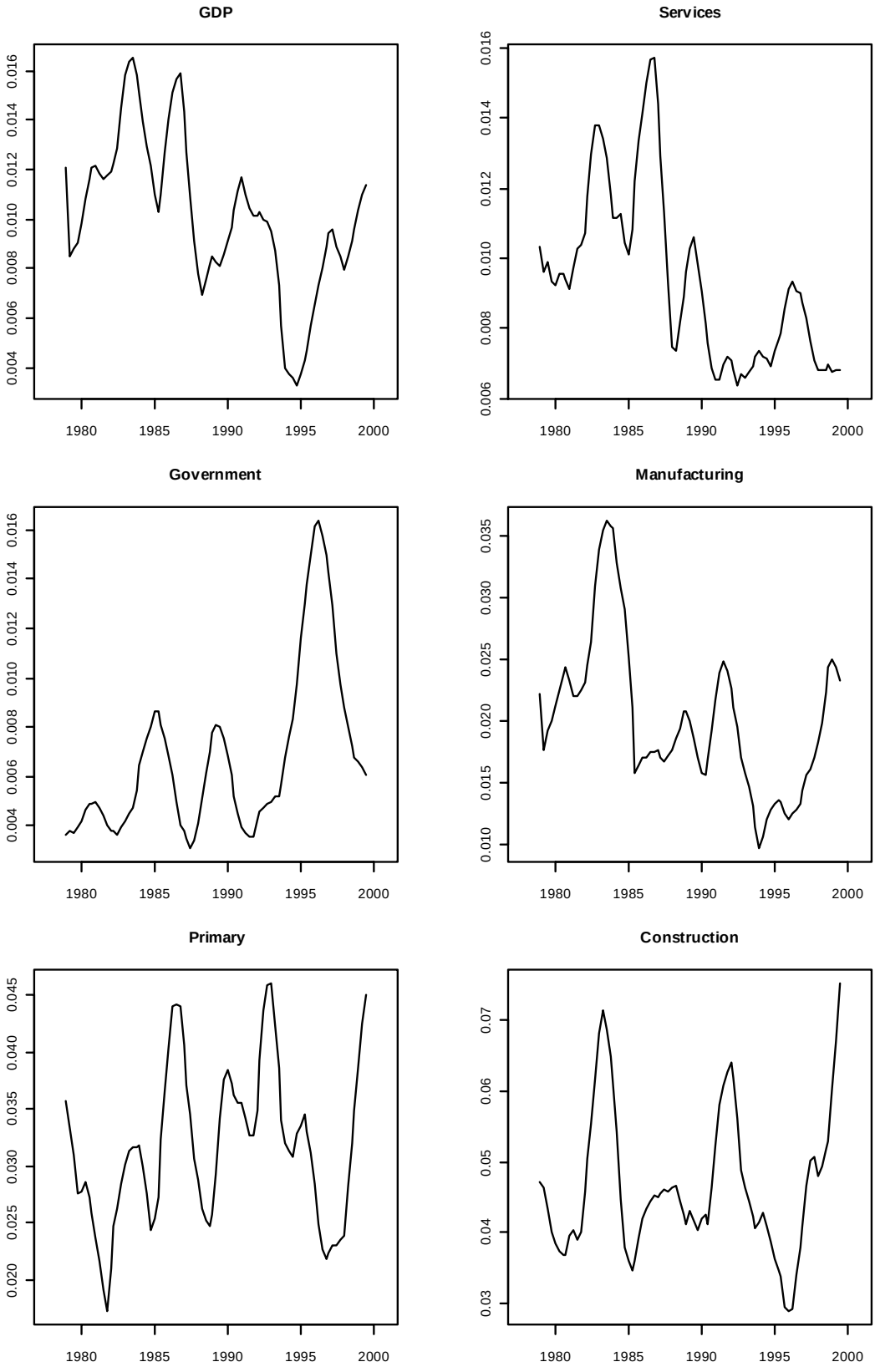
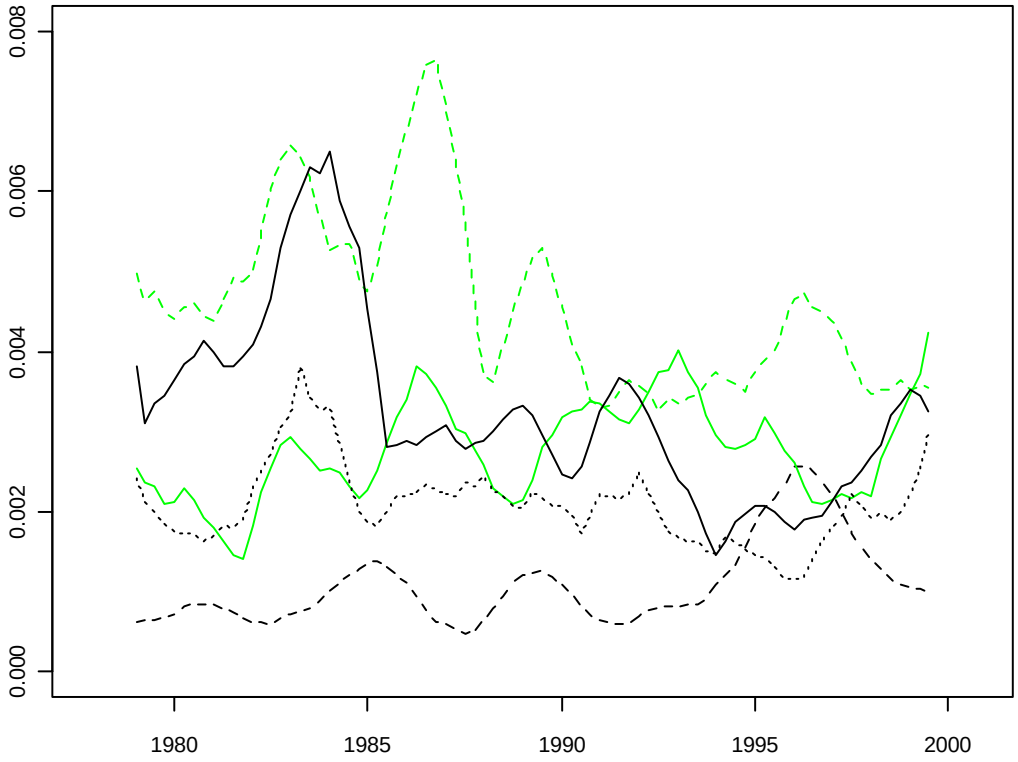
