Swine flu: what are the impacts on the New Zealand economy — a macro-modelling approach

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Abstract

We adopt a macro-economic modelling approach to estimating the potential impact of swine flu on the New Zealand economy. In particular, we use consumption and labour shocks to mimic the initial impact of the virus and use the Reserve Bank's new KITT model to model the dynamics of the shock transmission. We find relatively small impacts on the macroeconomy. Based on Ministry of Health assumptions that suggest less than 200 swine flu related deaths, we find declines in output of at most 0.62 percent.

1 Introduction

This note considers the impact of swine flu (that is, influenza A H1N1) on the New Zealand macroeconomy. The approach is similar to the macroeconomic modelling approach Keogh-Brown et al. (2009) use to model the impact of an influenza outbreak on the United Kingdom. Our analysis is based around three sets of assumptions about swine flu: (i) a set of epidemiology assumptions regarding the clinical attack rate and clinical fatality rate; (ii) an assumption that predominantly consumption and labour shocks can be used to mimic the initial macroeconomic impact; and (iii) the use of the KITT model to map the transmission of the shocks to the rest of the macroeconomy. The results are conditional on all three sets of assumptions.

Our preferred baseline case is predicated on recent Ministry of Health assumptions that suggest less than 200 swine flu deaths. We find relatively mild declines in output of, at most, 0.62 percent cumulated over the first year after the outbreak. The output declines are driven by reduced consumption demand and reduced supply of labour. These shocks tend to have offsetting implications for inflation and hence monetary policy. Further, firms and households

may engage in behaviour that smooths or minimizes the impact of the shocks (such as affected firms meeting demand by reducing stocks or workers deferring training to cover absent colleagues). These effects are not directly captured in the KITT macroeconomic model and thus we suggest our estimate of a 0.62 percent fall in output represents an upper threshold on the macroeconomic impact of swine flu.

Our baseline numbers are smaller than some reported recently in the markets (see O'Donovan and Zollner, 2009, for example), and elsewhere (the New Zealand Treasury working paper Douglas et al., 2006, for example). This is largely a function of using a more benign set of epidemiology numbers that we associate with no material school closures or prophylactic absenteeism.

In addition to our baseline case, we model a conservative scenario and a severe scenario associated with a less benign set of epidemiological assumptions and more disruption on household behaviour. These cases have progressively larger implications for output, mostly as a function of increased school closures and absenteeism rather than as a direct function of the number of deaths.

2 The swine flu shock

2.1 Epidemiology

Underlying the macroeconomic impact of the shock are assumptions regarding the epidemiology or virulence of swine flu. Swine flu is closely related to avian flu within the influenza family of viruses. While swine flu is a new strain of influenza, some basis for the proportion of the population who contract swine flu can be calibrated based on previous outbreaks, and by examining the pattern of spread of existing cases.

We assume that 30 percent of the population contract swine flu and develop symptoms. Ministry of Health planning suggests a higher clinical attack rate (CAR) but estimate just over one one-third of the New Zealand population will become symptomatic.

Our attack rate is the same attack rate as some earlier studies of influenza (see Douglas et al., 2006, for example). For comparison, Keogh-Brown et al. (2009) suggest a clinical attack rate of 25 percent for the United Kingdom experience of the 1918 influenza epidemic and note higher attack rates for the 1957 (greater than 30 percent) and 1968/69 epidemics (greater than 45 percent). For the case of the US, James and Sargent (2007) suggest an attack rate of 25 percent for the 1918 outbreak and 35 percent for the 1957 outbreak.

However, the clinical attack rate is likely to differ from country to country and from episode to episode.

The case fatality rate (CFR) also differs widely across influenza outbreaks. We use a fatality rate recently suggested by the Ministry of Health and consistent with less than 200 deaths in the New Zealand population. Relative to historical outbreaks and indeed, the seasonal flu, this is a relatively low fatality rate. We also explore more severe scenarios associated with a materially different set of epidemiology assumptions, where the fatality rate is 0.08 percent of those that contract the illness. Previous influenza outbreaks have often been restricted to one or two months (for example, deaths due to the 1918 US epidemic spiked in a single month) and we base our case to the third quarter of 2009. [1]

2.2 Impact on the labour force

The impact of the swine flu shock on the labour force is modelled through four channels (i) deaths from the virus itself; (ii) sickness from contracting swine flu; (iii) school closures; and (iv) "prophylactic absenteeism", where either employees absent themselves from work or employers direct employees not to attend work, in order not to catch the virus. We approximate the New Zealand labour force as equivalent to 3 million people and centre our analysis on the 13 weeks available in the quarter that the virus is assumed to hit the economy.

