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An Anchor in Stormy Seas: Does Reforming Economic Institutions Reduce Uncertainty? Evidence from New Zealand

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Abstract

This paper begins with a brief narrative on the close conceptual relationship between institutions and uncertainty, which motivates using uncertainty as a metric of institutional reform success in the subsequent econometric analysis. Our analysis, based on using uncertainty measures constructed on firm-level data in a Bayesian Structural AutoRegression model, suggests that while during the reform period uncertainty increased, New Zealand's wide-ranging institutional reform in the late 20th century (approximately 1984 to 1995) was eventually successful in lowering uncertainty from domestic institutional sources. We also contend that rising uncertainty immediately prior to reform could have been the spur to reform. Given New Zealand was one of many OECD countries that pursued market-oriented economic institutional reform over the period, our results have insights beyond just understanding the New Zealand experience.

Keywords

Institutions
economic reform
uncertainty
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JEL Classifications

C32, E02, O43, O56

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Disclaimer: The results and views presented in this study are the work of the author not the New Zealand Institute of Economic Research.

1 Introduction

The high economic and social costs of reforming economic institutions compels a given reform to be successful. Typically reform success is measured by comparing the level of certain macroeconomic variables post-reform (such as GDP, employment, inflation and balance of payments deficits), relative to their pre-reform level.[1]

This paper posits that the level of uncertainty should be considered in assessing the success of instituional reform. This claim reflects the close relationship between institutions and uncertainty. If it is true that: '[t]hroughout history, institutions have been devised by human beings to create order and reduce uncertainty in exchange' (North, 1991, pg. 97), then reform of previously poorly-functioning economic institutions is only successful if uncertainty is lower post-reform than pre-reform. Our argument is that poorly-functioning institutions create excess uncertainty which a successful institutional reform will reduce. Successful institutional reform will not necessarily reduce uncertainty to near-zero. This is because a well-functioning economy, with well-functioning institutions, requires some uncertainty to ensure that entrepreneurial and creative destruction forces operate.

Limited attention has been paid to using uncertainty as a metric of economic institutional reform success because measuring uncertainty is problematic. The various definitions of uncertainty employed in a number of studies give a sense of why measuring uncertainty is difficult: uncertainty has been described as 'the condition wherein one cannot ascertain the probability of an event' (North, 1991, pg. 106), reflecting nonergodic processes (Davidson, 1991), or defined as the unforecastable part of volatility (Jurado, Ludvigson, & Ng, 2015). Studies of institutions and reforms have therefore tended to focus on volatility (for example, Bolen & Williamson, 2019),[2] used small-scale surveys (Borner, Brunetti, & Weder, 1995) or focused on one narrow aspect (such as inflation uncertainty and inflation targeting/ central bank independence; e.g. Boero, Smith, & Wallis, 2008, Lawton & Gallagher, 2020.)

Fortunately, developments in recent years has meant quantifying uncertainty has improved. A renewed interest in studying uncertainty has been aided by a proliferation of data (in numerical and textual forms), along with advances in computing power and statistical methods.[3] Armed with these new methods to measure uncertainty, we demonstrate how to assess the success (or otherwise) of the reform of economic institutions at reducing uncertainty.

[1] An example in the specific episode we are studying is Evans, Grimes, Wilkinson, and Teece (1996)

[2] As Jurado et al. (2015, pg. 1178) put it, it matters "...not whether particular economic indicators have become more or less variable or disperse *per se*, but rather whether the economy has become more or less *predictable*; that is, less or more uncertain" [original emphasis].

[3] Bloom (2014), Castelnuovo, Lim, and Pellegrino (2017), Ferrara, Lhuissier, and Tripier (2018), Cascaldi-Garcia et al. (2020) all provide useful surveys on the recent research on uncertainty (including its measurement).

Our research question asks if the New Zealand economic reforms, which broadly covered the period 1984 to 1995, reduced uncertainty from institutional sources? The New Zealand case is interesting as it shares broad similarities with the market-oriented economic reforms in last quarter of the 20th century in all OECD countries. In saying this New Zealand's reforms were an extreme case; the reforms have been called 'one of the most notable episodes of liberalization history has to offer' (Henderson (1995, pg. 66)). Kelsey (1997, pg. 85) notes New Zealand's structural adjustment programme centred on five areas: liberalisation of domestic markets and trade, reduction of the role and scope of the state, price stability being the objective of monetary policy, labour market deregulation and fiscal restraint. The reforms were (and remain) controversial. In part, this reflects the conflicting messages from the conventional metrics used to evaluate institutional reform success. To adopt a legal analogy: the jury remains out. A highly cited article by Evans et al. (1996) contends that the reforms 'have markedly improved New Zealand's economic prospects and represent a radical break from New Zealand's past policies of heavy regulation and import protection, and the accompanying, by OECD standards, relatively large fiscal deficits and high rates of inflation' (pg. 1894). Silverstone, Bollard, and Lattimore (1996) also conclude the reforms were a success: 'New Zealand's economic reform process may still rank as one of the more successful by world standards, with the potential to improve economic well-being compared to the outcomes from an unreformed economy' (p. 23); their conclusion is based, in part, on rising sectorial productivity and falling unemployment.

Not all authors have been so glowing. Dalziel (2002, pg.34) argues that pre-reform is not the relevant counterfactual. He argues a better counterfactual is the more moderate reform that took place in other countries. Dalziel (2002) chooses Australia as his comparator and concludes, based on some statistical analysis 'that New Zealand sacrificed a large volume of real per capita gross domestic product after 1987'(pg. 38).[4]

Although there are a few papers that have measured uncertainty in New Zealand via different methods (Goodson, 1995; Greig, Rice, Vehbi, & Wong, 2018; Kamber, Karagedikli, Ryan, & Vehbi, 2016; Tran, Vehbi, & Wong, 2019, Ballingall, Dorigo, Hogan, & Lees, 2020), none have looked at the impact of the reforms on uncertainty.

This paper offers three key contributions to the literature. The first contribution is conceptual. We set out the channels through which poorly-functioning institutions can influence uncertainty. In particular we argue that policy uncertainty, which has been found to have detrimental macroeconomic effects (e.g. Baker, Bloom, & Davis, 2016), is a proximate outcome of institutional dysfunction. Our second contribution is providing an empirical framework for, one, isolating the influence of institutional reform on uncertainty,

[4]In terms of other studies: B. H. Easton (1997) and Bayliss (1994) agreed with the microeconomic ideas (with reservation) and disagreed with the macroeconomic ideas; Hazledine (1998) and Kelsey (1997) are critical.

and, two, assessing if uncertainty is lower post-reform, relative to pre-reform. Thirdly, we show that New Zealand's reforms were successful when assessed on the criteria of reducing uncertainty from institutions (henceforth 'institutional uncertainty').

The remainder of this paper is structured as follows. Section 2 explains why uncertainty is an important metric for assessing the success of institutional change. In section 3 we briefly discuss New Zealand's institutions pre-reform and how they were changed during the reform. Sections 4 and 5 presents our methodology and results respectively. Section 6 outlines our conclusions; the main one being the New Zealand's reforms lowered institutionally-sourced uncertainty.

2 Institutions and uncertainty: comments on the conceptual relationship

2.1 Institutions, organisations and policy

Douglass North defined institutional frameworks ('institutions') as: 'humanly devised constraints that structure political, economic and social interaction' (North, 1991, pg. 97). North (1991) identified two types of institutions: formal institutions, which consist of formal constraints such as laws and rules, and informal institutions such as norms, codes of conduct and trust and co-operation. Together these constraints (and their enforcement) define a country's set of institutions and determine a country's incentive structure for savings, investment, trade and production. Consequently, when we talk about a set of well-functioning institutions, we refer to the situation where formal and informal constraints, backed by appropriate enforcement, all incentivise positive economic outcomes: high levels of trade, production, investment and saving.

Institutions are commonly used as a synonym for organisations. However, North was careful to make a distinction between the two concepts. If institutions are the rules of the game (in that they constrain behaviours), North likened organisations (and their members) to the players of the game. In North's view, the types of organisations that emerge depend on the incentives set by institutions. North (1994, pg. 361) says:

> if the institutional framework rewards piracy then piratical organizations will come into existence; and if the institutional framework rewards productive activities then organizations – firms – will come into existence to engage in productive activities.

Institutions do not just determine the type of organisations operating in the private sector. Formal institutions, such as the law and rules around competition and markets (among other rules) will determine the types of policy-making and regulatory organisations that emerge. A law which constraints one firm from controlling the whole market (a

formal institution) will give rise to a regulatory agency that monitors firm acquisitions. An informal norm, that high levels of inflation and deflation representing unacceptable social costs (an informal institution), can give rise to a formal law giving responsibility to a central bank (an organisation) to target a level of inflation via changing its policy settings.

It is also useful to distinguish between policy and institutions. A central bank that targets a medium-term inflation rate of two per cent might move its interest rate 25 basis points – this is a change in policy; the formal institution – the Act prescribing inflation targeting – remains unchanged. However, if the central bank changed from trying to achieve a certain level of inflation to, say, a certain level of the exchange rate, this would represent institutional change – the rules under which monetary policy are conducted have changed.

2.2 Institutions as a source of uncertainty

North (1990, pg. 3) defined institutions less formally as the 'rules of the game in a society'. *As The Economist* quote below illustrates (referring to the process surrounding Britain's leaving the European Union or 'Brexit'), when the rules of the game are unclear, ill-conceived or inconsistently applied, uncertainty increases.

> *Britain's supposedly sovereign Parliament has voted against just such a no-deal Brexit on the ground [sic] that it would do the country grave harm. There will doubtless be more parliamentary machinations to stop a no-deal Brexit or force one through. The constitution is unclear on whether the executive or Parliament should prevail. It is unclear how to even choose between them.*
>
> *Behind this uncertainty lies the fact that Britain's constitution is a jumble of contradictions scattered across countless laws, conventions and rules.*[5]

For our application—the New Zealand situation in the 1970s and beyond—we see institutional uncertainty as the situation where unclear, ill-conceived or inconsistently applied laws, conventions and rules (and their enforcement) governing the activities in the economy result in erratic and unpredictable changes in policy but also erratic and unpredictable changes in how key prices and quantities are determined.[6]

On the policy and uncertainty link, studies (e.g. Baker et al., 2016) have found that policy uncertainty can lead to detrimental outcomes. Just as Acemoglu, Johnson, Robinson, and Thaicharoen (2003) argue that poor policies resulting in heightened volatility

[5] 'The next to blow: Britain's constitutional time-bomb', (2019, 30 May), *The Economist*.

[6] Well-functioning institutions also play an important role in dampening the impact on domestic uncertainty of shocks from other sources through, in part, ensuring a consistent, credible policy response. We leave it to further research to investigate this channel in the context of individual country institutional reform. In a cross country context, Carrière-Swallow and Céspedes (2013, pg. 320) find: 'countries with lower-quality institutions experience deeper falls in investment following global uncertainty shocks.'

are really symptoms of deeper institutional problems, we argue that detrimental outcomes owing to policy uncertainty are really the capturing the proximate effect of poor institutions. Erratic and unpredictable changes in policy arise when the institutional constraints on policy-makers are weak and result in an increase in the range of possible outcomes, which in turn, increases uncertainty.

This certainly was the New Zealand case prior to reform as this quote from McAloon (2013, pg. 197) illustrates: 'After 1981, increasingly preoccupied with inflation, Muldoon [the then Prime Minister and Finance Minister] reversed previous liberation, re-regulated financial markets, froze wages and prices, and had Parliament enact what was effectively a property speculation tax of the sort he had vehemently opposed in 1975'.

The Reserve Bank of New Zealand Act (1964), the institution governing monetary policy prior to the reform, also provides a good example of how the lack of an effective institutional constraint on policy makers can lead to erratic policy. The Act required monetary policy to maintain and promote: 'economic and social welfare in New Zealand, having regard to ...promoting the highest level of production and trade and full employment, and of the maintaining a stable internal price level.'[7] Evans et al. (1996, pg. 1864) notes this meant there was 'inconsistent application of monetary policy towards a particular target' meaning 'it could be directed towards whatever short-term problems was uppermost of the government's agenda (including reelection)'; Sullivan (2013, pg. 7) concurs with this point.

