A PRIMER ON THE MACROECONOMIC EFFECTS OF AN INFLUENZA PANDEMIC

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ABSTRACT

Interest in pandemics has increased dramatically in recent times with the emergence of Avian Influenza and conditions conducive to a global flu outbreak. While understandably most of the focus is on public health policies that might prevent or ameliorate the effects of a pandemic, there is often reference to the possible economic effects. This paper discusses the pathways through which a pandemic might affect the Australian economy. The Treasury macro-econometric model (TRYM) is used to illustrate these pathways. The paper finds that confidence effects and the (large) short-term withdrawal of labour are probably the dominant mechanisms through which a pandemic adversely affects the economy. The macroeconomic policy implications flow naturally from these potential economic effects. In particular, policies that restore confidence and consumption, support business in the short-term, and promote a quick return to work are likely to be most effective in offsetting the adverse economic consequences of a pandemic.

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1. INTRODUCTION

Over the past few years there has been increasing interest in the possible, or some would argue probable, emergence of an influenza pandemic. Most interest had been among academics and researchers but more recently there has been heightened interest among policy makers. A combination of factors has contributed to the focus on pandemics including the re-emergence and spread of Avian Influenza, the occurrence of other illnesses such as Severe Acute Respiratory Syndrome (SARS), the development of conditions deemed conducive to the emergence of the human-to-human spread of specific types of influenza, and the recognition that it has been some time since the world was affected by a severe influenza. This last factor does not represent a simple notion of a poorly understood cycle: it reflects the dynamics of rising and falling resistance to diseases within populations.

The threat of a possible new pandemic is fuelled by re-visiting the dramatic effects of past pandemics, especially the Spanish Influenza of 1918–19. This pandemic is estimated to have killed around 50 million people worldwide with some estimates as high as 100 million (Garrett 2005 and Osterholm 2005). The

grim manner in which the Spanish Influenza killed people adds to the fear surrounding a new pandemic.[1]

Sensibly, governments across the world are responding to the threat of a pandemic although there is considerable variation in their states of preparedness and ability to respond. The Australian Government is well advanced in its preparation with the release of draft plans for responding to a pandemic and the stockpiling of medicines and medical equipment (see Australian Management Plan for Pandemic Influenza 2005).

What should economists make of the threat of a pandemic? A statement that often accompanies the predictions of loss of life is the dire economic effects that a pandemic is likely to engender (see, for example, Garrett 2005; Osterholm 2005; and Cooper and Coxe 2005). However, there is usually little detail associated with these dire economic predictions and there have been few studies of macroeconomic effects of pandemics. Exceptions include Lee and McKibbin (2003), who examined the economic effects of SARS, and more recently Cooper and Coxe (2005) and Edwards (2005) on Avian Influenza. One might question the importance of understanding the (macro) economic effects of pandemics, particularly compared with the potentially dramatic loss of life. It is true of course that the primary policy issue surrounding pandemics is the preservation of life and not the maintenance of per capita growth in gross domestic product (GDP). However, the potential for economic effects to add to the disruption caused by a pandemic and to be one of the key pathways through which negative global consequences are promulgated means that economic effects are an important part of the pandemic story. By extension, policies designed to

1 For example, many were afflicted by acute respiratory distress syndrome and many died as a result of the 'cytokine storm' or virus-initiated immune response. For details, see Garrett (2005).

alleviate negative economic effects are also an important complement to public health policies.

In this paper, we explore the possible macroeconomic effects of a pandemic. We begin in section 2 by discussing the notions of shocks and equilibrium in economics, the methodology through which we can distinguish short-run and long-run economic effects, and the possible long-run economic effects of a pandemic. Readers familiar with these topics might choose to skip this section of the paper. We look more closely at the short-run effects of a pandemic in section 3, where we consider the effects on the major economic actors — households, firms, government and the rest of the world — and on markets, including labour and financial markets. In section 4, Treasury's macro-econometric model, the TRYM model, is used to illustrate the potential magnitude of the economic effects for Australia. The paper concludes with a discussion of policies that might ameliorate the negative short-run economic effects of a pandemic.