Fatalities from the virus can be calculated by simply multiplying the case attack rate by the case fatality rate. Here, we take the latest Ministry of Health release that suggests 200 influenza deaths for the entire population in New Zealand, which generates a comparatively low fatality rate in the region of 0.02 percent. Table 1 shows the impact on the New Zealand labour force (assumed to be approximately 3 million) under the baseline scenario.

We make a number of specific assumptions that are relevant to the labour force. First we assume that the possibility of death can occur at anytime in the quarter so the number of weeks out of the labour force due to death averages 6.5 weeks out of the possible 13 weeks. The direct impact of deaths on the labour force is insignificant.

Contracting swine flu has a larger impact on the labour force than the number of deaths from the illness. Both our baseline and conservative case assume the period of illness associated with catching swine flu is 4-6 days. We assume that this translates to a period of approximately one week not working. This generates a decline of 897,600 weeks in aggregate or a 2.3 percent decline

[1] Some outbreaks have been characterized by waves of infection. However, we do not model the incidence of waves of attack in this study.

in the labour force under the baseline case. Table 1 shows our assumptions regarding the impact of the swine flu shock on the labour force for the baseline, conservative and severe scenario. We ignore the impact of deaths on the labour force since this effect is extremely small.

Both our conservative and severe scenarios assume a less benign form of swine flu than the baseline case. Our conservative case assumes material school closures of every school closing for one week. We assume that this is associated with a 15 percent decline in the labour force (for one week) since parents have to look after school children. [2] Further, our severe case assumes an additional impact from prophylactic absenteeism, where 20 percent of the work force otherwise unaffected by swine flu is told not to come to work, in order to avoid catching swine flu. School closures and prophylactic absenteeism generate just over half of the labour force shock in the severe scenario. Assumptions about the magnitude of the aggregate labour force shock are clearly conditional on assumptions for school closures and prophylactic absenteeism. [3]

2.3 Impact on consumption

To examine the impact on consumption, we split consumers into three types: (i) those hit by the flu (labelled 'sick'); (ii) those that stay home because of absenteeism or school closures (labelled 'Absent, school closure'); and (iii) normal consumers (those that don't contract swine flu, and are unaffected by school closures or prophylactic absenteeism). We then take the New Zealand consumption bundle and make specific assumptions about expenditure by each consumer type across types of goods. These expenditures are then weighted by the proportion of each consumer in each category and the duration of time each consumer in each category (no more than one week of the thirteen in the quarter), to produce an aggregate shock for the quarter.

Table 2 shows the impact of our assumptions regarding consumption expenditure for the baseline, conservative and severe scenarios. We assume that illness substantially reduces expenditure for many types of goods. However, this is temporary and the rightmost three columns of table 3 show assumptions regarding how much consumption of each good is delayed rather than lost permanently. This assumption produces a boost to consumption in the quarter immediately following the impact of the flu outbreak.

Note that the consumption reductions are more pronounced for the conserva-

[2] The 15 percent assumption is identical to the assumption in Keogh-Brown et al. (2009).

[3] The number of reported deaths and the nature of media coverage might impact on the extent of these effects.

Table 1
Impact on labour force

	Cause	Population Affected	Individual weeks	Impact on total weeks	Supply impact
		Baseline Scenario			
i)	Contracting flu	30.00%	1	897,600	-2.30%
ii)	School closures	0.00%	0	0,000	0.00%
iii)	Absenteeism	0.00%	0	0,000	0.00%
				Total impact on the labour force:	**-2.30%**
		Conservative Scenario			
i)	Contracting flu	30.00%	1	897,600	-2.30%
ii)	School closures	15.00%	1	450,000	-1.20%
iii)	Absenteeism	20.00%	0	0,000	0.00%
				Total impact on the labour force:	**-3.50%**
		Severe Scenario			
i)	Contracting flu	30.00%	1	897,600	-2.30%
ii)	School closures	15.00%	1	450,000	-1.20%
iii)	Absenteeism	20.00%	1	600,000	-1.50%
				Total impact on the labour force:	**-5.00%**

tive and severe cases since we assume a less benign strain of influenza. Further, we reduce consumption for employees that are absent since we assume this group undertake behaviour aimed at reducing the likelihood of catching the disease and reduce travel and social interaction.