Lack of clear rules for the conduct of fiscal policy meant it too focused on constantly shifting targets. Post the terms of trade fall in the mid-1970s, the government adopted the view that *economic growth should be maintained* to get through the crisis and increased its overseas borrowing to fund its own expenditure (Dalziel & Lattimore, 2001). However, the resulting increases in the balance of payments and budget deficits, promoted a change in direction in the 1976 Budget: *solvency* now became the goal. Falling domestic demand meant unemployment followed. In 1979, the strategy shifted away from fiscal consolidation to *export promotion* via increased subsidies and reducing external protection (B. H. Easton, 1997). With the second oil shock occurring in 1979 and the *desire to reduce the dependence on imported fuel and boost employment* resulted in a number of large construction projects in the energy sector (collectively termed 'Think Big') in the early 1980s. Finally in 1982, *inflation* became the target (despite the balance of payments not improving): a wage-price freeze was implemented in response.

Poorly functioning institutions can also give rise to uncertainty through unpredictable changes in how key prices and quantities are determined. An example of this in the New Zealand pre-reform context concerns labour market institutions. Wage setting in New Zealand from the end of the war until 1968 had been successfully governed via the Arbit-

[7]Reserve Bank of New Zealand Act 1964; as quoted in Evans et al. (1996, pg. 1864).

ration Court system. In the event unions and the employer organisations could not reach an agreement on pay and conditions, the Court set binding minimum pay and conditions for the group of workers (B. H. Easton, 1997). The labour market institutions reflected both a formal institution (a set of rules around how the dispute would be resolved) and an informal institution (that all parties would respect the Court's judgement). However, in 1968 the Arbitration Court issued a nil-wage order despite considerable consumer price inflation (McAloon, 2013). The order was seen as 'open invitation for further and more serious industrial dissension'.[8] Further, the government stopped abiding in all cases by the informal institution of respecting the Court's judgement: '[In July 1979 a group of ministers (following a judgement they disagreed with)] recommended repealing the...[General Wage Order] Act in favour a new Remuneration Act allowing the government to regulate pay and conditions. This was a complete reversal of the of the 1977 return to free bargaining...' (McAloon, 2013, pg. 189). The possibility of both industrial dissension and switching between governmental interference and free-bargaining would have added considerable uncertainty for firms about the level of wage growth (and potentially the availability of labour owing to disputes).

Another example of a set of poor institutions leading to uncertainty about a key price in the economy was the fixed exchange rate regime (which operated from 1931 to mid-1979 and mid-1982 and March 1985), coupled with interest rate controls. With interest rates unable to ensure appropriate adjustment in the capital account, the fixed exchange rate regime was characterised by large devaluations/ revaluations of the exchange rate that were not predictable both in the timing and magnitude (Quigley, 1992).[9] The prospect of large changes in the exchange rate meant firms in the tradables sector faced uncertainty about their input or export prices (or both).

Poorly-functioning institutions can also exacerbate the consequences of institutional uncertainty discussed above. Earlier we quoted North (1994, pg. 361) as saying 'if the institutional framework rewards productive activities then organizations – firms – will come into existence to engage in productive activities'. Prior to 1984, the New Zealand government's use of the tax system to promote certain industries, resulted in organisations and firms strong in taking advantage of the tax system rather than generating productivity gains. New Zealand agriculture prior to 1984 is a good example. In 1983, immediately prior to the reform, agricultural support accounted for 40 per cent of sheep farm income (Vitalis, 2007). This meant a significant proportion of farmers' income relied on decisions taken by the government and normally economically irrational decisions—such as bringing a large area of marginal land into farm use—were taken to maximise the

[8]This quote is from Archie Grant, the workers' representative on the court; as quoted in McAloon (2013, pg. 136).

[9]The crawling peg, which operated between 1979 and mid-1982, involved more frequent, smaller changes in the exchange rate, so was less of a source of uncertainty than the fixed rate regime but still a source of uncertainty.

gains from the governmental assistance (Vitalis, 2007). This meant that rather than uncertainty about farm viability coming from the whims of commodity prices and climatic conditions, uncertainty about farm viability also reflected the whims of political favour and the policy choices of government. In such a situation, firms become more exposed to institutional uncertainty.

3 The New Zealand economy and its reform

The New Zealand Economy prior to the reforms

The depression and the world wars resulted in an institutional framework that focused on state-facilitated full employment (Dalziel & Lattimore, 2001, McAloon, 2013). The post-war global economy expansion until 1973 meant New Zealand enjoyed strong economic growth post-war (with the exception of a recession resulting from a large declines in wool prices in 1967) and low employment. However by the 1970s, economic institutions were problematic. Carroll (2012) notes in the face of a declining terms of trade 'the institutional wage, price and monetary policy settings made it difficult to maintain macroeconomic stability in the 1970s (pg 9).' McAloon (2013, pg. 172) notes '[t]he institutions of economic management were, it seems, inadequate to shape a new consensus around an economic transition'

The reforms

Between 1984 and the mid-1990s, New Zealand embarked on significant and multifaceted reforms of its institutions. The genesis of these reforms was, among other reasons, a declining economic performance relative to other developed countries, strong inflationary pressures and large fiscal and balance of payments deficits. Of the reforms themselves, Dalziel (2002) provides a succinct summary:

> Within a year of a change of government in July 1984, interest rates were deregulated, international capital restrictions had been removed, the currency was floating freely in foreign exchange markets and most agricultural subsidies and tax incentives were being phased out. Over the next decade and a half, domestic market regulations were comprehensively reformed in favour of contestability and competition, all import quotas were eliminated and a timetable was set for reducing tariffs to zero by 2006. In 1989, price stability was designated the sole statutory objective of monetary policy (New Zealand was the first country to adopt this reform). In 1991, labour legislation was radically transformed from a corporatist, union-based framework to a decentralised, individual-based contracts system. Since 1994, the Fiscal Responsibility Act

has prohibited budget deficits 'on average, over a reasonable period of time (pg. 31).

Figure 1 below, adapted from Silverstone et al. (1996) and Stillman, Velamuri, and Aitken (2010), shows the phasing of the reforms across the different areas, and includes some key events.

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1993	1994
Capital markets													
Financial sector		5	7										
Industrial regulation	1	3											
International trade	2			10									
Monetary policy			6				17						
Tax reform		4		9	14	15							
Corporatisation				8	11					22,23			
Privatisation					12						25,26		
Public expenditure/ public sector management						16	18						
Labour market					13				19				
Resource use									21				
Social services									20	24			

1 Phase out of import licensing requirements
2 Signing of the Closer Economic Relations trade agreement with Australia
3 Major agricultural reform (including abolition of supplementary minmum prices for farming and terminating various producer boards)
4 Phasing our of export performance tax incentives
5 Deregulation of foreign exchange trading,removal of controls on outward investment and borrowing and lifting of interest rate controls.
6 Free float of the exchange rate
7 End of formal financial controls (reserve ratio requirements, sector lending priorities)
8 State-Owned Enterprises Act led to corporatisation and restructuring of electricity generation and transmission and the introduction of user pays principles for remaining state trading activity
9 Introduction of a broad-based consumption (Goods and Services) tax
10 Start of reduction of import tariffs from an average of 28% to an average of 5%
11 Corporatisation of 24 state-owned enterprises (in transport, finance, tourism, forestry, broadcasting, utilities, and service industries)
12 Full or partial privatisation of many SOEs
13 Some contestability in union coverage under Labour Relations Act
14 Removal of tax concessions for savings
15 Flattening and lowering of personal income tax rate
16 Reform of core government departments on corporate lines through the State Sector Act, with separation of policy, provision, and funding
17 Independence of Reserve Bank formalised (monetary policy devoted to achieving price stability)
18 Public sector management reform through Public Finance Act and the redesign of government accounts on a more commercial basis with accrual accounting and output based monitoring systems
19 Introduction of the Employment Contracts Act which decentralised labour bargaining and decreased the role for unions.
20 Large cuts to spending on education, health, social welfare and superannuation.
21 Resource Management Act to govern more liberal planning and environmental legislation
22 Corporatisation of government research bodies (Crown Research Institutes)
23 Quasi corporatisation and fee paying for tertiary education institutions
24 Separation of funding from provision of state health services, establishment of Crown Health Enterprises and private sector deregulation
25 Corporatisation, privatisation and deregulation of gas and electricity distribution and introduction of competition in electricity generation
26 Privatisation of New Zealand Rail

Figure 1: The sequence of reform in New Zealand and some key events

The reforms are generally dated as starting with the election of the then new Labour government in July 1984; although relatively small in relation to what happened subsequently, prior to 1984 some reform had already occurred (Bayliss, 1994). The reform could be characterised as having three distinct periods. Evans et al. (1996, pg. 1856) notes 'the pace of the reform was uneven, being extremely rapid during the first two and a half years, in some areas, particularly in the financial sector and with respect to export subsidies and taxes'. The reform process slowed between early 1988 and October 1990 reflecting internal disagreement in the ruling Labour party. The pace quickened again from late 1990 as the newly-elected National government announced and enacted major changes to the welfare system (large cuts to benefit entitlements) and changes to the labour market.

New Zealand's reforms were focused on changing formal institutions and their enforcement. Evans et al. (1996, p. 1862) notes the reforms 'sought to enhance policy credibility

and reduce the risks of policy reversals by setting and achieving targets...and enhance market constraints on government through deregulation and greater transparency'. That is, the reforms sought to reduce erratic and unpredictable changes in policy by providing institutional constraints (and providing an enforcement mechanism for these constraints). For example, the Reserve Bank Act 1989, and the Public Finance Act 1989 and the Fiscal Responsibility Act 1994, provided institutional constraints on the conduct of monetary and fiscal policy respectively. Monetary policy was to focus on low inflation, fiscal policy on ensuring prudent government debt levels and predictable and stable taxation rates (Barker, Buckle, & St Clair, 2008).

4 Methodology

In this section we discuss three aspects of our method. The first aspect is *measuring* uncertainty (or more correctly *proxying* uncertainty). The second aspect of our method is isolating the component of uncertainty owing to institutional sources. The final aspect of our method is how to determine whether or not uncertainty is lower post-reform (relative to the period pre-reform).

4.1 Proxying uncertainty

4.1.1 Using firm-level survey data

We define uncertainty as North (1991, pg. 106) does: 'the condition wherein one cannot ascertain the probability of an event'. It follows that increased uncertainty is the condition where the range of possible outcomes with unknown, but non-negligible, probabilities increase. This definition of uncertainty does not naturally result in a measure of uncertainty meaning we need to proxy uncertainty.[10] A wide range of proxies have been proposed in the literature. We briefly outline the four uncertainty proxies we use below. Our decision to use these as our proxies (compared to other proxies in the literature) reflects their relative conceptual strength and the availability of data for New Zealand over a sufficient number of years pre- and post-reform to construct them.[11] As we dis-

[10]Numerous uncertainty proxies have been proposed in the literature. Broadly speaking the measures of uncertainty can be aggregated into three groups. The first group are those that measure uncertainty by equating it with disagreement. The disagreement can either be between survey respondents or between a forecast and the actual outcome (e.g. Girardi & Reuter, 2016; Arslan, Atabek, Hulagu, & Şahinöz, 2015; Bachmann, Elstner, & Sims, 2013; Caggiano, Castelnuovo, & Nodari, 2017; Scotti, 2016). A second group of measures are text-based and assess perceptions of uncertainty by counting the proportion of specific words in a set of texts (e.g. Baker et al., 2016; Castelnuovo & Tran, 2017). A final group are variance or volatility type measures (e.g. Jurado et al., 2015; Ludvigson, Ma, & Ng, 2015; Mumtaz & Theodoridis, 2017).

[11]Ballingall et al. (2020) finds newspapers are not digitally available with sufficient quality before 1995 to construct a text-based uncertainty index. Unfortunately, this precludes the construction of a policy uncertainty index in the style of Baker et al. (2016). This is unfortunate because, as we noted in section

cuss, we use a combination of four uncertainty proxies as our final uncertainty measure because each individual proxy has relative strengths and weaknesses. Therefore using a combined measure means conceptual weaknesses with one proxy are less significant. All uncertainty measures/ proxies used in this paper are normalised to have a mean of zero and a standard deviation of one.

The first three proxies are constructed using firm-level survey data. As Binge and Boshoff (2020, pg. 3) notes: 'survey-based measures have the advantage that they are derived from opinions of key economic agents, as opposed to outside observers (e.g. professional forecasters) or investors on financial markets'. Within the class of survey-based measures there are two categories: dispersion–based and those based on expectation errors. We will construct both types. Our dispersion-based proxy is based on the work of Girardi and Reuter (2016), the two expectation-error based proxies are based on Bachmann et al. (2013) and Arslan et al. (2015).