2. A PANDEMIC AS A SHOCK TO THE ECONOMY

We begin by describing a simple framework that is useful for examining the workings of the economy and the economic impact of events such as pandemics. This framework includes the concepts of an equilibrium path, which is important for identifying the long-run effects of a pandemic, and shocks to that path, which helps us to think about short-run effects. The framework also distinguishes between levels and growth rates, aggregate and per capita GDP, and short-run and long-run effects. The TRYM model, which we use in section 4 to illustrate the impact of a pandemic, is built on just such a framework.

Economists often use the idea of shocks to motivate their thinking on the economy and, in particular, how events affect the economy in the long- and

short-run. For example, a familiar scenario is to consider the question: If productivity was to increase by one per cent, what are the likely short- and long-run economic consequences? How much will profits rise in the short-term and what will be the long-run effect on wages and so on? Underlying this thinking is the notion of equilibrium or an equilibrium growth path. Shocks move the economy away from this path. However, as behaviour changes in response to a shock, the economy moves back toward the equilibrium path. That is, most models of the economy have equilibrating mechanisms (the economy adapts to its new circumstances).

The notions of equilibrium and adaptation are familiar to social scientists and are present in disease processes such as influenza. This is the idea that after some shock to a system (or particular organism) there is a process of adaptation which results in the system regaining an equilibrium state.[2]

The equilibrium growth path of the economy is the path of output along which supply balances demand. In this context, supply represents the productive capacity of the economy — that is, the ability to supply goods and services — and demand is demand for those goods and services. The equilibrium growth path is largely driven by productivity and employment growth.[3] Productivity reflects the size of the physical capital stock (which depends on interest rates and the investment environment), technology, and the education level of the labour force. Employment growth reflects population growth (which is driven

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2 Most models of how stress can affect health encompass the idea of equilibrium, with people needing some optimal amount of stimulation for optimal health. Furthermore, in the case where people are exposed to bad stressors, they adapt to the circumstance and regain their equilibrium level of health. However, if people are repeatedly exposed to bad stressors their equilibrium level of health may be permanently lowered.

3 This corresponds to the three Ps — productivity, population and participation — identified in the Australian Government's 2002–03 Intergenerational Report as a method of decomposing economic growth. Employment captures both population and participation.

by birth rates, death rates and migration), the age composition of the population, the participation rates of the various age groups, and the efficiency of the labour market (the unemployment rate). As an illustration, the simulations using the TRYM model that are reported in table 4.1 in section 4 assume labour productivity grows by 2.2 per cent each year and the labour force grows by 1.4 per cent, so GDP grows by 3.6 per cent each year on the equilibrium growth path.[4]

It is useful to think of the equilibrium growth path as describing the path that output would follow in the absence of shocks. Many shocks have little effect on the equilibrium growth path: they push the economy off the equilibrium growth path but over time the economy returns to this same path. Other shocks — such as a major pandemic — change the equilibrium growth path itself. Such shocks usually have additional, often larger, short-run effects as the economy adjusts.

Shocks can come from either the demand or the supply side of the balance that produces the equilibrium growth path. Examples of demand shocks are a temporary loss in confidence by investors (a negative shock) and a temporary boom in demand for exports (a positive shock). These shocks have mainly short-run effects and do not change the equilibrium growth path.[5] Many supply shocks have permanent effects on the labour force or productivity and thus affect the equilibrium growth path. Some, however, such as a drought that reduces farm output, have purely short-run effects.

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4 In practice, both productivity and employment growth rates have varied substantially over history and are unlikely to be constant in future. The assumed values in the TRYM model reflect average growth rates in recent history.

5 In some cases, however, the effects can be quite long lasting. For example, it is often argued that deep recessions reduce the job-market skills of laid-off workers who cannot quickly find new jobs and of new entrants who are prevented from finding a first job.