The table shows that the baseline scenario produces a -1.2% consumption shock in 2009Q3 with a 0.8 percent positive, "bounceback" shock in 2009Q4. The shock is larger in the conservative scenario: -4 percent in 2009Q3 and 1.3 percent in 2009Q4. The severe scenario suggests consumption declines 13% before increasing by 4 percent in the next quarter. Declines in spending in the hotels and restaurants category is a key feature of the conservative and severe scenarios.

As a comparison, the Congressional Budget Office (2006) performs an evaluation of the impact on the United States' GDP for two scenarios: a severe pandemic of 1918/1919 proportions and a mild pandemic of 1957 and 1968 proportions. The severe pandemic has a gross infection rate of 30 percent and

Table 2
Impact on consumption

	Cons. frac.	Sick	Absent, School Closure	Normal	Sick	Absent, School Closure	Normal
Baseline case			**09:Q3**			**09:Q4**	
Food and beverages	0.2	50%	na	100%	138%	na	100%
Clothing and footwear	0.06	50%	na	100%	138%	na	100%
Housing	0.19	100%	na	100%	100%	na	100%
Household goods	0.16	50%	na	100%	138%	na	100%
Transport	0.18	0%	na	100%	175%	na	100%
Hotels and restaurants	0.08	0%	na	100%	125%	na	100%
Other goods	0.13	50%	na	100%	138%	na	100%
	TOTAL SHOCK: -1.2 %				TOTAL SHOCK: 0.8 %		
Conservative case			**09:Q3**			**09:Q4**	
Food and beverages	0.2	20%	50%	100%	160%	115%	100%
Clothing and footwear	0.06	20%	50%	100%	160%	115%	100%
Housing	0.19	100%	100%	100%	100%	100%	100%
Household goods	0.16	20%	50%	100%	160%	138%	100%
Transport	0.18	0%	50%	100%	175%	138%	100%
Hotels and restaurants	0.08	0%	50%	90%	175%	138%	108%
Other goods	0.13	20%	50%	100%	138%	115%	100%
	TOTAL SHOCK: -2.7 %				TOTAL SHOCK: 1.1 %		
Severe case			**09:Q3**			**09:Q4**	
Food and beverages	0.2	20%	50%	100%	160%	115%	100%
Clothing and footwear	0.06	20%	50%	100%	160%	115%	100%
Housing	0.19	100%	100%	100%	100%	100%	100%
Household goods	0.16	20%	50%	100%	160%	138%	100%
Transport	0.18	0%	50%	100%	175%	138%	100%
Hotels and restaurants	0.08	0%	50%	90%	175%	138%	108%
Other goods	0.13	20%	50%	100%	138%	115%	100%
	TOTAL SHOCK: -4.0 %				TOTAL SHOCK: 1.3 %		

a case fatality rate of 2.5 percent, whereas the mild pandemic has a gross infection rate of 20 percent and case fatality rate of 0.1 percent. Under the severe pandemic an 80 percent reduction (for three months) in the entertainment, arts, recreation, lodging, and restaurant industries is assumed. Most other industries suffer a 10 percent reduction in demand except for the government and education sectors, which have no demand side effect, and health for which demand increases by 15 percent.

In addition to the labour and consumption shocks listed above, we assume some impact of influenza on the New Zealand tourism industry in the conservative and severe scenarios only. In particular, we assume that the Northern hemisphere experiences an influenza epidemic of a similar magnitude to that suggested in tables 1 and 2. We assume that the shock reduces net exports of services by 5 percent over 2009Q4 and 2010Q1 (the Northern hemisphere winter), reducing non-commodity exports by 1.5 percent in each quarter in the baseline scenario. In the conservative scenario we simply double this effect and input 3 percent shocks for non-commodity exports in 2009Q4 and 2010Q1. Finally, we assume that half of this expenditure is returned to New Zealand in 2010Q2 because a fraction of tourists delay rather than cancel travel plans.

2.4 Macroeconomic projections

With a set of macroeconomic shocks in hand, we use the KITT DSGE model (see Lees, 2009, for an introduction to the model) to understand the possible impact of the shocks on the macroeconomy. Confronted with a large labour supply shock, the model would typically produce a large increase in wages to encourage labour supply. In this analysis we assume that both workers and firms recognise the temporary, extraordinary nature of the shock and we assume no increase in wages for the influenza scenario (by introducing offsetting shocks).

Figure 1 shows the implied paths of key macroeconomic variables following the swine flu shock for the preferred baseline case. Consumption immediately falls as a direct result of the shock. This lowers firms' investment plans. Net exports increase initially as a result of a reduction in imports driven by lower consumption. By the first quarter of 2010, the effect of the influenza attack on the Northern hemisphere dominates and net exports are actually slightly negative.