The Girardi and Reuter (2016) dispersion–based proxy

For each economic concept, c, under consideration (e.g. profits, costs) in a given forward-looking question, Girardi and Reuter (2016), using data from the Euro Joint Harmonised EU Programme of Business and Consumer Surveys, construct a dispersion index:

$$DISPFW_{c,t} = (fu_{c,t} + fd_{c,t} + (fu_{c,t} + fd_{c,t})^2)^{0.5} \tag{1}$$

where $fu_{c,t}$ ($fd_{c,t}$) is the fraction of firms reporting they expect an 'increase' ('decrease') on the given survey question j about economic concept c.

The time-series of the measure $DISPFW_c$ is then standardised to have a zero mean and a unit standard deviation.

Girardi and Reuter (2016) argues that survey-based dispersion measures capture three concepts: heterogeneity reflecting different firm circumstances (e.g. some firms are more exposed to export markets), disagreement owing to different firm information sets and uncertainty.[12]

For each sector i, each question j relating to a different economic concept c, and in each quarter t, we create the forward-looking index described above ($DISPFW.ijt$).[13] In our dataset, discussed in more detail in section 4.1.2, there are five sectors: financial

2.1, there is a conceptual link from institutions to policy uncertainty.

[12]Girardi and Reuter (2016) propose a method for removing the effect of firm heterogeneity but this requires assuming that economic conditions remain (broadly) stable between consecutive surveys. Unfortunately this assumption is not valid in our context. The pre-reform period was a time of instability in economic conditions in New Zealand. For example, labour relations were a source of instability in the pre-reform, as were periodic policy reversals and the changing targets of policy (see section 3).

[13]We impose a requirement of a minimum of 30 sectorial responses for each question; if that threshold is not meet, we interpolate the index for that quarter using the spline interpolation procedure in the imputeTS R package.

services, other (non-financial) services, builders, manufacturers and merchants (retail and wholesale) and each sector has J forward–looking questions.[14] We then create an overall sector measure for each sector i, *DISPFW.it*, by taking the first principal component across the J indices for each sector.

The two expectation errors-based proxies

Arslan et al. (2015), Bachmann et al. (2013) and Binge and Boshoff (2020) use a slightly different transformation of the directional survey data to calculate uncertainty. These papers take advantage of a forward looking question in time $t-1$ and an *ex post* assessment in t about a given economic concept c. The argument is that expectation errors are more likely when uncertainty is higher.

These papers transform differences in actual and forecast outcomes into numerical data; although the precise transformation differs between papers, Table 1 illustrates how such a transformation can be made.[15] Where the experienced and the expected activity agree (the diagonal elements of Table 1) then a value of zero is assigned. If the experienced activity in time t was higher (lower) than expected activity in *t-1*, then we assign a weight, $w_{i,t}$, of –0.5 or –1 (0.5 or 1) depending on the extent of the disagreement. For example if, in the Q3 survey, a firm expects an increase in profits in Q4 but in the Q4 survey the firm reports a decrease in profits then a weight of +1 is assigned.

Table 1: Weights from Arslan et al. (2015)

	$Decrease_{c,t}$	$Nochange_{c,t}$	$Increase_{c,t}$
$ExpectedDecrease_{c,t-1}$	0	–0.5	–1
$ExpectedNochange_{c,t-1}$	0.5	0	–0.5
$ExpectedIncrease_{c,t-1}$	1	0.5	0

Using these weights, it is possible to calculate the following uncertainty proxy:

$$IDIO_t = \frac{\sum_{i=1}^{N}(w_{i,t} - \overline{W_t})^2}{N} \tag{2}$$

where $\overline{W_t}$ is average 'uncertainty' across all respondents:

$$\overline{W_t} = \frac{\sum_{i=1}^{N}(w_{i,t})}{N} \tag{3}$$

where N is the number of firms.

[14]The number of forward-looking questions, J, differs between sectors; we discuss this in the Appendix.

[15]This is the Arslan et al. (2015) setup. Bachmann et al. (2013) use different weights and have to adjust for the fact the backward-looking question in the survey they use only reports on the last month, whereas the forward-looking question asks about the next three months; this is not an issue in our case. Binge and Boshoff (2020) use the above weights scaled by two.

Arslan et al. (2015, pg. 644) describes the measure in equation (2) as an 'idiosyncratic uncertainty measure because it measures how individual firms depart from the overall mean on expectation errors'. Arslan et al. (2015) also propose a formula based on the average error:$(\overline{W_t})^2$. They call this aggregate uncertainty. We create both of these indices.

The two expectations-based indices (the aggregate uncertainty and the idiosyncratic uncertainty indices) are created for each forward-looking question, for each sector and for each quarter. To calculate expectation errors, each forward-looking question must have a corresponding backward looking question; this results in a smaller pool of available questions than the dispersion-based measure discussed above (see the Appendix). Two sector measures (one for aggregate uncertainty and the one for idiosyncratic uncertainty) for each sector are then created by taking the first principal component across the relevant individual question indices for each sector.

We now have three indices for each sector: the dispersion-based index, the aggregate uncertainty expectations-based index and the idiosyncratic uncertainty expectations-based index. Ultimately we want to aggregate these indices up into an economy-wide combined index. The first step is to create combined sector-specific indices. To do this we take an arithmetic average of the three indices (dispersion-based and the two expectations-based ones) for each sector (taking a principal component makes little difference). The second step is to combine the sector-specific indices into an economy-wide index. To do this, for each quarter t the combined sector-specific indices are weighted by the share of real GDP of the sector corresponding to the March year that quarter t falls in.[16] This gives our economy-wide index based on survey data. We plot, and discuss, this combined economy-wide index in section 4.3.

4.1.2 The Quarterly Survey of Business Opinion

The combined economy-wide index measures firm uncertainty as the three proxies described above which contribute to it are constructed using unit record firm-level survey data from the Quarterly Survey of Business Opinion (the 'QSBO'). Since 1961, the QSBO has continuously surveyed New Zealand firms. Beginning with manufacturers, firms from various sectors were added to the survey at different points in time.[17]

The QSBO uses stratified sampling based on employee groups; however all firms with fewer than six employees are excluded and all firms with more than 200 employees are sampled (Buckle & Silverstone, 2011).[18] In creating our indices, we weight firm responses

[16]The sectorial GDP data comes from Statistics New Zealand's Infoshare (http://archive.stats.govt.nz/infoshare/; accessed 20 December 2019) .

[17]Merchants who were retailers were the last to be added in 1974 (Silverstone, 2006). More information on the QSBO, its history and its use in research is available in Silverstone, 2006, Buckle & Silverstone, 2011, and O'Connor & Allen, 2011). At the present time the only notable exceptions from the survey are respondents in agriculture, utilities and government.

[18]There are six employee groups: 1 to 20, 21 to 50, 51 to 100, 101 to 200, 201 to 500 and 500 and over.

by employee size; the weights were provided by NZIER. Weighting requires that there is sufficient sample size in each employee group. Our analysis suggests we reach a sufficient sample size in each employee group in 1975, therefore we start constructing our indices from then (plus the retail sector only started being included in 1974).[19] We plot this combined economy-wide measure in section 4.3.

4.2 Stochastic volatility-based measure

As a data source, the QSBO is very useful but it does exclude firms in the agriculture, government and utilities sectors. Given the importance of agriculture to the New Zealand economy, the omission of such respondents is significant. That said, the inclusion of respondents from the primary manufacturing sector means there is a chance uncertainty from agriculture sources will be captured (to some degree, at least).

Further, one of our uncertainty indices—the dispersion-based measure—is really a 'lack of consensus' or disagreement measure. An on-going debate in the literature has been if you can equate 'lack of consensus' with high uncertainty.[20]

To ensure the robustness of our results we construct another uncertainty proxy based on a totally different data set and methodology. T. Berger, Grabert, and Kempa (2016) use a dynamic factor model (DFM) with stochastic volatility to estimate global and country-specific output uncertainty for a set of OECD countries.[21] The DFM is:

$$y_{i,t} = \beta_i^0 + \beta_i^1 \pi_{i,t} + \tau_i R_t + I_{i,t} + \epsilon_{i,t} \tag{4}$$

where $y_{i,t}$ is output growth in country i in time t, β_i^0 is a country-specific constant and $\pi_{i,t}$ controls for inflation. R and $I_{i,t}$ represent the common (across countries) and idiosyncratic drivers of growth respectively. R_t and $I_{i,t}$ are assumed to follow the following process:

$$R_t = \sum_{k=1}^{2} \rho_k R_{t-k} + exp(h_t)\zeta_t \tag{5}$$

$$I_{i,t} = \sum_{k=1}^{2} \phi_k^i I_{i,t-k} + exp(g_{i,t})\eta_{i,t} \tag{6}$$

$$h_t = h_{t-1} + \gamma_t \tag{7}$$

[19] We weight to be consistent with some of the literature (e.g. Binge & Boshoff, 2020) and also the statistics generally reported from the survey such as the headline business confidence number. It makes little difference however at a sector-level with the correlations between weighted and unweighted indices are between 0.88 and 0.97.

[20] For example, Zarnowitz and Lambros (1987) reports a positive association between disagreement and uncertainty; Boero et al. (2008) and Abel, Rich, Song, and Tracy (2016) report weak correlations.

[21] This explanation of the T. Berger et al. (2016) model draws heavily on their paper.

$$g_{i,t} = g_{i,t-1} + \omega_t \tag{8}$$

where ζ_t, η_t, γ_t, ω_t are all approximately $iidN(0,1)$.

h_t and $g_{i,t}$ represent the common OECD and country-specific idiosyncratic stochastic volatility measures respectively. T. Berger et al. (2016) label h_t and $g_{i,t}$ as common OECD and country-specific uncertainty proxies respectively. They explain country-specific uncertainty as domestically-sourced uncertainty plus the country-specific impact of common OECD uncertainty.

The sample used in their paper runs from 1970Q1 to 2013Q4. Given our sample runs from 1975Q4 to 2018Q4, we used the authors' code to create a longer time span for the New Zealand-specific measure.[22]

Figure 2 shows the New Zealand-specific ('NZL') and common OECD uncertainty ('Common') proxies we created using the T. Berger et al. (2016) approach; both are normalised to mean zero and standard deviation one. The major spike in the OECD common uncertainty proxy occurs around the global financial crisis, with lesser spikes around the two oil shocks and the stock market crash in 1987. Interestingly, the Asian Financial Crisis does not appear to register. The New Zealand-specific uncertainty proxy rose prior to 1984; this could reflect the uncertainty associated with the wage/prize freeze, the government's financial position and the foreign exchange situation (or a combination of all three). The proxy was also highly elevated over the period 1982 to 1987; the proxy then falls, but remains elevated relative to other periods, over the period 1988 to 1995. This is consistent with the narrative that the first part of the reform was more intense than the second part (see discussion in Section 3). Interestingly, the impact of the major global events cited above (such as the global financial crisis) have no New Zealand-specific effect; put another way these events impacted on New Zealand and this effect was similar to other countries: there was no New Zealand idiosyncratic effect.

Figure 3 plots the T. Berger et al. (2016) ('Berger') proxy for New Zealand against our combined economy-wide QSBO measure ('QSBO') which we discussed in section 4.1.2. The proxy of T. Berger et al. (2016) is smoother than the combined QSBO proxy and peaks at a higher level over the reform period. The combined economy-wide QSBO measure spikes around the early 1990s recession, the Asian crisis of 1997/98 and the Global Financial Crisis.

[22]The GDP data is from the OECD (data from: https://stats.oecd.org/Index.aspx?datasetcode=SNA_TABLE1_ARCHIVE [accessed 20 December 2019]; the GDP data is real/volume-based and stated in PPP terms. Using more up-to-date data gives us broadly similar results as the original paper; although the New Zealand specific uncertainty measure estimated on the more up-to-date data is less elevated in the pre-1984 era than the measure in the original paper. We suspect the effects of data revisions are at play.