In thinking about the equilibrium growth path and shocks, there are two important distinctions that should be made. The first is between the level of the equilibrium growth path and the growth rate of the economy along the path. For example, a temporary increase in migration would permanently raise the level of the equilibrium growth path but have little effect on its growth rate beyond the year in which the extra migration occurred. Population and output would grow at the same rate as before the shock, but from a higher base, so their levels would be permanently higher. On the other hand, a permanent increase in migration levels, or permanently faster productivity growth, would permanently increase the growth rate of the economy. A temporary shock such as a drought will not affect the equilibrium growth path, but it will push actual output below that path and cause growth to be slower than on the equilibrium growth path while the drought lasts. Once the drought ends, however, GDP growth will be faster than in equilibrium as the economy moves back (catches up) to the equilibrium growth path.

The second important distinction is between aggregate GDP and per capita GDP (GDP per person). Individual welfare is more closely linked to the latter. The equilibrium growth path of per capita output depends on productivity but not population, though it might be affected by the age composition of the population and participation rates. In the simulations in section 4, the growth rate of per capita GDP is the labour productivity growth rate: 2.2 per cent. Thus a permanent increase in migration would increase the growth rate of equilibrium GDP but not of equilibrium per capita GDP, while permanently higher productivity growth would increase both growth rates.

This loss of skills produces higher equilibrium unemployment that is reduced only gradually once the recession ends.

A pandemic will have short-run demand effects and both short-run and long-run supply effects. In the short-run, the supply-side effects are largely negative and affect both aggregate and per capita output. The biggest short-run supply effects relate to labour supply and temporary business closures due both to people getting sick and to people staying home to avoid infection or to care for friends or relatives who have become sick. On the demand side, there are both positive and negative effects. Investment and consumption are likely to be adversely affected by a fall in confidence, demand for exports will fall if other countries are hit by the pandemic, and some industries such as tourism and restaurants may virtually close down. On the other hand, there would be greater demand for health services and the provision of relief. These short-run effects are discussed more fully in the next section.

The short-run effects on output are largely deviations from the equilibrium growth path, though in some cases the deviations may last for some time. In the long-run, to the extent that the pandemic causes deaths, this will permanently reduce population. Population will also be permanently reduced if net migration falls during the pandemic and this is not 'caught up' after the pandemic has passed.[6]

The most important effects of population loss, of course, are not those on GDP, but rather the loss of life for those who die and the social disruption and sense of loss for loved ones. In GDP terms, aggregate output will be lower but output per capita may not be much affected in the long-run since lower output will be shared among proportionately fewer people. In the short-run, there could be negative effects from the loss of key personnel. On the other hand, the direct effect of loss of life would be to leave more capital per person and potentially

6 The net impact of the pandemic on migration is difficult to judge. It is likely that inward migration would fall, but outward migration is also likely to fall.

raise per capita output and wages.[7] This effect would fade away in the long-run as the capital stock adjusted, and even in the short-run might be swamped by the effects of loss of confidence on investment.[8]

There are ways in which a pandemic might have medium- to longer-run impacts on per capita output.[9] One way would be through changes in the age composition of the population. For example, the Spanish flu disproportionately affected young workers and a similar outcome in a future pandemic might lower the level of per capita GDP by reducing the number of workers as a proportion of the population. It is also possible that a pandemic could have long-lasting psychological effects that discouraged innovation and entrepreneurship, and encouraged current consumption at the expense of saving and investment, though these are difficult to quantify. What is clear, however, is that except in the most extreme circumstances — more extreme than those experienced in the Spanish flu epidemic — the short-run effects of a pandemic on GDP from illness, social distancing and loss of confidence would be much larger than the long-run effects from deaths, in both aggregate and per capita terms.

3. THE IMPACT OF A PANDEMIC ON ECONOMIC AGENTS

While the long-run effects of a pandemic are somewhat ambiguous in terms of per capita growth outcomes, the short-run effects are clearly negative. The extent and type of short-run economic effects will vary depending on the extent of the pandemic, but even a well-contained pandemic killing a relatively small number

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7 This was the case following the Black Death in Europe in the fourteenth century.

8 Brainerd and Siegler (2003) found that in US states hit hardest by the Spanish Influenza, per capita growth did in fact rise in the following years.