Since the consumption and labour shocks are broadly offsetting, there is only a small movement in headline consumer price inflation. The impact of the consumption shock slightly dominates, suggesting some deflationary pressure. This produces a decline in the policy rate and a concomitant fall in the ex-

Table 3
Cumulative impact on output

Scenario	**One quarter**	**One year**	**Three years**
Baseline scenario	-0.57	-0.62	-0.75
Conservative scenario	-1.10	-3.30	-4.05
Severe Scenario	-1.52	-8.15	-11.48

change rate.

Figure 2 shows the impact of the more conservative scenario. The fall in consumption is quite dramatic and there is a large fall in investment. The powerful consumption shock produces a marked improvement in the net export position because of a reduction in imports. The effects of the shock to exports from northern hemisphere tourists reducing spending is clearly visible in the exports panel. Although the falls in output are much more pronounced than for the baseline case, the consumption and labour supply shocks are broadly off-setting with little movement in inflation or the interest rate.

Figure 3 shows the results of the severe scenario. This scenario depicts quite marked declines in output and key macroeconomic variables, particularly investment. With less demand for goods, firms reduce production and inputs to production. Investment falls. However, even under a substantive swine flu event, it's not clear that reductions in investment of the magnitude in figure 3 are realistic and are probably a function of stark simplifying modelling assumptions regarding how firms produce goods and services.

One key feature of this severe scenario is large cumulated output losses. These output losses can be compared across the scenarios in table 3.

3 Robustness checks

This paper approaches the question of the magnitude of the impact of swine flu on the New Zealand economy from a very specific macroeconomic modelling perspective. There are weaknesses in the model. For example, the model abstracts from the ability of firms to absorb slack in demand by simply allowing inventories to increase temporarily rather than reducing production substantively. Furthermore, firms may be able to reduce the effective magnitude of the labour supply shock by simply postponing training and leave, freeing up staff to replace colleagues absent because of swine flu. To gain some understanding of the materiality of points such as these, we compare our study with other studies and historical influenza episodes.