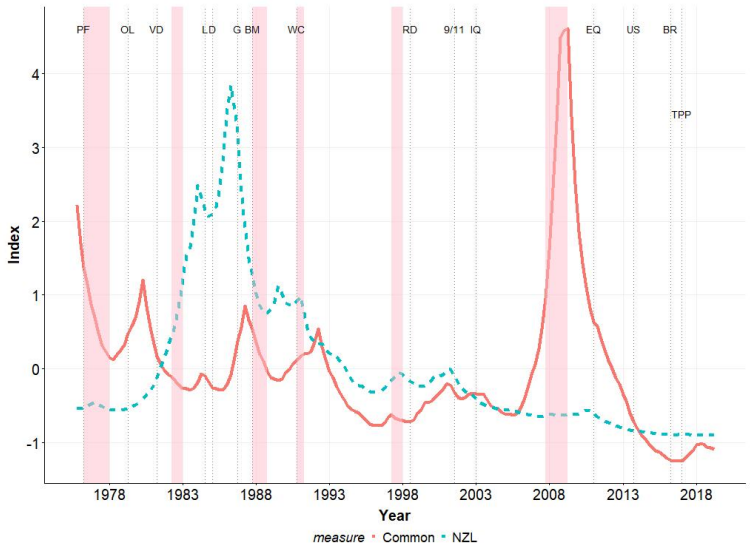


Figure 2: Updated OECD common and New Zealand-specific measures using the T. Berger et al. (2016) methodology

4.3 The final proxy of New Zealand-specific uncertainty

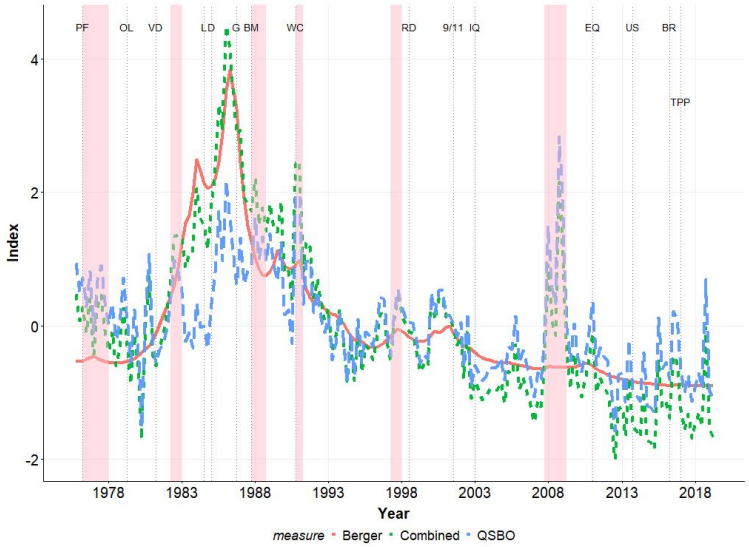
We feel both proxies have information content. Our final, preferred proxy of uncertainty, is therefore the first principal component of the two proxies (plotted in Figure 3 as 'Combined'). Papers studying uncertainty generally use visual inspection to validate their uncertainty measures. Visual validation of uncertainty measures examines how well spikes in measured uncertainty correlate with events hypothesised to result in/ or be the result of heightened uncertainty. In the Figure 3, red shaded areas represent recessions (as identified by Hall & McDermott, 2016) and the dotted lines, with an associated code, represent other significant events associated with uncertainty. The event the code represents is set out at the bottom of Figure 3. In general, the combined measure spikes during recessions and around the significant events identified; further it is evaluated during the reform period (particularly the early part).

4.4 Isolating uncertainty from domestic institutional sources

Having constructed our final proxy of New Zealand-specific uncertainty, we now try to isolate uncertainty that comes from domestic institutional sources. This requires us to control for the effects on uncertainty from other sources. We now discuss channels, apart from institutions, that might affect uncertainty.

Although there is debate about the intensity of the channel, it is a plausible hypothesis that uncertainty might also result from the state of the business cycle: with uncertainty rising during recessions.[23] Further a small open economy, might 'import' uncertainty

[23]Ludvigson et al. (2015) show that macroeconomic uncertainty is an endogenous response to recessions; others, such as Angelini and Fanelli (2019),suggest it is not.



Date	Event	Code
1976Q2	Start of 12 month price freeze	PF
1979Q2	2nd oil shock	OL
1981Q2	Peak of Volcker deflation	VD
1984Q3	Election of Labour government	L
1985Q1	NZD floated	DF
1986Q4	GST introduced	G
1987Q4	Black Monday sharemarket crash	BM
1990Q4	Announcement of welfare cuts	WC
1998Q4	LTCM crisis/Russian default	RD
2001Q3	Terror attacks on the US	9/11
2003Q1	Iraq invaded	IQ
2011Q2	Christchurch Earthquake	EQ
2013Q2	Start of 2013 debt ceiling crisis	US
2016Q2	Brexit vote	BR
2017Q1	TPP withdrawal by the US	TPP

Figure 3: New Zealand specific uncertainty measures

from foreign sources.

We use two proxies of foreign uncertainty: the US financial uncertainty proxy of Ludvigson et al. (2015) and the Global/OCED common output uncertainty proxy of T. Berger et al. (2016) discussed above (see Figure 2). US financial uncertainty will affect the New Zealand economy via the cost (and perhaps the availability) of capital, as well as through the exchange rate.[24] Output uncertainty will affect the New Zealand economy through demand for New Zealand's exports. Given New Zealand recessions have been triggered, in part, by events overseas (Reddell & Sleeman, 2008), we also include a measure of the OECD output gap.[25] We also include a domestic (New Zealand) output gap; this was created by applying the technique outlined by Kamber et al. (2018) to the

[24]In times of uncertainty, money tends to flow towards the USD (a 'safe haven') and away from the New Zealand dollar; see Kamber et al. (2016).

[25]We create this by using the OECD Industrial Production series to construct an output gap using the technique outlined in Kamber, Morley, and Wong (2018); we made use of the R code provided by James Morley https://sites.google.com/site/jamescmorley/research/code.

real GDP series of Hall and McDermott (2011).

We estimate a small Structural Vector AutoRegression (SVAR) to control for endogeneity between uncertainty and output. We estimate two versions of the Structural VAR model via Bayesian methods. Both versions have four lags and are estimated over the sample period 1975Q4 to 2018Q4.[26] The first model, subsequently called the time-invariant SVAR (or TI-SVAR) for short, treats parameters as time-invariant.[27]

We begin with a reduced form VAR of the form:

$$\begin{bmatrix} Y_t^F \\ Y_t^{NZ} \end{bmatrix} = B(L) \begin{bmatrix} Y_t^F \\ Y_t^{NZ} \end{bmatrix} + u_t \tag{9}$$

where Y_t^F is the set of foreign variables: foreign financial uncertainty, foreign output uncertainty and the foreign output gap. Y_t^{NZ} is the set of New Zealand variables: uncertainty and the output gap. $B(L)$ is the lag operator of length four. Consistent with New Zealand's small open economy status, the foreign block is 'block exogenous' to the domestic block: foreign variables can affect domestic variables but not vice versa. This means $B(L)$ is better expressed as:

$$\begin{bmatrix} B(L)_{F,F} & 0 \\ B(L)_{NZ,F} & B(L)_{NZ,NZ} \end{bmatrix} \tag{10}$$

where $B(L)_{NZ,F}$ is the lag operator in the block where foreign variables are the independent variables and New Zealand variables are the dependent variables and $B(L)_{F,F}$ ($B(L)_{F,F}$) is the lag operator in the block where foreign (domestic) variables are both the independent variables and dependent variables.

In equation 9, u_t is a vector of reduced-form errors. The structural errors are recovered from the reduced form errors by imposing Cholesky factorisation, separately, in both the foreign and the domestic blocks. The ordering to achieve identification in the foreign variable block is foreign financial uncertainty, foreign output uncertainty and the foreign output gap; we adopt this assumption (that uncertainty affects output contemporaneously, not vice-versa) as it is a common one in the literature (for example, see Bloom, 2009; Bachmann et al., 2013; Bekaert, Hoerova, & Duca, 2013; Kamber et al., 2016), but it also seems plausible that given output variables are released with a lag, bad news about the economy might take a while to impact on uncertainty.[28] The domestic

[26]We implement the models in the Bayesian Estimation, Analysis and Regression (BEAR) toolbox. This a statistical package that has been developed by Roman Legrand, Alistair Dieppe amd Bjorn van Roye of the External Developments Division of the European Central Bank. We are grateful that they have made this available publicly.

[27]The number of Gibbs sampling iterations are 10,000 with 5,000 burn-in iterations. The SVAR uses a Minnesota prior. The reader is referred to Dieppe, Legrand, and Van Roye (2016) for more detail on the Gibbs sampling algorithm and the Appendix for more detail on priors.

[28]Rivolta and Trecroci (2020, pg.12) notes different studies suggest different ordering for the uncertainty variables, but all suggest that uncertainty variables should be ordered before output variables. Our

block orders uncertainty first, output second. Again, this reflects the standard practice in the literature, but also the fact that the QSBO—the survey on which part of our uncertainty measure is constructed from—is conducted in the last month of the quarter and asks about the next three months, whereas GDP in New Zealand is released three months after the quarter has finished. It would be more plausible, therefore, to assume that GDP does not have a contemporaneous effect on uncertainty.[29]

An implicit assumption in the above model—that the relationships between the economic variables remain constant over time—might be too strong. The opening up of a previously protected domestic sector to competition from foreign imports and the removal of restrictions on foreign capital means that the impact of foreign variables could be more significant on New Zealand uncertainty than prior to 1984. To allow for this, our second model implements a time-varying version of the model in the BEAR toolbox;[30] we call this model TV-SVAR for short. Owing to difficulties imposing block exogeneity with time-varying parameters in the BEAR toolbox, we treat the foreign variables as exogenous (what is termed an SVARX by Kilian & Lütkepohl, 2017).[31] The specific version of the time-varying model we estimate is based on the following model:[32]

$$y_t^{NZ} = A_{1,t}y_t^{NZ} + ... + A_{4,t}y_{t-4}^{NZ} + C_t y_t^F \epsilon_t \tag{11}$$

The model can be expressed as:

$$y_t = \bar{X}_t \beta_t + \epsilon_t \tag{12}$$

where:

$$\bar{X}_t = I_n \otimes X_t, X_t = (y_{t-1}^{NZ'}, ..., y_{t-4}^{NZ'}, y_t^{F'}) \tag{13}$$

and:

$$\beta_t^{'} = vec(B_t) \tag{14}$$

ordering of financial uncertainty before real/output uncertainty is consistent with Jurado et al. (2015).

[29]Recursive identification of SVARs is common place but not without its critics (see Kilian & Lütkepohl, 2017 or Ludvigson et al., 2015 in the uncertainty context.)

[30]The toolbox makes use of the sparse matrix approach of Chan and Jeliazkov (2009) (see https://www.ecb.europa.eu/pub/research/working-papers/html/BEARExtensions4.2.pdf [accessed 21/1/2020]). The BEAR toolbox documentation (FAQs) notes the spare matrix is not sensitive to initial conditions as it uses a diffuse prior. We also ran a version of the model with stochastic volatility only (no time-varying parameters)—the key results below still hold with this model.

[31]The difference between the SVARX set up and the 'block exogeneity' set up is in the 'block exogeneity' set up, the foreign variables are allowed to 'interact' with each other and this means shocks to these foreign variables can be identified; in the SVARX set up, the foreign variables are exogenous to the system (the system being the two domestic/New Zealand variables).

[32]The following write up heavily follows Dieppe et al. (2016). The reader is referred to this paper for more detail, particularly on the Gibbs sampling algorithm.

$$B_t = \begin{bmatrix} A'_{1,t} \\ ... \\ A'_{4,t} \\ C'_t \end{bmatrix} \tag{15}$$

The VAR coefficients are modelled as following a first-order autoregressive process:

$$\beta_t = \beta_{t-1} + v_t, v_t \approx N(0, \Omega) \tag{16}$$

where Ω, the co-variance matrix, is endogenous.

In equation 12:

$$\epsilon_t \approx N(0, \Sigma_t) \tag{17}$$

We assume:

$$\Sigma_t = F \Lambda_t F' \tag{18}$$

where F is a lower triangular matrix with ones on the diagonal and Λ_t is a diagonal matrix:

$$diag(\Lambda_t) = (\bar{S_1} exp(\lambda 1, t), ..., \bar{S_n} exp(\lambda_{n,t})) \tag{19}$$

We assume:

$$\lambda_{i,t} = \gamma \lambda_{i,t-1} + \vartheta_{i,t} \tag{20}$$

$$\vartheta_{i,t} \approx N(0, \phi_i) \tag{21}$$

Our time-varying model means both time-varying relationships between variables (via equation 16) and heteroscedasticity (via equation 20) are allowed for. As with the time-invariant SVAR, the domestic structural shocks are identified by Cholesky factorisation of the reduced form residual: ϵ_t; the variables are ordered New Zealand uncertainty, New Zealand output gap. Owing to the SVARX structure of the time-varying model, shocks to foreign variables can not be identified. The model is again estimated using Bayesian techniques; the time-varying SVAR are 6,000 Gibbs sampling iterations with 1,000 burn-in iterations and every 20th iteration is retained. We use less Gibbs sampling iterations with this model as it is computationally more intensive.