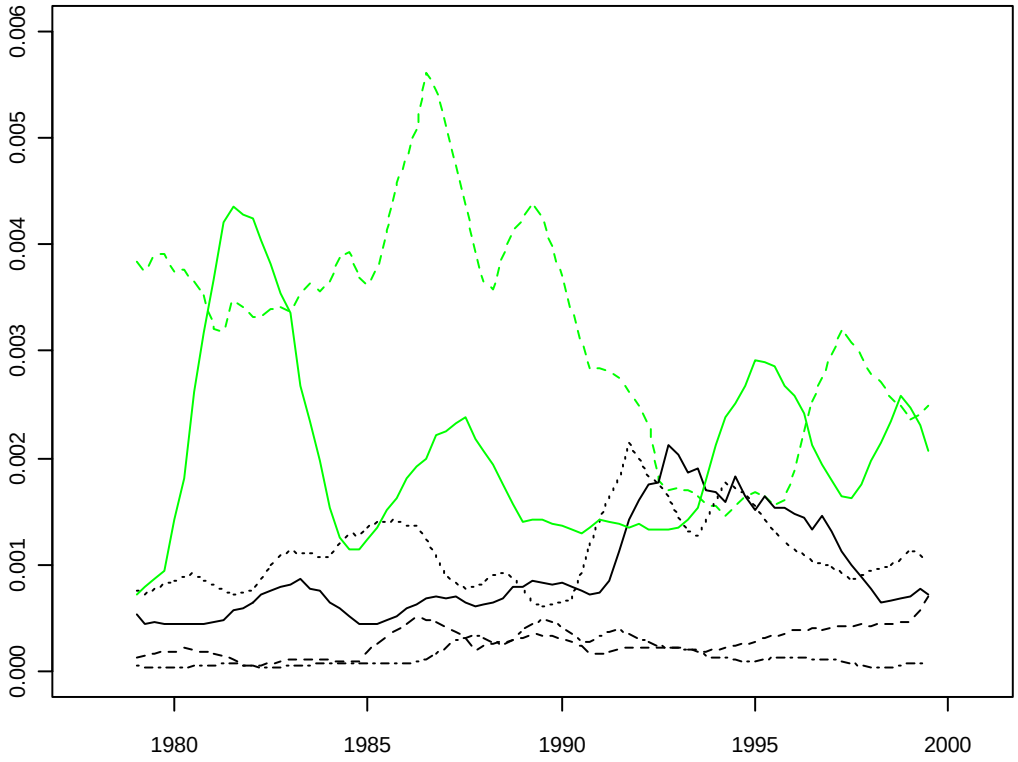