9 A death rate dramatically higher than is contemplated in recent discussion of a flu pandemic could cause a long-run breakdown of economic relationships. For example, the

of people may have a large short-run economic impact. The most recent example of the economic impact of a relatively small disease outbreak is the SARS episode. While relatively few people died or were infected and the outbreak was of relatively short duration, the short-run economic effects were large in a number of countries — for example, Lee and McKibbin (2003) estimate that the loss to Hong Kong was around 5.5 per cent of GDP in 2003. Others found that GDP growth in East Asia as a whole was reduced by ½ to 1 per cent of GDP in 2003 as a result of SARS (Economic Roundup, 2003).

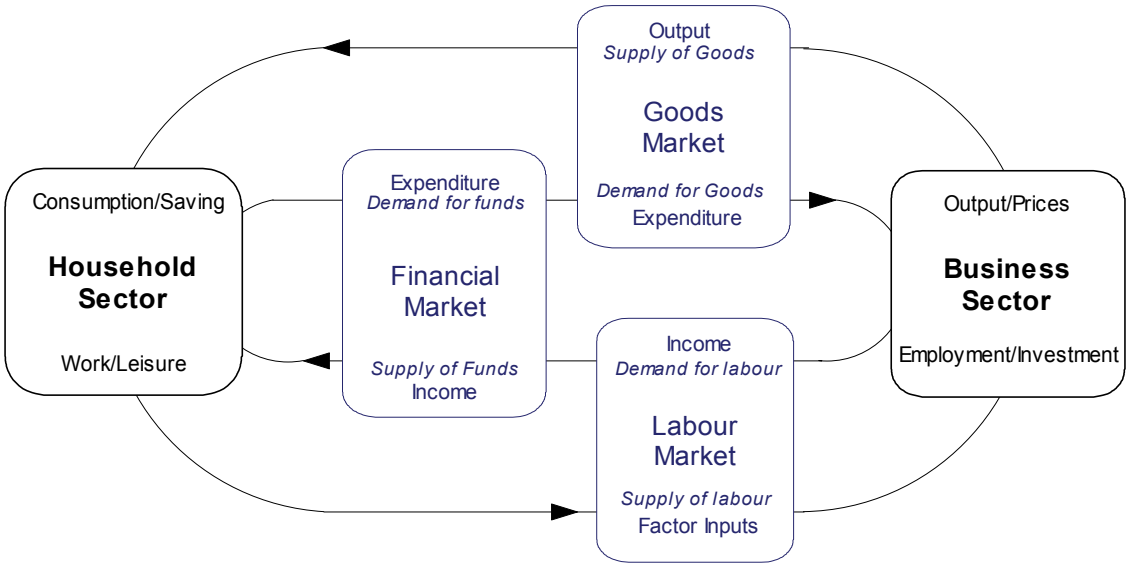
The SARS episode also illustrates how the effects of disease outbreaks in a small number of countries can have global consequences. The Australian economy was also affected by SARS with the number of inbound tourists from Asia falling sharply in the months surrounding the SARS crisis.

In examining the short-run it is useful to consider a stylised representation of the economy. In this representation there are households, firms and government. They interact with each other through goods markets, the labour market and financial markets (see Figure 1). They also interact with rest of the world. Households supply labour, consume domestic and imported goods and services, save, and invest in dwellings. Firms hire labour, make investment decisions and produce goods, partly for domestic consumption and investment, and partly for export. Governments impose taxes to finance the provision of services and to redistribute income. They also set the regulatory framework of the economy. The rest of the world buys our exports, supplies the goods we import — consumption goods, investment goods and intermediate goods used in production — and finances our current-account deficit (CAD).

Black Death, which killed around one-third of the European population, had significant impacts on the social and economic structures of the time.

In the remainder of this section, we examine the economic effects of a pandemic on the various actors and markets in the stylised representation of the economy. In doing so, we shall focus on a scenario where there are a large number of deaths, although, where relevant we shall discuss the scenario where there are relatively few deaths.

Figure 1: Simple flow diagram of a closed economy



3.1 Households

An immediate impact of a pandemic would be the reduction in labour supplied by households. This may have two sources: first, a permanent reduction in labour supply caused by death; and second, a temporary reduction caused by illness and, potentially, both voluntary 'social isolation' and mandatory measures used to contain the spread of the influenza virus.