Both forms of the Structural VAR model discussed above allows—via the estimated structural shocks and estimated regression coefficients—for the construction of an historical decomposition. This is a key tool in our analysis. In the case of the time-invariant SVAR, an historical decomposition of New Zealand uncertainty allows us to understand how much of the historically observed movements in New Zealand uncertainty can be explained by each of the structural shocks in the model: foreign financial uncertainty, foreign output uncertainty, foreign output, New Zealand output and its own shock. Con-

sider an hypothetical example. In 2006Q1, New Zealand uncertainty was, say, one index point; again say, 0.1,0.15,0.2,0.25 of that index value was contributed by foreign financial uncertainty, foreign output uncertainty, foreign output and New Zealand output shocks respectively; this leaves 0.7 index points of observed New Zealand uncertainty accounted for. Of the remaining 0.3, say 0.2 comes from New Zealand uncertainty's own shocks and 0.1 from the exogenous variables in the model (e.g. the constant). In the time-varying SVAR we can only decompose New Zealand uncertainty into its own shocks and the contribution from the New Zealand output gap owing to the SVARX structure. The combined contribution of the foreign variables and the constant are measured as one in the exogenous shock variable. Kilian and Lütkepohl (2017) offers a detailed exposition of historical decompositions.

The question then becomes how does one interpret New Zealand uncertainty's own shocks? Our key assumption is that New Zealand uncertainty's own shocks are from institutional sources. Why might this hold true? Our model identifies the impact on uncertainty of shocks from macroeconomic or financial sources (e.g. the state of the economy, the financial sector), leaving us with a possible interpretation that New Zealand uncertainty's 'own shocks' as being from non-macroeconomic or financial sources. Our discussion in section 2 indicates that institutions are the prime candidate of a non-macroeconomic or financial source of uncertainty given the events in the New Zealand economy over our sample period.

It is however worth considering other explanations. Being a small, open, agricultural dependent economy, climatic events and natural disasters in New Zealand could represent non-macroeconomic or financial sources of uncertainty. However our robustness tests in the Appendix show that controlling for climate and natural disasters in the model makes little difference to the estimated contribution of its 'own shock' to the New Zealand uncertainty series; the impact of natural disasters is seen more on New Zealand output. We also conduct a robustness test (also reported in the Appendix) where we control for the changing structure of the economy; specifically the idea that a compositional shift from manufacturing to services might lower uncertainty (Fernández-Villaverde & Guerrón-Quintana, 2020). Again this made little difference to the estimated New Zealand uncertainty 'own shock' series. Finally one could propose that technology disturbances drive New Zealand uncertainty shocks. Given New Zealand is a open, small economy we would argue these are likely to be captured by the foreign uncertainty shocks/variables, rather than the domestic uncertainty shocks.

It is probable that quarterly movements in the 'own shock' series are affected by factors other than institutional factors. However, as our empirical method focuses on comparing averages pre- and post-reform, it is acceptable for uncertainty's 'own shock' to be affected by omitted—non-institutional—variables, as long as the omitted variables

are not systematically higher or lower post-reform than pre-reform.

Finally a technical issue with using series from the historical decomposition is that historical decomposition involve approximation error at the start of the sample owing to truncation of the moving average representation (Kilian & Lütkepohl, 2017, pg. 118). As Kilian and Lütkepohl (2017, pg 118) recommends we plotted the actual series against the relevant historical decomposition series and find the approximation error is small.

4.5 Understanding if institutional uncertainty is lower post-reform than pre-reform

Our key research question is if the level of institutional uncertainty has fallen post-reform, relative to the period pre-reform. We assess this two ways. The first is to estimate a regression of the form:

$$UNZ_{unz,t} = c + \gamma_1 * Reform + \gamma_2 * PostReform + \varepsilon_t \tag{22}$$

where $UNZ_{unz,t}$ is the contribution of New Zealand uncertainty shocks to New Zealand uncertainty at time t; that is, our proxy for uncertainty from institutional sources. *Reform* is a dummy variable covering period 1984Q3 to 1995Q4 and *PostReform* is a dummy variable covering the period 1996Q1 to 2018Q4. If the reform was successful in reducing uncertainty from institutional sources, then we would expect $\gamma_2 < 0$; that is the average level of uncertainty is lower pre-reform than post-reform.

The second way is to test for unknown structural breaks in the equations:

$$UNZ_{unz,t} = c \tag{23}$$

and

$$UNZ^{RO}_{unz,t} = c \tag{24}$$

where $UNZ^{RO}_{unz,t}$ is the $UNZ_{unz,t}$ variable reordered:
$\Big(1977Q1 : 1984Q2 : 1996Q1 : 2018Q4\Big)$. That is the data are rearranged so the reform period is omitted so the pre-reform period is followed by the post-reform period.

The first breakpoint test—on the temporally ordered institutional uncertainty variable—allows us to test for structural breaks in institutional uncertainty as the economy transited into and out of the reform. The first breakpoint test—institutional uncertainty variable with the reform period removed—allows for testing for a structural break between the pre- and post-reform period.[33]

[33]Structural break testing for multiple, unknown structural breaks is implemented in EViews using the Bai-Perron tests of L+1 vs. L sequentially determined breaks. We allow for a maximum of five

5 Results

5.1 Our estimates of institutional uncertainty

Figure 4 shows our estimate of institutional uncertainty from our two models: the time-invariant model (TI-SVAR) and the time-varying SVAR (TV-SVAR). As Figure 4 shows the model shows a strong degree of correlation (0.89) between the measures produced by the two models. Both series show spikes in institutional uncertainty in the initial period of the reform (a period that included the floating of the exchange rate, a removal of capital controls, introduction of GST amongst other things), in the December quarter of 1990 (a quarter which saw the announcement of large social welfare benefit cuts and new employment legalisation in what was called the 'Economic and Social Initiative Budget') and around the GFC (perhaps reflecting some uncertainty about New Zealand's response). Visually both series show institutional uncertainty was highly elevated during the reform period and that institutional uncertainty was higher in the pre-reform period, on average, than the post-reform period.[34]

5.2 Did institutional uncertainty fall post-reform?

As discussed in section 4.5, our first empirical test of whether institutional uncertainty was lower pre-reform than post-reform is an Ordinary Least Squares model with the institutional uncertainty variable as the dependent variable regressed against dummy variables for the reform period and a dummy for the post-reform period; we run the model twice: once for each institutional uncertainty estimate from each specification of the Structural VAR (time-invariant and time-varying). In our initial estimation, we found low values of the Durban-Watson statistic (in the region of one or lower) indicating positive autocorrelation is present. We re-estimated the model with a lagged dependent variable; Table 2 reports the results. In both of our models, relative to the pre-reform period, the reform period had a higher level of institutional uncertainty on average and the post-reform period had a lower level of institutional uncertainty on average (with the

breaks, test for breaks at a five per cent significance level and trim 15 per cent of the observations at the beginning and end of the sample. We also allow for heterogeneous error distributions across breaks.

[34] In additional to the robustness tests discussed in section 4.4, we ran some further robustness tests. We ran the models with eight lags, instead of four lags. The key dynamics of our estimated institutional uncertainty series were not affected. Nor were the results affected by changing the prior mean of the first lag of the dependent variable under our Minnesota prior from 0.8 to 0.1. This is equivalent to moving from an assumption that variables follow processes close to a random walk to them following processes close to white noise. Finally, we ran a version of the model that included the natural logarithm of the real exchange rate; again the key dynamics of our estimated institutional uncertainty series were not affected. More information on our robustness test results are contained in the Appendix. The exchange rate data was sourced from the Bank of International Settlements (narrow version of the exchange rate): https://www.bis.org/statistics/eer.htm [accessed 20 November 2019].

differences pre- and post-reform being statistically significant at the one per cent level).[35]

Table 2: Regression Results: Reform and post-reform dummies

	Institutional uncertainty from:	
	TI-SVAR	TV-SVAR
	(1)	(2)
Reform	0.206	0.138
	(0.147)	(0.129)
Post_reform	−0.316**	−0.259**
	(0.133)	(0.119)
Lagged dep variable	0.721***	0.549***
	(0.057)	(0.067)
Constant	0.122	0.133
	(0.106)	(0.099)
Observations	168	168
R^2	0.770	0.502
Adjusted R^2	0.765	0.493
Note: Standard errors are in brackets	*p<0.1; **p<0.05; ***p<0.01	

Our second testing procedure tests for unknown structural breaks on both the temporally-ordered institutional uncertainty series and the same series with the reform period removed. Table 3 shows the identified breakpoints for the two institutional uncertainty estimates from the respective models; the critical values are from Bai and Perron (2003). Figure 5 show the average (mean) of our estimates of institutional uncertainty in the periods bordered by our breakpoints.

When the full sample equation is used, two breakpoints are found consistently across both uncertainty series from the respective models: one in the region 1983Q1 to 1983Q3 (i.e a year or so prior to the reform); another in 1993Q2. Further the top two graphs in Figure 5 show the mean of our estimates of institutional uncertainty is higher in the pre-reform period as identified by our breakpoints than in the post-reform period (and uncertainty was highest during the reform period itself). Finding 1993Q2 to be a breakpoint is interesting as Evans et al., 1996, Figure 2 indicates the last of the reform announcements were made in 1992 and 1993.

Turning to results based on the institutional uncertainty data reordered such that the reform period is removed; this allows us to test directly if uncertainty was lower post-

[35]Results of a robustness test with an alternative measure of institutional status are reported in the Appendix.

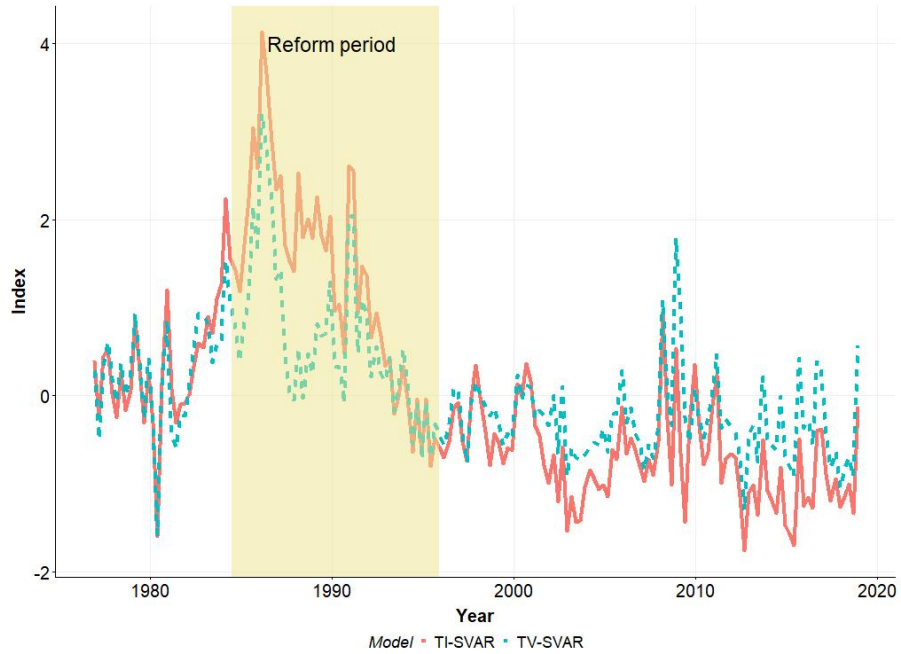


Figure 4: Historical contribution of New Zealand uncertainty's own shocks to New Zealand uncertainty

Table 3: Identified breakpoints in the institutional uncertainty series

Breakpoint	Scaled F-statistic	5 per cent critical values
Institutional uncertainty from time-invariant SVAR		
Temporally-ordered		
1983Q3	86.4	10.13
1993Q2	151.7	8.58
2001Q3	37.9	11.14
2012Q2	11.9	12.83
Reform period removed		
1996Q1	57.7	8.6
2002Q2	12.0	11.1
2012Q2	26.4	10.1
Institutional uncertainty from time-varying SVAR		
Temporally-ordered		
1983Q1	21.5	10.13
1993Q2	67.81	8.58
Reform period removed		
1996Q1	21.7	8.6