Fig. 1. Baseline scenario

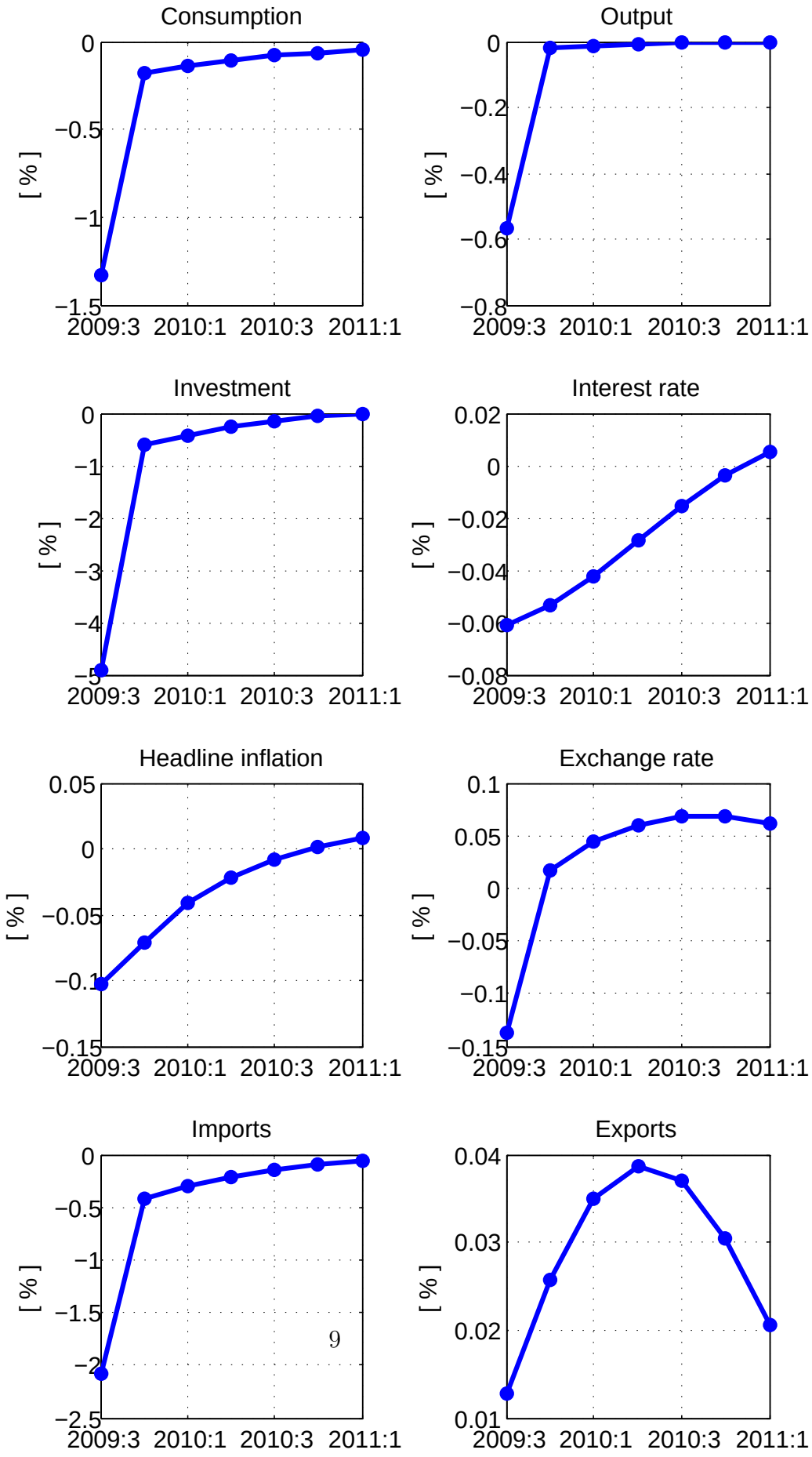


Fig. 2. Conservative scenario