Figure 8: Sector weighted standard deviations
(Weighted by sector share of GDP;
11 quarters centred triangular moving average)



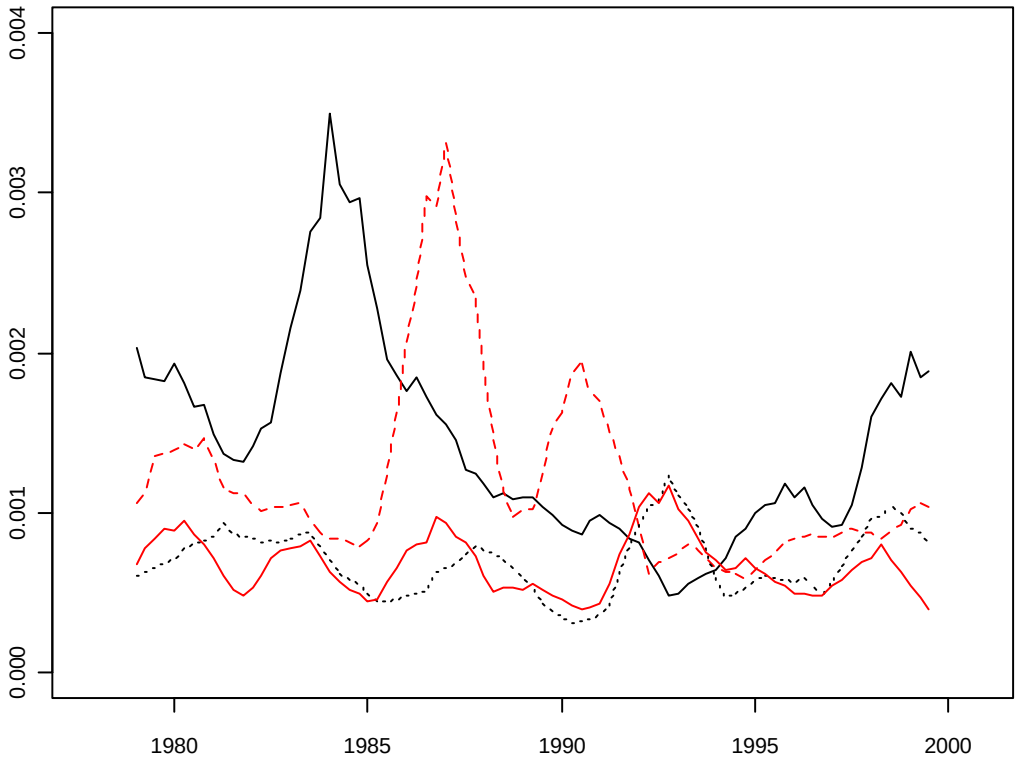
The lines are: **dash grey**, Services, **dash black**, Government and community services, **solid grey**, Primary, **solid black**, Manufacturing, and **dotted**, Construction.

Figure 9: Services industries standard deviations
(Weighted by sector share of GDP;
11 quarters centred triangular moving average)



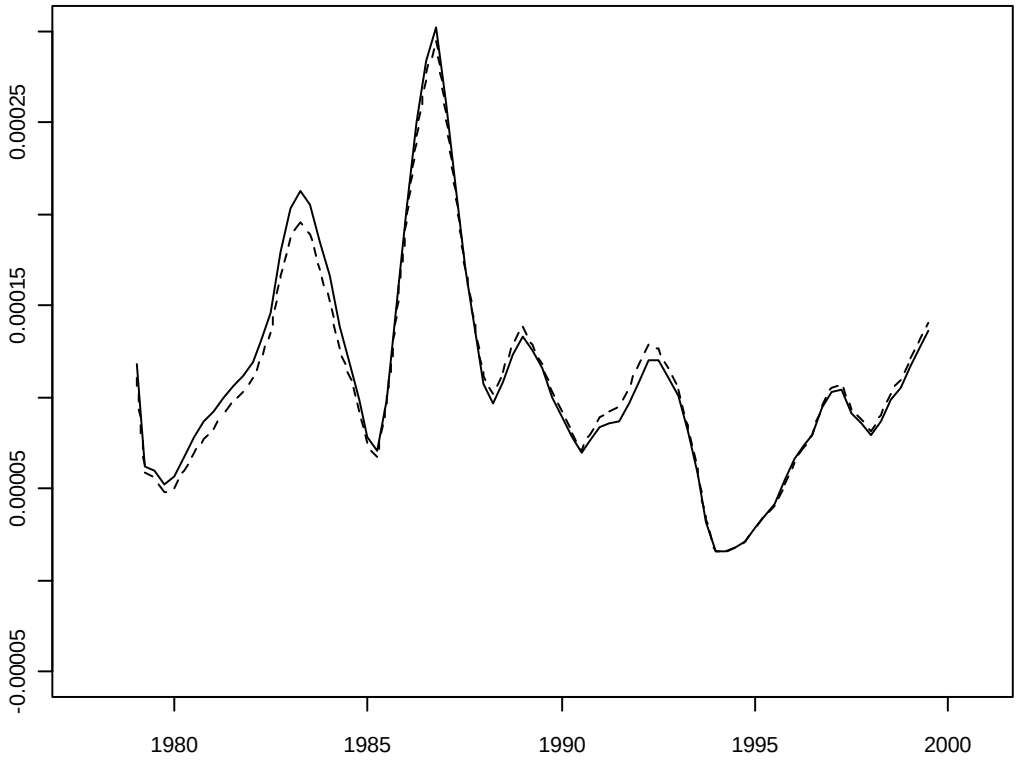
The lines are: **dash grey**, Wholesale trade; **dash black**, Communications; **solid grey**, Finance & real estate; **solid black**, Electricity, gas & water; **dotted**, Transport & storage; **dot-dash black**, owner occupied dwellings.