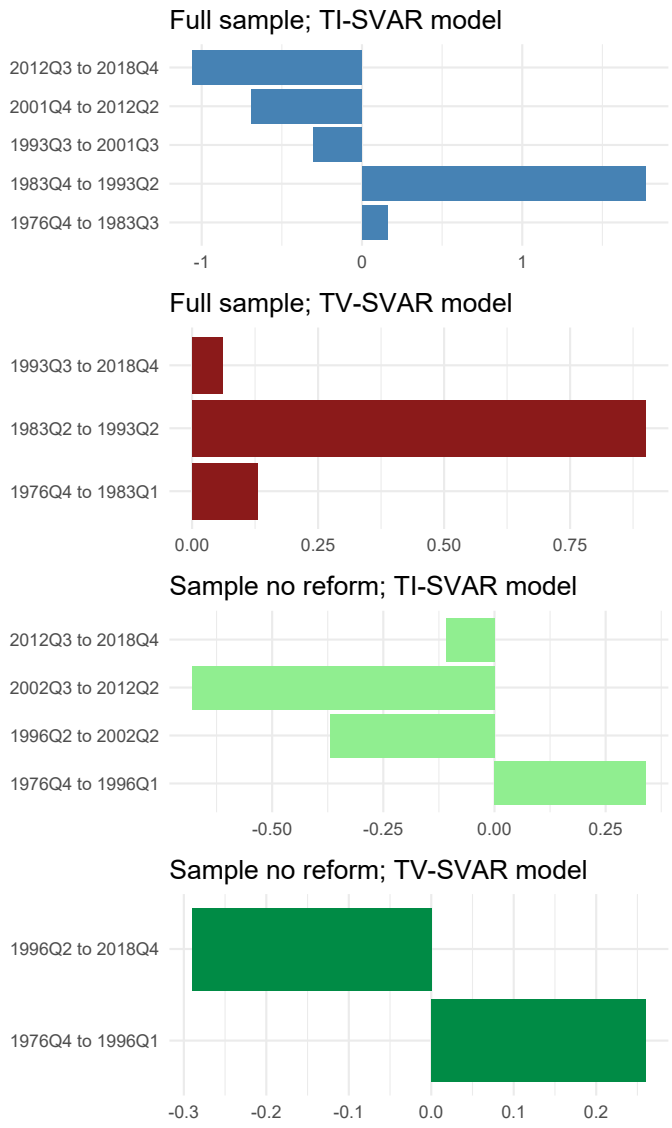


Figure 5: Mean uncertainty in periods bordered by identified breakpoints

reform, relative to pre-reform. The results would suggest uncertainty is lower post-reform than prior to it: a structural break in 1996Q1 (i.e. the start of the post reform period) is identified in the institutional uncertainty series from both models. Further the mean of institutional uncertainty is lower after this breakpoint (see in Figure 5, bottom two graphs).

5.2.1 Understanding the historical drivers of uncertainty in New Zealand

In addition to being a tool that allows us to isolate a proxy for institutional uncertainty, the historical decomposition allows us to look at what other factors significantly affect New Zealand uncertainty, and how their relative significance may have changed through time. Kilian and Lee (2014; cited in Kilian & Lütkepohl, 2017) proposes a simple way to present the information conveyed by historical decomposition: the bar chart. In their bar chart, the total change in the variable of interest between two dates is presented as one bar, with the other bars being the contribution of shocks to the other variables (as well as its own shock) to the change. This device allows the researcher to understand which shocks lead to the majority of the change in the variable of interest between the two dates. We adopt this approach. We split our sample into three-yearly groups. Figure 6 shows how the three-year cumulative contribution of each shock to New Zealand uncertainty has changed through time; we used the time-invariant SVAR for this analysis as it allows us to examine foreign influences.

The year on the y axis represents the end of the period, so the panel on the graph labelled 1984Q2 shows the cumulative contribution of each shock to the change in New Zealand uncertainty between 1981Q3 and 1984Q2. In this period, the index level of overall New Zealand uncertainty rose 1.9 units ('TOTAL'), the main contributor was institutional uncertainty as proxied by New Zealand uncertainty's own shocks ('OWN') which grew 1.7 units over the period (the blue bar). The other possible influences foreign financial uncertainty (red, denoted FFU), foreign output uncertainty (tan bar, denoted FOU), foreign output (green bar, denoted FYGAP) and the New Zealand output gap (purple bar, NZYGAP), all made negligible contributions.[36] In Figure 6, a number of things stand out. The large increase in institutional uncertainty immediately prior to the start of the reform; this is consistent with the findings of Bonfiglioli and Gancia (2015) who find, in a cross-country study, heightened uncertainty increases the likelihood of countries adopting reforms. We also see, with the exception of the period around the GFC, institutional uncertainty has been a negative contributor to uncertainty growth

[36] All the different shock contributions should add to the change in overall New Zealand uncertainty. In practice they do not because the historical decomposition point estimates are the median values from the empirical distribution from the many models sampled via the Gibbs sampling algorithm (see BEAR toolbox FAQ); individual models add up but point estimates from the empirical distribution do not as they likely correspond to different models.

since 1987.[37] There are a few of periods where foreign financial uncertainty has been a positive contributor to uncertainty in New Zealand: the period 1996Q3 to 1999Q2 (the Asian Crisis) and the period 2005Q3 to 2008Q2 (the latter part of this period included the first part of the GFC: 2007Q3 to 2008Q2). While the second oil shock and the Volcker deflation appeared to impact New Zealand uncertainty more through the foreign output gap; this might reflect the fact that at this time New Zealand was very closed to overseas capital (meaning foreign financial uncertainty was less important), so uncertainty was felt more through uncertainty about demand for New Zealand's goods.

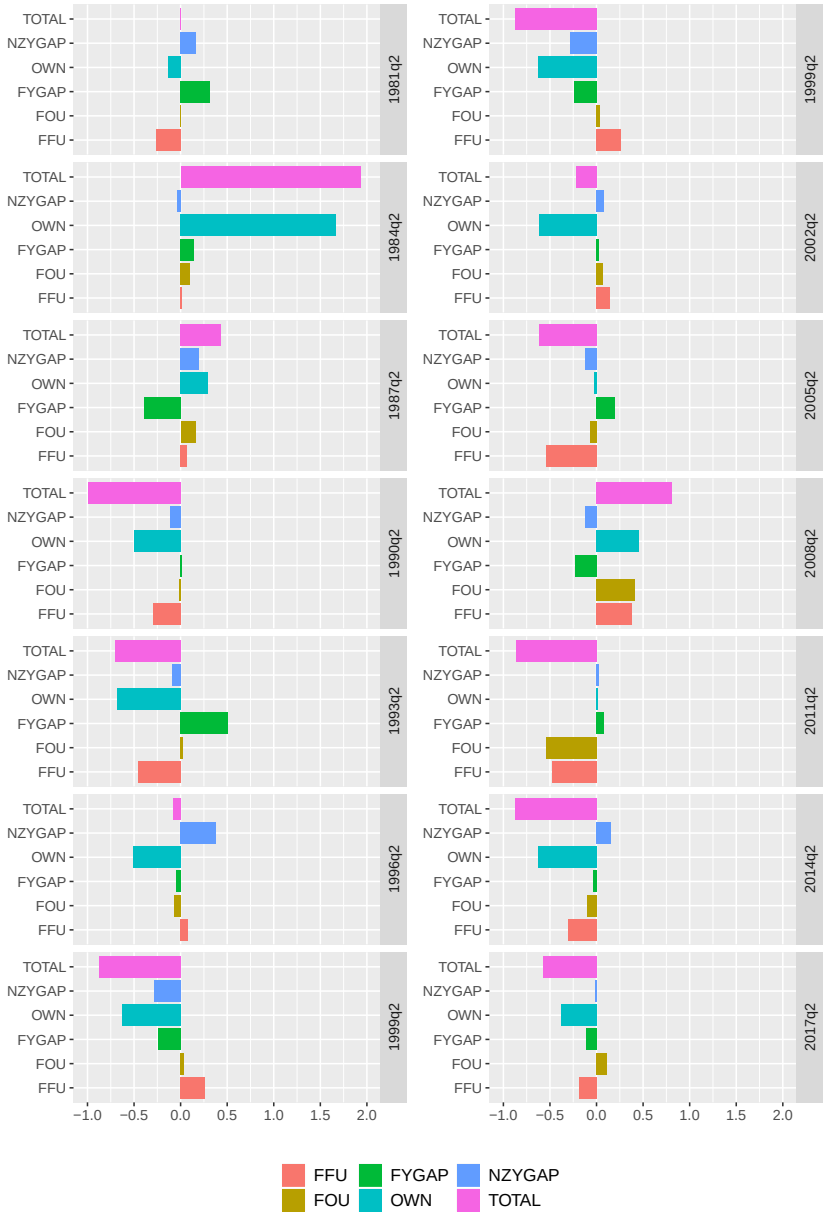


Figure 6: Historical contribution of all shocks to New Zealand uncertainty

[37] A possible explanation for why institutional uncertainty rose around the GFC is that firms were initially uncertain about how government would respond.

5.3 Testing the robustness of our results by explicitly including a measure of institutions

Sims (1998) makes the point that equally valid SVAR specifications can imply quite different shock series (and therefore historical decomposition series). Although we have undertaken a number of robustness tests (including by adding other variables), it may be that our identified 'own' uncertainty shocks and therefore our measure of institutional uncertainty is dependent on the specification. One idea to test our key conclusion—that the New Zealand reforms lowered institutional uncertainty— is to include a measure of institutional status in the model. We re-estimate our time-invariant SVAR with the same variables as the baseline specification outlined in section 4.4 but with a measure of institutional status added.

Our revised ordering assumes that changes to New Zealand's institutions affect New Zealand's uncertainty contemporaneously but, owing to the slow pace of changing institutions, it takes time for uncertainty in New Zealand to affect institutions.

The measure of institutional status is constructed using variables from Prati, Onorato, and Papageorgiou (2013). The measure is plotted in Figure 7 and more information is available in the Appendix.[38] The index reflects the tenor of our discussion of the reform in section 3: the initial period of the reform was rapid but then the pace slowed. Finally the indicator shows that by 1995 the reform was more or less complete. We acknowledge that market liberalisation is only one aspect of institutional reform, but is an important one. B. Easton (2020) characterises the reform as a move toward 'more market'. Further, a measure of the liberalisation of the New Zealand economy is likely to be strongly correlated with a hypothetical overall measure of institutional status given all the institutional changes occurred over a confined period in the mid-1980s to the mid-1990s.[39]

We calculate the impulse responses as per local projections method of Jordà (2005). The method requires the estimating a regression for each horizon,h = 0,1,2,..., for each variable:

$$y_{t+h} = \alpha_h + \beta_h shock_t + \psi(L)z_{t-1} + \epsilon t + h \tag{25}$$

[38] As the Prati et al. (2013) series is only available to 2005, we extrapolate the data out to 2018 based on the assumption that the degree of liberalisation is similar over the period 2006 to 2018 as it is in 2005. Further the original data is annual, so we interpolate a quarterly series using the Denton-Cholette method via R's Tempdisagg package.

[39] As we stated in the introduction, Kelsey (1997, pg. 85) notes New Zealand's structural adjustment programme centred on five areas: liberalisation of domestic markets and trade, reduction of the role and scope of the state, price stability being the objective of monetary policy, labour market deregulation and fiscal restraint. The indicator we use reflects the first two of these areas. Given the announcements and implementation of changes in the other areas happened slightly later it may be that the indicator we use underestimates the speed of the institutional reform in the latter period.

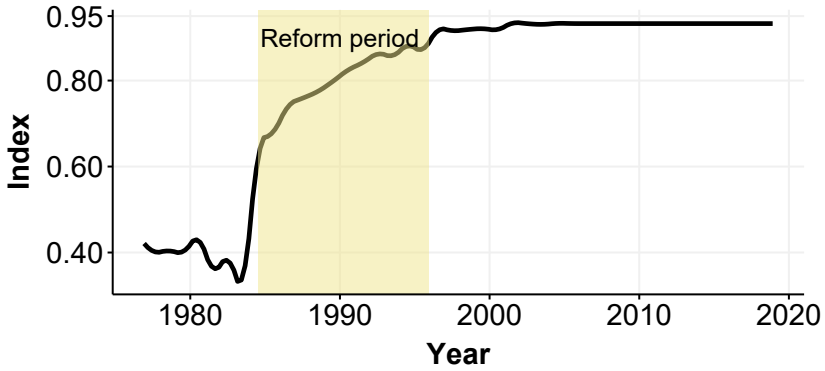


Figure 7: Measure of institutional status

where y is the variable of interest, *shock* is the identified shock series from the aforementioned recursive SVAR. Below we use two shocks: a shock to institutional status and a New Zealand uncertainty. z is is a vector of control variables which is all the variables in the aforementioned recursive SVAR plus an estimate of (log) potential GDP. $\psi(L)$ is the lag operator.