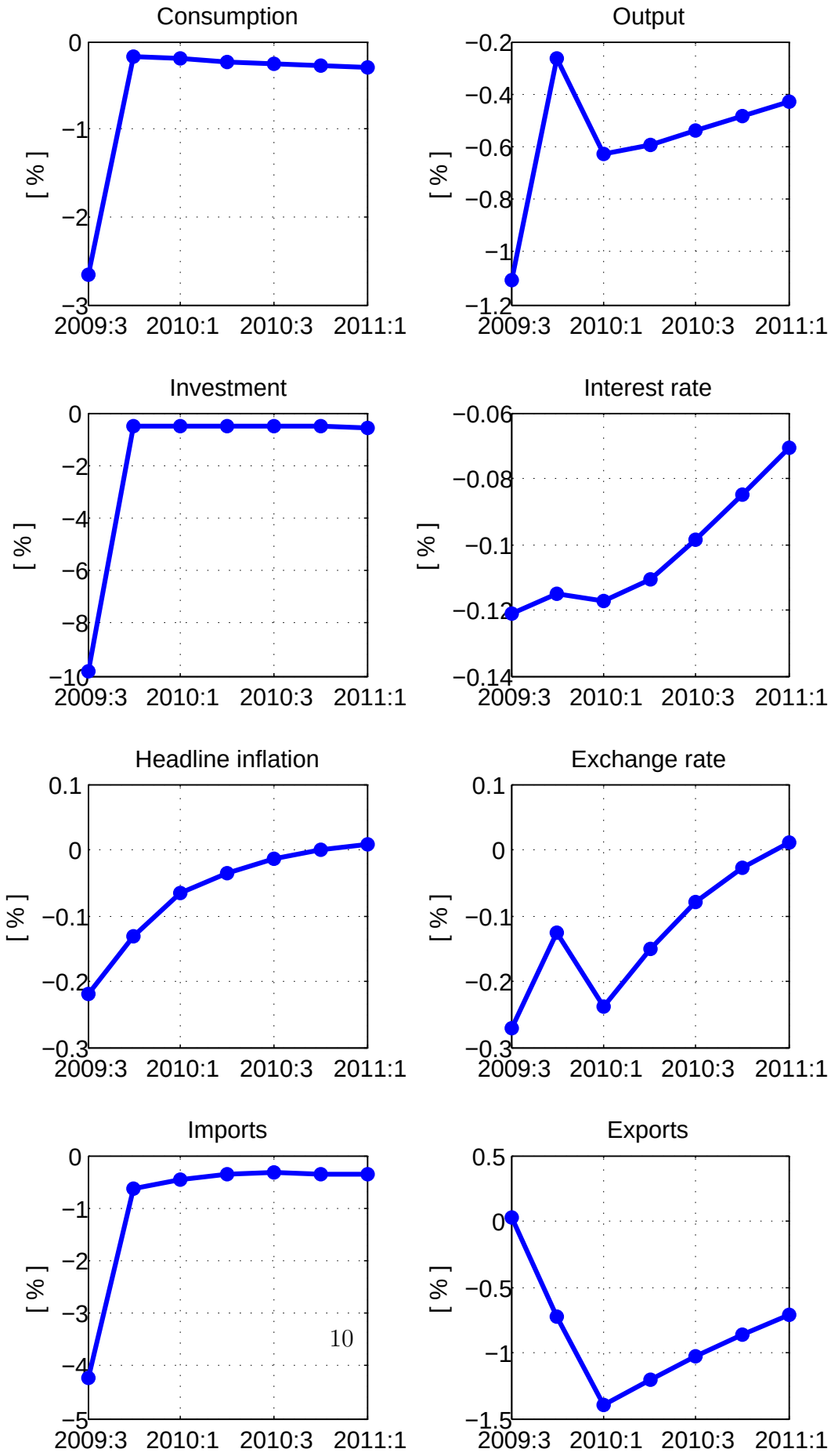
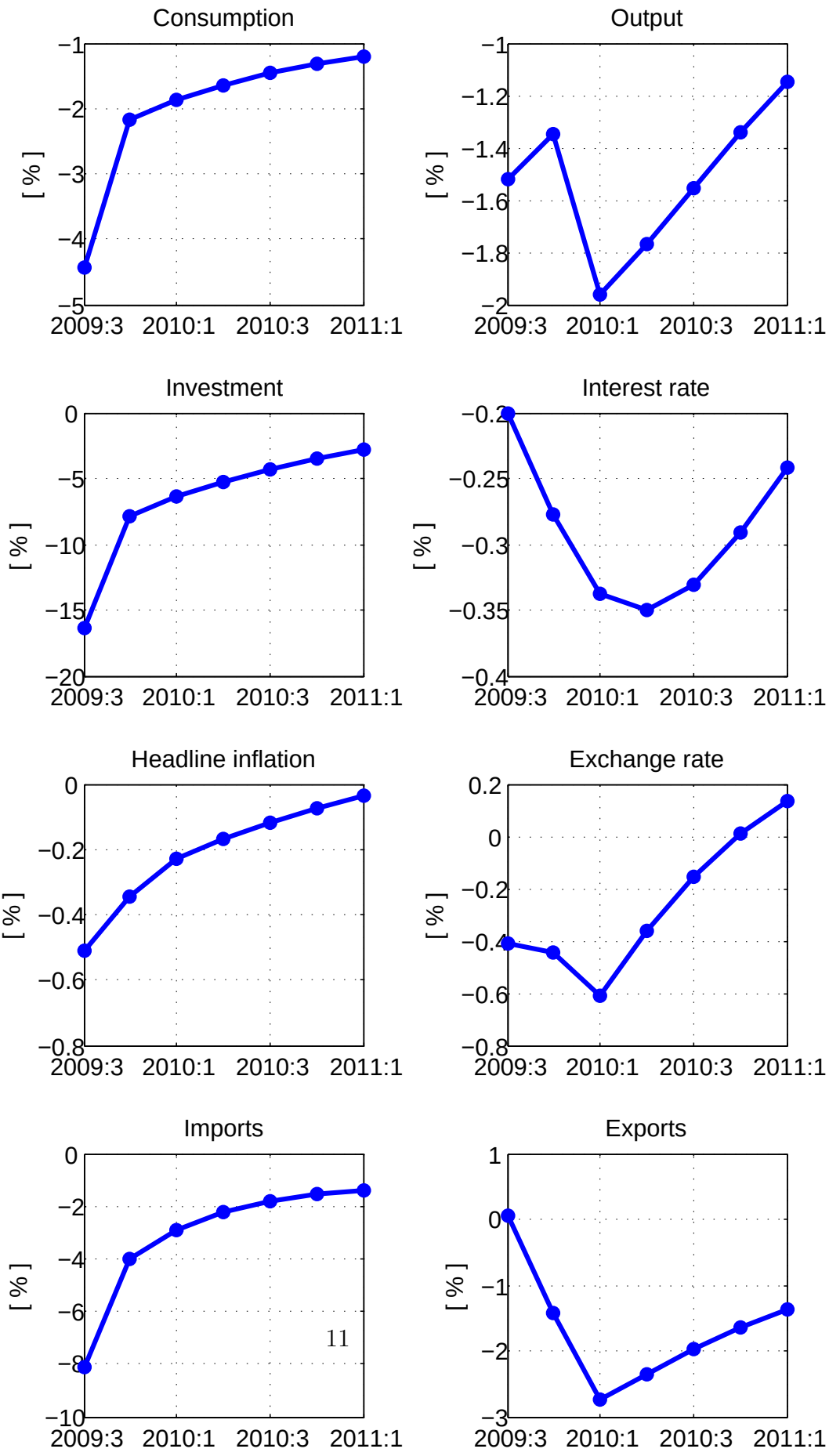