Another effect of a pandemic related to households is a likely reduction in consumption. Again, there would be a permanent reduction in consumption commensurate with the number of people who die as well as a more severe, but temporary, fall. The temporary fall would be particularly acute for parts of the economy such as recreation, tourism and travel-related services.

Consumption might also fall if the pandemic creates uncertainty for households and they increase their precautionary saving. However, this may not mean that people place more of their saving in banks if they think that there are financial stability risks.

Housing investment — that is, construction of new dwellings — is also likely to be dramatically negatively affected. House prices and prices of other assets held by households are also likely to fall given the reduction in demand.

3.2 Firms

The reduction in labour supplied by households would immediately affect firms by reducing their ability to produce goods and services. In addition, quarantine measures might cause workplaces to be temporarily closed. The likely reduction in consumption would also affect firms because of the reduced demand for their products.

Firms would also need to adjust to an environment where they held too much capital (or at least the wrong type of capital) compared with the number of workers. This, in combination with the reduction in demand for their products, is likely to lead to firms dramatically reducing investment. Further, similarly to the likely fall in value of housing related assets, firms are likely to see the value of their capital fall dramatically.

3.3 Wages, prices, labour market

The likely dramatic reduction in demand would see prices for many products fall although some prices may rise in the very short-term if there is panic buying and stockpiling. Conversely if the supply of goods and services is restricted as firms shut down and the flow of imports is curtailed, then there may be

upwards pressure on prices. The net effect on prices would depend on which of the effects on demand or supply dominates.

The effect on wages will depend on whether the economy-wide effects that prompt a reduction in demand for labour dominate the reduction in labour supply. If a large number of people die, then over the longer term wages are likely to be bid up due to the shortage of labour. However, in the shorter term, wages may fall if demand is reduced dramatically and businesses are very badly affected.

Exchange rates might also be affected though this would probably depend on the extent to which the pandemic was differentially impacting countries and the predominance of their trading relationships with other countries.

3.4 Financial sector

Many businesses would suffer substantial economic losses in the event of a pandemic. The resulting effects on the financial sector have the potential to cause extensive disruption. In the case of a severe pandemic, not only are a number of asset classes likely to be re-valued, which would clearly affect bank balance sheets, but also many businesses may encounter difficulties meeting short-term financing commitments. These domestic effects could be exacerbated by a rapid deterioration in global financial conditions with potentially disruptive movements in exchange rates and financial flows.

3.5 Government

A pandemic would affect the provision of public services and government more generally. For example, health services would clearly be put under substantial pressure and there is likely to be a necessity to increase funding for a range of

health goods. There would also be falls in tax revenues and, in combination with additional spending measures, the likely emergence of budget deficits.

Other operations of government that may be affected include regulation around the financial sector and monetary policy.

3.6 Global effects

The global effects of a pandemic would work similarly to those described for the domestic economy. There is a strong likelihood that trade flows — both imports and exports — would be substantially affected by both the disruption caused by sickness and death and possible policy responses which, in attempting to contain the spread of influenza, restricted the movement of goods and services.

For these reasons and because of a global fall in demand for goods, demand for our exports is likely to fall. This will be the case even if the pandemic itself does not reach Australia. Thus Australia could not entirely escape the effects of a pandemic even if it was successful in preventing the disease from entering the country.

Falling demand in Australia, due to the effects of the pandemic on consumption and investment, will also lead to lower imports. This fall would offset, to a greater or lesser extent, the impact of lower exports on the current account balance. Imports would also be affected by disruptions to trade flows. The fall in imports from this source would cause problems where domestic goods could not easily be substituted for foreign ones.

An important aspect of this arises from the increasing global integration of countries and linking of production chains, which may mean that companies are more affected than previously. However, the flexibility that is inherent in these production chains may also mean that companies can move production quickly

to other countries less affected by a pandemic, unless quarantine measures disrupt the flow of goods between countries.

Apart from trade in goods and services, flows of capital and possible financial disruption are also possible outcomes of a pandemic.