Figure 10: Manufacturing industries standard deviations
(Weighted by sector share of GDP;
11 quarters centred triangular moving average)



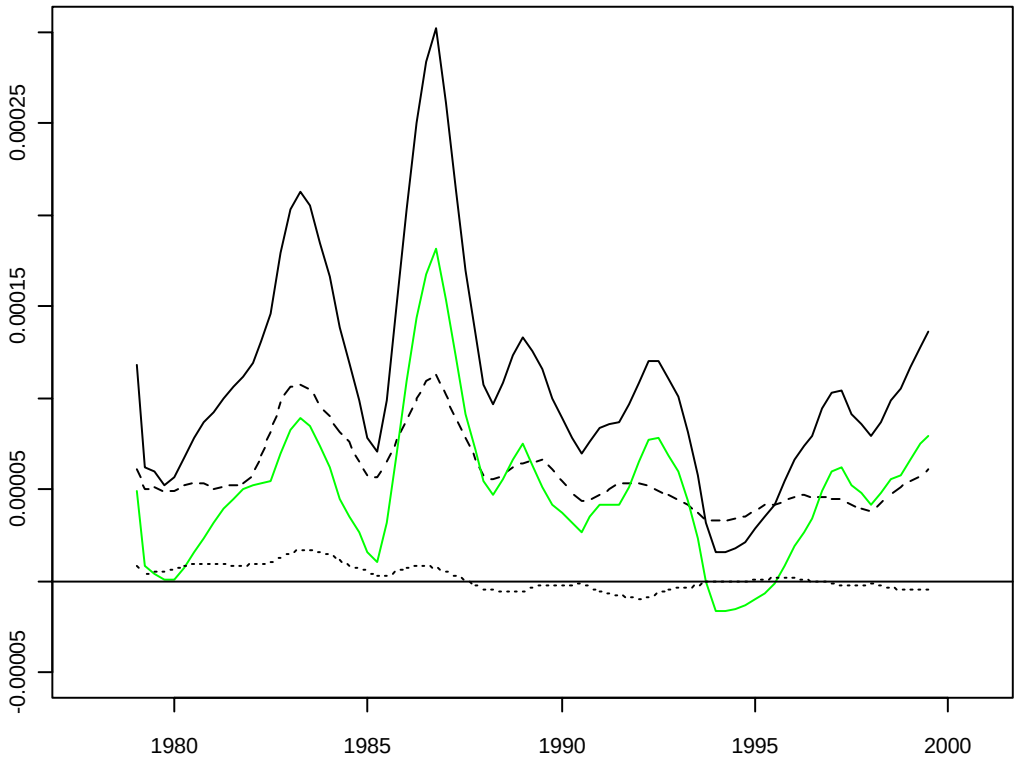
The lines are: **solid black**, Machinery and equipment manufacture; **solid grey**, Printing and publishing; **dash grey**, Other food manufacturing; and **dotted**, Wood and paper products manufacturing.

Figure 11: Comparison of real GDP volatility using constant and moving sector shares
(11 quarters centred triangular moving averages)



The lines are: **solid**, with moving shares and **dotted**, with constant shares.

Figure 12: Contributions of sector shares, variances and co-variances to GDP volatility
(11 quarters centred triangular moving averages)



The lines are: **black**, total variance with moving shares (sum of sectors); **black dashed**, sum of sector variances (mean shares), **grey**, sum of sector co-variances (mean shares); **black dotted**, effect of changing shares relative to mean shares (that is, the difference between total GDP variance with moving shares and sum of sector variances and co-variances with mean shares).