Fig. 3. Severe scenario



3.1 Other studies

There are other cross-country studies that we can draw from when considering the impact of swine flu. Some of the cross-country differences may be large however and may affect both the attack rate of the influenza (depending on the density of population and cultural norms) and the macroeconomic impact (for example, through the impact on net exports). Notwithstanding these points, table 4 shows the impact of our study in the context of other similar studies.

James and Sargent (2007) produce a very detailed analysis of a range of scenarios largely eschewing a macromodelling perspective. Their conclusion is that the macroeconomic impact of swine flu is likely to limited and produce a wide range of estimates for three scenarios that range from 0.09 to 1.6 percent of GDP in the first year following the outbreak.

Keogh-Brown et al. (2009) apply a macroeconomic modelling approach to a hypothetical influenza outbreak for the UK and suggest a wide range of estimates of the impact on GDP. The epidemiological assumptions they adopt are on balance less benign than in this paper (certainly less benign for the baseline case) but suggest similar macroeconomic findings.

Of particular relevance is the 2006 New Zealand Treasury study by James Douglas, Kam Szeto and Bob Buckle. Their paper is based on two scenarios: (i) a severe scenario where the 40 percent of the population is infected with a fatality rate of 2 percent; and (ii) a mild scenario where 30 percent of the population is infected with a fatality rate of 0.25 percent. Their scenarios work from a range of assumptions about declines in demand and increased absenteeism. Their mild scenario suggests reductions in GDP over a range between 1-2 percent in year 1 and 1-3 percent over four years. These results are different to our baseline assumption but in keeping with the different set of epidemiology assumptions that underpin both our conservative and severe scenarios.

3.2 Historical episodes

In addition to examining macroeconomic studies, we can look at historical episodes of influenza outbreaks to help determine possible macroeconomic impacts. Both influenza outbreaks and the impact of the SARS (Severe Acute Respiratory Syndrome) on Hong Kong and Singapore prove useful cases to provide a check on the analysis that comes from making microeconomic assumptions and extrapolating to the macroeconomy using a model.

The SARS virus

Table 4
Comparison with other studies†

Author	**Country/Region**	**Negative % GDP**
James and Sargent 2007	Canada	0.09 to 0.28
		0.34 to 0.92
		0.4 to 1.1
Jonung and Roeger 2006	EU-25	1.1 to 1.6
McKibbin and Sidorenko 2006	United Kingdom	0.72 to 11.11
Keogh-Brown et al 2009	United Kingdom	0.22 to 4.5
		2.52 to 6.05
Douglas, Szeto and Buckle 2006	New Zealand	1-3 (mild case)
		10-15 (severe case)
This study	**New Zealand**	**0.62 (baseline)**
		3.3 (conservative)
		8 (severe case)

†Other studies relate to influenza or avian flu and not swine flu *per se*.
‡The assumptions regarding epidemiology and the macroeconomic impact vary across both "severe" studies.

The SARS virus hit Hong Kong in 2003 infecting around 2,000 people and killing 300. The main impact of SARS was felt through tourism, declines in restaurant receipts (see figure 4, from James and Sargent 2007) but only a limited impact on retail sales. Further, exports of goods were strong throughout the period. In aggregate, the virus had limited impacts on GDP. Only minor declines in GDP were recorded relative to the historical volatility in GDP series.

1918 pandemic

The 1918 pandemic killed about 650,000 people in the US. The epidemic was characterized by a large spike in a single month in the US. While the toll on the population was severe, figure 5 (from James and Sargent 2007) shows the impact on US industrial production was not large. They conclude that while the structure of the economy may have changed over time, the broad pattern of data from historical episodes does not support large impacts on output from outbreaks of influenza.