We use the local projection method, rather than the standard delta method, because the confidence intervals 'remain valid even if the data exhibits unit roots, and even at horizons that are allowed to grow with sample size'(Olea & Plagborg-Møller, 2020, pg. 2). Both the institutional status variable and (log) potential output contain unit roots. Selected impulse responses are plotted below (Figure 8). We see that initially a 'positive' institutional shock (i.e. a more towards market liberalisation) increases uncertainty, consistent with the idea that firms do not like change and are unsure about how the new regime will work. Further many of the reforms exposed previously protected firms to foreign competition, meaning, initially, uncertainty increased as firms adjusted to this new situation.[40] However once firms adjusted, uncertainty eventually fell. The interaction between uncertainty and institutions appears to run both ways, uncertainty shocks also appear to bring about institutional change; this is consistent with our findings in section 5.2.1 . We also see institutional change leads to an increase in the output gap and potential output.

A one unit uncertainty shock lowers the output gap by 0.4 percentage point; this is slightly higher than Greig et al. (2018) and Tran et al. (2019) who find a peak impact of between -0.25 and -0.35 percentage points on the output gap after three to four quarters. A one unit shock to uncertainty lowers the level of potential output by one percent; this is consistent with uncertainty delaying investment which leads to a lower capital stock.

[40]Heightened uncertainty immediately after the institutional change is also consistent with the description of the implementation of New Zealand's reform process by Kelsey (1997). She talks of 'the changes being implemented at a blistering pace', with '[m]uch of the legislation...made on the hoof...with details added part-way through the parliamentary process' (pg. 42-43).

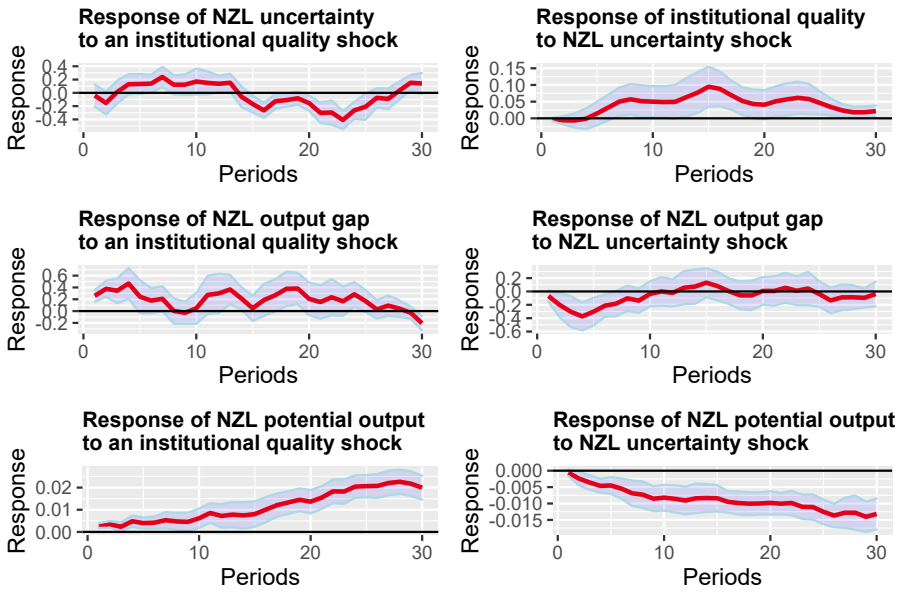


Figure 8: Impulse responses: Linear projections model with institutions

The solid line represents median responses of the variables to a unit shock to uncertainty (about one standard deviation) and a one standard deviation shock to institutional status. The shaded area represents the 90 per cent confidence bands.

We need to note some caution with these results. Because our institutional status variables suffers from measurement error, so will our estimate of shocks to institutional status. This will lead to attenuation bias in our estimated impulse responses. One solution, as set out in Ramey and Zubairy (2018), is instrumental variable estimation of the local projection model. Our attempts to do this, with some caveats around the analysis, are reported in the Appendix.

6 Conclusion

Douglass North argued that institutions are designed to reduce uncertainty. The corollary of this is the transition from poorly-functioning to well-functioning institutions will be marked by a reduction in uncertainty. The change in level of uncertainty post-reform relative to pre-reform is therefore an important metric for judging the success of reform. However isolating how uncertainty has changed post-reform relative to pre-reform is difficult owing to, amongst other things, measuring institutional change and uncertainty and isolating the movements in uncertainty owing to changes in the institutional settings and movements owing to other reasons. In this paper we offer a preliminary method for addressing some of these issues.

We applied our method to the New Zealand institutional reforms from the mid-1980s to the mid-1990s; we assess the reforms were successful in reducing uncertainty from insti-

tutional sources (although we are silent about whether more or less radical reform would have been more successful). Consistent with earlier literature, we find that heightened uncertainty pre-reform may have been the catalyst for reform itself.

We show that besides domestic institutional sources, changes to foreign demand and foreign uncertainty cause uncertainty in New Zealand periodically; this is likely to be the case for most small open economies. Given small open economies have no control over events in foreign countries, the onus is on governments and the citizens in these economies to ensure their institutions are functioning as effectively as they can and not generating uncertainty unnecessarily.

Earlier we described our paper as offering a preliminary method; there is no doubt our method can be refined. A few immediate suggestions are as follows. The models in this paper are identified via recursive identification which is popular in the literature owing to its ease. Alternative identification methods, such as sign restrictions and instrumental/proxy variables, have been developed in the literature and future papers could use these methods to test how robust our conclusions are. Further D. Berger, Dew-Becker, and Giglio (2020) notes the tight relationship between news and uncertainty shocks. Further research might examine if the reduction of uncertainty owing to institutional change we find, is actually owing to positive news shocks about the future of the economy rather than a reduction in uncertainty.

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Appendix

This appendix contains additional information on our study. The first section provides extra information on the QSBO. The second section reports the results of our robustness tests. The third section provides extra information on our alternative measure of institutional status. The fourth section reports on an alternative estimation of our local projections model.

Extra information on the QSBO

Linking responses to the QSBO

To create the expectation errors index we need to be able to link a firm's response in time *t-1* to their response time *t*. Figure 9 shows, for each quarter, the number of firms in time *t-1* that are able to be linked to time *t*. The solid horizontal line at 30 responses represents what we have imposed as the minimum acceptable sample size in a given quarter. If there are not that many responsesin the sample for the quarter we impose a null/missing value for that quarter and then interpolate the index based on the surrounding quarters.[41]

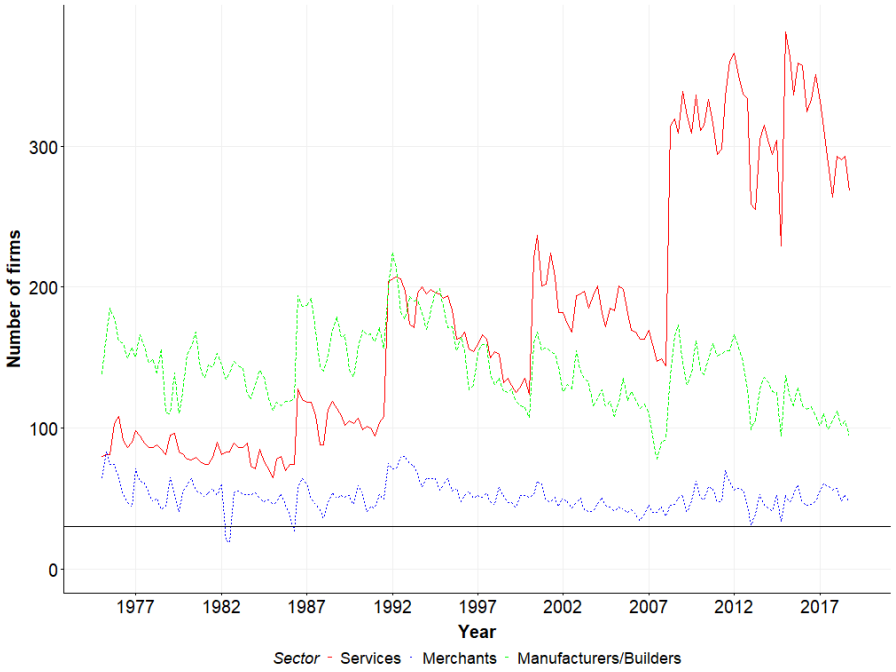

Figure 9: HHI: Linked Sample counts by sector

[41]Interpolated using the spline interpolation procedure in the imputeTS R package; owing to a smaller sample, 15 is minimum required sample for the Financial Services sector.

Questions in the QSBO

Table 4 shows the economic concepts asked about in (or topics of) the questions in the QSBO. The table breaks the questions down into those that are common to all sectors (apart from Architects) and questions that are specific to manufacturers, builders and merchants.[42] In constructing our indices, we do not restrict ourselves to topics/questions that are common between all sectors; we make use of all the topics/questions available for the given sector. The table has three columns. The first column states topics/ economic concepts where there is a question asking about expectations of the future as well as experienced activity. These questions are used for both our expectation errors and dispersion-based uncertainty proxies. The second column states topics/ economic concepts where there is a question about expectations of the future only; these are used for our dispersion-based proxy. The final column are topics of questions that we do not use as their answers are not in a form that allows us to create the aforementioned proxies.[43]

[42] Architects have their own more idiosyncratic set of questions and they are excluded from our study.

[43] For example, the 'limiting factor' question asks which factor of a list is limiting the firm increasing its turnover

Table 4: The economic concepts asked about in the QSBO questions

Expected and experienced	Expected	Other
Common		
Average cost	General business situation	Limiting factor
Average price	Investment in buildings	
Numbers employed	Investment in buildings	
Overtime	Finding skilled labour	
Profits	Finding unskilled labour	
Volume		
Labour turnover		
Manufacturers, Builders and Merchants		
Debtors		
Orders		
Delivery/exports overseas		
Delivery/sales NZ		
Merchants only		
Stock (value and volume)		
Manufacturing/builders only		
Output		Present stock
Production	Capacity Utilisation	
Finished goods		
Stock (raw and finished)		

Additional information on priors

The following table reports the hyperparameters used to determine the priors. How these hyperparameters are used to determine the priors of the parameters of interest is set out in Dieppe et al. (2016).

Table 5: Hyperparameters used in Bayesian estimation of SVAR model

SVAR:time-invariant		SVAR: time-varying	
Lambda 1:	0.1	Gamma:	0.85
Lambda 2:	0.5	Alpha0:	0.001
Lambda 3:	1	Delta0:	0.001
Lambda 4:	100		
Lambda 5:	0.001		
Lambda 6:	1		
Lambda 7:	0.1		

An alternative measure of institutional status

The measure

A quantitative measure of the change in functioning of New Zealand's institutions will always be imperfect. We make use of the market liberalisation indicators of Prati et al. (2013). The first three graphs in Figure 10 plot various liberalisation indicators for New Zealand from Prati et al. (2013). All indicators are re-scaled to range between 0 and 1, with higher values corresponding to a greater degree of liberalisation.[44] In terms of the individual indicators, 'Trade' measures tariff rates, while 'capital' and 'current' reflect restrictions on the respective external accounts. The financial indicators measure various aspects of domestic financial liberalisation (such as the lack of controls on credit and interest rates; the degree of competition; the quality of regulation). In the other indicators graph, 'Agriculture' and 'Network' refer to the degree of liberalisation in the agriculture, and telecommunications and electricity sectors respectively and measure the extent of

[44]The scaling occurs relative to all countries, so it is not necessary that New Zealand will ever score a zero or a one.

state intervention and the quality of regulation (in the case of telecommunications).[45] For our purposes it is enough to note the rapid increase in liberalisation occurs across most indicators post 1984; with the exceptions being in network industries (which were corporatised and privatised in the late 1980s) and the slower progress made on reducing tariff rates.

The indicators in the fourth graph (the lower right panel) in Figure 10 are our creation. The first ('total index') is a straight arithmetic average of all indicators in the other three graphs. It measures the overall extent of liberalisation and is the measure we use in section 5.3. The second indicator ('% change in the index') is the percentage change in the total index.