Fig. 4. Impact of SARS on the Hong Kong Economy: James and Sargent (2007)

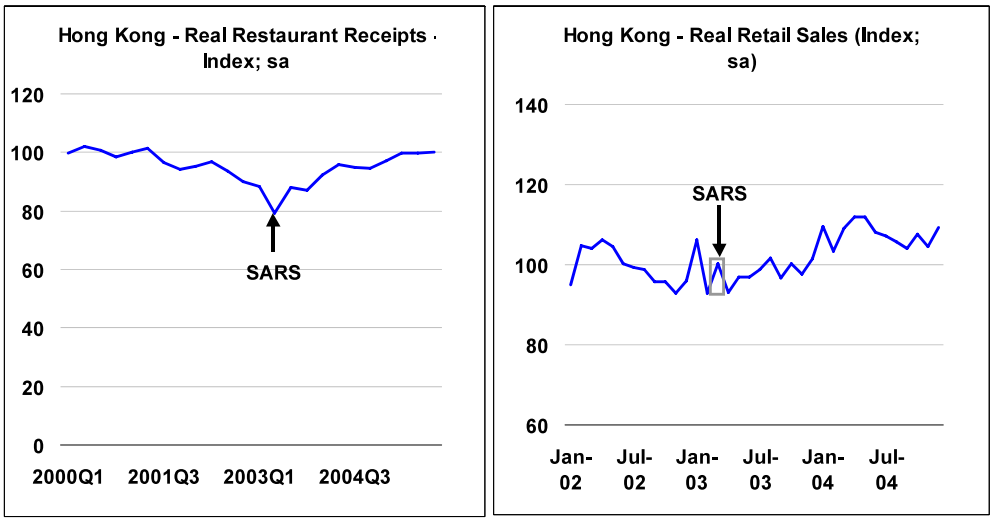
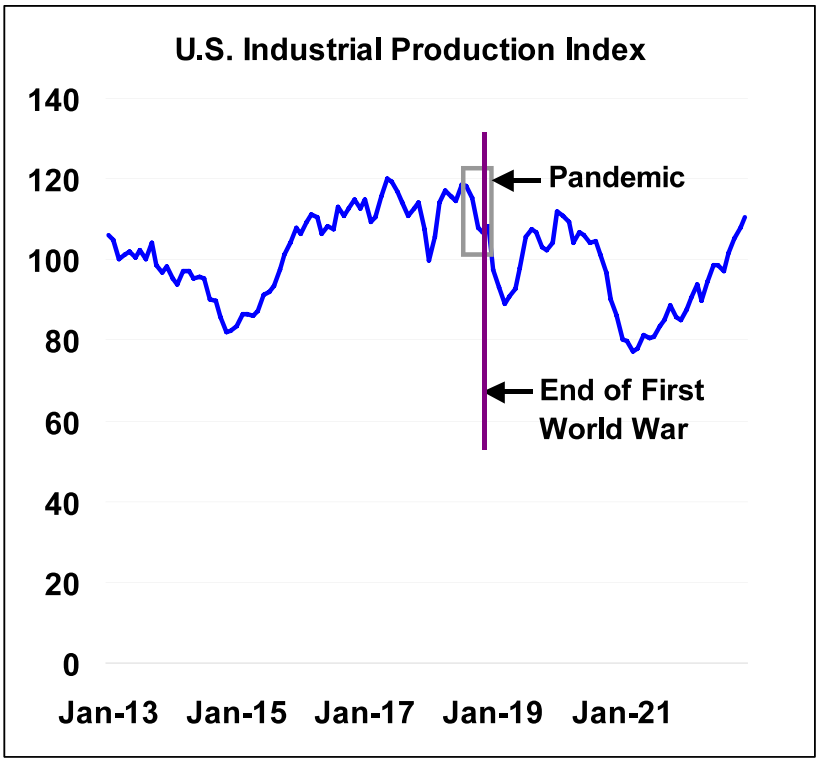


Fig. 5. Impact of 1918 Influenza on US Industrial Production: James and Sargent (2007)



4 Concluding comments

Estimates based on the latest Ministry of Health information suggest a limited macroeconomic impact of swine flu on New Zealand. A less benign epidemic would have more pronounced output and consumption effects although the inflation and policy effects are small. More pronounced output and consumption effects are largely a function of assumptions made for both the extent of school closures and prophylactic absenteeism.

Our baseline scenario produces a 0.62 percent decline in output, smaller than typically suggested in the literature for influenza outbreaks. The ability of firms to use inventories as a buffer and also reschedule staff activities is not modelled and may mitigate the impact on output. Furthermore, while our study is within the broad range of estimates produced by other researchers, historical episodes of influenza outbreaks do not support large impacts on the macroeconomy. We believe the impact of swine flu on the New Zealand macroeconomy is unlikely to be large.

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