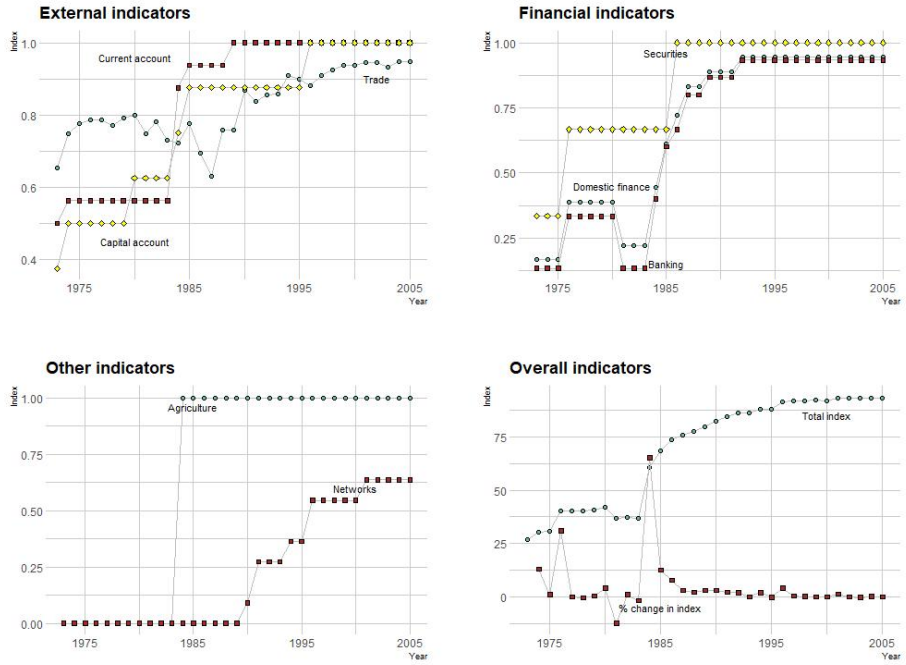

Figure 10: Measures of market liberalisation

Did the reforms lower institutional uncertainty? Alternative measure of reform

In section 5.2 we regressed our measure of institutional uncertainty on dummies for the reform and post-reform period to test if institutional uncertainty had fallen in the post-reform period. As an alternative test, we use the liberalisation index we developed above. The regression contains two variables: the overall level of institutional liberalisation ('Overall_q') and the percentage change in the total index ('change_q')—the latter variable will be high during the reform as the overall index will be changing rapidly.

[45]For the sake of brevity, the reader is referred to Prati et al. (2013) for a detailed description of each indicator.

Table 6 shows the results. We see in both models that the higher the level of liberalisation status, the lower the level of institutional uncertainty, which indicates the reform lowered institutional uncertainty.

Table 6: Regression Results: alternative reform measure

	Institutional uncertainty from:	
	IV-SVAR	TV-SVAR
	(1)	(3)
Overall_q	−0.423*	−0.401*
	(0.241)	(0.222)
Change_q	1.024**	0.980***
	(0.404)	(0.370)
Lagged dep variable	0.806***	0.608***
	(0.043)	(0.060)
Constant	0.309	0.315*
	(0.199)	(0.185)
Observations	168	168
R^2	0.767	0.499
Adjusted R^2	0.763	0.489
Note: Standard errors in brackets	*p<0.1; **p<0.05; ***p<0.01	

Robustness tests: how do different modelling specifications change the measures of institutional uncertainty?

In section 4.4 we discussed our assumption that we can proxy institutional uncertainty by the historical contribution of New Zealand's uncertainty 'own shocks'. We noted there that climate and natural disasters are other potential non-macroeconomic and financial factors that contribute to New Zealand's uncertainty 'own shocks'. To understand what makes a material difference to our estimates of institutional uncertainty, we conducted a number of robustness tests using the time-invariant SVAR as our baseline.[46]

Our first robustness tests concern climate and natural disasters. We use the Southern Oscillation Index (SOI) data as a variable to capture a potential source of climate uncertainty. The SOI measures the difference in surface air pressure between Tahiti and Darwin and is used to predict weather patterns in New Zealand. According to the Australia Bureau of Meteorology: 'sustained positive SOI values above about +8 indicate a

[46]We choose the time-invariant SVAR as our baseline as it runs the fastest.

La Niña event while sustained negative values below about –8 indicate an El Niño.'[47] El Niño events are typically associated with droughts in the east of New Zealand affecting agricultural production; while La Niña tends to result in lower summer flows into the hydroelectric lakes (McKerchar, Pearson, & Fitzharris, 1998). We transform the SOI two ways for different specifications of models. The first transforms the SOI into two dummy variables. The first dummy variable, *La Niña* takes a value of one if the SOI is greater than or equal to 8 and a value of zero otherwise. The second dummy variable, *El Niño* takes a value of one if the SOI is less than or equal to -8 and a value of zero otherwise. In the second specification, we take the absolute value of the SOI. This means a high value of the index means either a La Niña or El Niño event are likely.

Natural disasters also are likely to be sources of uncertainty (see for example, Baker et al., 2016). We use cost data from the Insurance Council of New Zealand to control for this.[48] We inflation adjust the cost data using Statistics New Zealand's CPI and expressed the cost of the natural disaster as a percent of GDP. Including both the climate and the natural disaster data made no material difference to the estimates of institutional uncertainty.[49] Figure 12 plots the institutional uncertainty measure from the baseline specification discussed in the body of the paper (see section 5.1) against a 'Scenario A' which is the institutional uncertainty measure from the baseline VAR augmented with the natural disasters data and the *El nino* and *La nina* dummies. 'Scenario B' substitutes the absolute measure of the SOI for the SOI dummy variables.

We also carry out some other robustness tests. Scenario C adds the real exchange rate to the baseline SVAR; scenarios D and E are the baseline SVAR estimated with eight lags and different priors respectively.[50] The institutional uncertainty measures associated with each of these scenarios is plotted in Figure 12. In section 4.4 we also noted that a shift from manufacturing to services might have lowered uncertainty through time (Fernández-Villaverde & Guerrón-Quintana, 2020). To test for this effect, we create our QSBO-based uncertainty measure with constant GDP weights (the weights in the first year of the sample period), rather than the weights updating annually as we do in our main specification. The institutional uncertainty measure associated with constant-weight index is shown as scenario F in Figure 12.

Across all our robustness tests, the dynamics of the institutional uncertainty proxy

[47] http://www.bom.gov.au/climate/enso/history/ln-2010-12/SOI-what.shtml [accessed 14 January 2020].

[48] Available at https://www.icnz.org.nz/natural-disasters/cost-of-natural-disasters/ [accessed 7 Febuary 2020]

[49] Looking at the estimated impulse responses (not reported), it appears that climatic events and natural disasters affect the output gap more than New Zealand uncertainty. Climatic events have a negative effect on the output gap; this is consistent with lost agricultural production. Natural disasters have a positive effects on the output gap. Natural disasters destroy some of the stock of capital but this is not subtracted from GDP; the rebuild of this capital stock is however counted and adds to GDP.

[50] Specifically the autoregressive prior is lowered from 0.8 to 0.1.

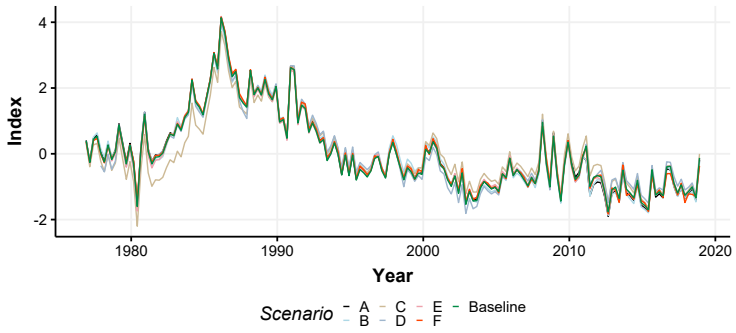

Figure 11: Historical decomposition of own shocks to New Zealand: scenarios

remain consistent with the baseline scenario. Including the real exchange rate probably has the biggest effect but this still does not change what one infers from the institutional uncertainty proxy: institutional uncertainty rose immediately prior to the reform, remained elevated during the reform and then fell post reform.

Instrumental variable estimation of the local projections model

In section 5.3 we note if our measure of institutional status suffers from measurement error, so will our estimate of shocks to institutional status. The result is attenuation bias in our estimated impulse responses. Ramey and Zubairy (2018), in the context of estimating the impact of government spending on the economy, propose a solution using instrumental variable estimation of the local projection model. In one formulation of their model they use government spending shocks from a Structural VAR to instrument the government spending variable. Analogously we could use our institutional status shocks (from our time invariant SVAR) as instruments for the first difference of our institutional status variable (we first difference our institutional status variable as it is non-stationary). There are two conditions instruments that are conventionally required to be met: the relevance of the instrument to the variable of interest and contemporaneous exogeneity with other shocks. In terms of the relevance of the instrument, the heteroskedasticity and autocorrelation robust F-statistic from regressing the first difference of our institutional status variable on our institutional status shocks is 26.95; this is higher than the 'rule of thumb' of 10 as set out in J. Stock and Yogo (2005).[51] In terms of instrument exogeneity with the other shocks this is more difficult to assess as the other shocks are not directly observed. One imperfect test is to look at the correlation between the institutional status shock and the other shocks identified in the time-invariant SVAR; this is reported below in table 7 and we see no evidence of a lack of contemporaneous exogeneity at a five percent statistical significance level. J. H. Stock and Watson (2018) also illustrate

[51] We use autocorrelation-robust standard errors owing to a low Durban-Watson statistic. A better test would be to use the test of Olea and Pflueger (2013).

the need for a third condition when using instrumental variables with local projections: lead/lag exogeneity. This requires no correlation between our shock of interest, and leads and lags of the other shocks. We look at the correlation between the institutional status shock and the $t-4, ...t-1$ lags and $t+1, ...t+4$ leads of the other shocks identified in the recursive SVAR. In three instances we find a correlation that is significant at a five percent level; this suggests caution in interpreting our results.[52]

Table 7: Correlations between other shocks and the institutional status shocks

Shock	Correlation	P-value
Foreign financial uncertainty	0.11	0.16
Foreign output uncertainty	0.11	0.15
Foreign output gap	-0.00	0.99
NZ uncertainty	-0.08	0.33
NZ output gap	-0.05	0.56

Below we present the impulse responses from the local projections for a positive change in institutional status when we use the shock as an instrument. For comparability, the shock is the same size as one presented in figure 8. There is little real difference in the results between the figure below and figure 8.

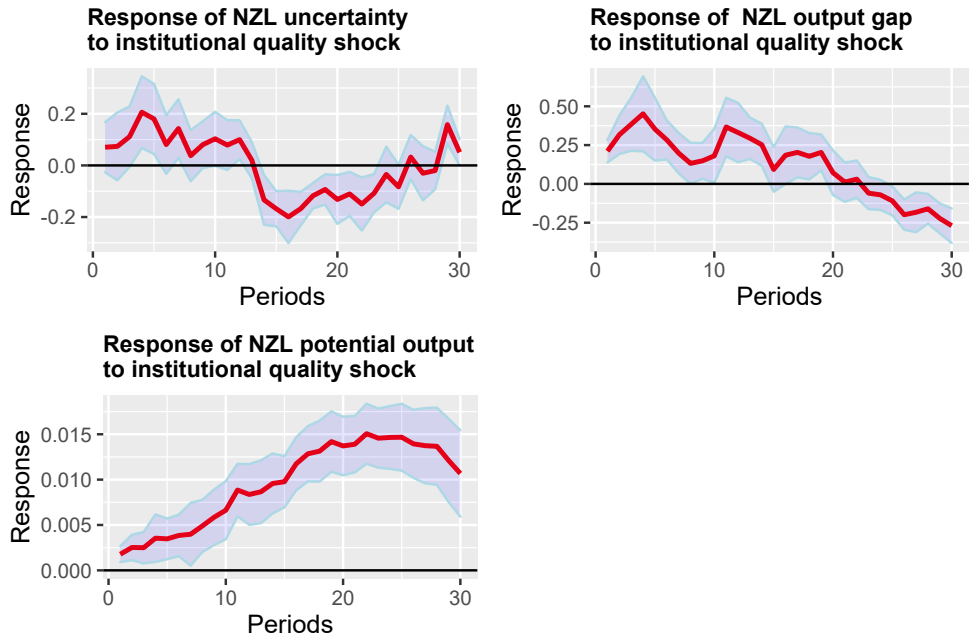

Figure 12: Impulse responses to an institutional status shock: LP model with instrument

The solid line represents median responses of the variables to a one standard deviation shock to institutional status as reported in figure 8. The shaded area represents the 90 per cent confidence bands.

[52]These instances are: the first lag of the foreign uncertainty shock, the second lag of the foreign output shock and the fourth lag of the New Zealand uncertainty shock.