4. TRYM MODELLING OF A PANDEMIC SHOCK

In this section we present a simulation of a pandemic scenario using the Treasury Macroeconomic (TRYM) model. While the TRYM model is not explicitly designed to model the economic effects of a pandemic, it does provide an internally consistent theoretical framework within which to consider the likely impacts, which can then be used as a starting point in considering possible policy responses. Because the model does not include representations of many of the transmission mechanisms that are likely to play an important role in a pandemic, some aspects of the shock have been imposed using arbitrary adjustments to existing model equations.[10]

In order to make clear the mechanisms by which a pandemic would affect the economy, and to highlight the effects of different aspects of the shock, we present the pandemic scenario by introducing effects one-by-one and presenting the cumulative effects on the economy. We start with the effects on demand for our exports of our trading partners being affected by the pandemic. Then, in turn, we add the effects of domestic deaths, the effects of labour force absenteeism, confidence effects on consumption, confidence effects on investment, and finally the impact of business closures on the demand for labour.

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10 For example, the household consumption equation in the model does not include an explicit theoretically consistent representation of risk. In the short-run dynamics of the equation there is an unemployment-rate term which is there to capture a response in consumption to any increased risk to labour income flows. However, in the case of a pandemic, the impact of risk is likely to be considerably more immediate.

Another consideration in using the TRYM model is that it abstracts from inter-regional and inter-industry effects. These may be important if the outbreak is confined to a particular region and that region has an industrial sector concentration.

This is by no means an exhaustive list of all of the elements of the economic impact of a pandemic outbreak on the Australian economy. However, we think that it does capture the major components of such a shock, which then, through the linkages in the TRYM model, propagate through the entire economy.

The scenario we model is of a nationwide outbreak of a highly contagious influenza virus with a mortality rate of 0.2 per cent of the population, or 40,000 deaths nationwide. This is lower that in the 1957 and 1968 pandemics, when the mortality rate was 0.65 per cent of the population, and is small relative to the 1918 outbreak, for which mortality rates are estimated in the range of 2 to 5 per cent. The number of deaths that would result from a pandemic depends on how contagious the virus is, its virulence, and the success of measures to limit its spread, and the mortality rate we have chosen is meant only to be illustrative.

Our analysis is done at the aggregate level for Australia, effectively assuming that the virus spreads extremely rapidly and has a uniform impact across the entire country. This assumption is made in large part to suit the highly aggregate nature of the TRYM model. We also assume that the shock is one-off although it is generally accepted that there are likely to be a total of three or four waves of infections spread out over a period of up to 18 months.

The cumulative effects of the shocks are presented in Table 4.1 in through-the-year growth terms. We only examine the effects in the first year. In the right-most column of the table we include the steady-state growth rates of each of the economic series we consider. These growth rates represent the assumed rates at which each of the series would grow if the economy were

unaffected by shocks or disturbances.[11] This is referred to as the equilibrium growth path or the steady-state balanced growth path.[12]

4.1 Step 1 — World demand shock

A pandemic is unlikely to start independently or spontaneously within Australia and is likely to manifest itself first in neighbouring countries. There is likely to be a dramatic and immediate economic response to this, particular in the tourism exports sector.

Foreign tourism to Australia is estimated to generate close to $18 billion a year in exports, which is over 2 per cent of GDP and 12 per cent of total exports of goods and services. Moreover, foreign tourism directly accounts for around 2½ per cent of total Australian employment.

An outbreak in trading partner countries is also likely to result in an interruption in the supply of, and demand for, imports. In particular, we would expect a large decline in tourism-related overseas travel by Australians.

In our simulations, we limit our attention to the shock to export demand. To capture the overall impact on exports, we assume a 20 per cent fall in major trading partner demand that then slowly recovers to a long-run level that is

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11 Note that the table shows actual growth rates in the first year after the shock. Thus the impact on growth of Step 1 (the world demand shock) is the difference between the growth rate in the first column in the table and the steady-state growth rate in the last column of the table. For other steps, the marginal effect of the step is the difference between the growth rate including the step and the growth rate for the step before (in the column immediately to the left). The cumulative effect of all steps up to the one in question is the difference between the growth rate for that step and the steady-state growth rate.

12 The steady-state values in Table 4.1 of rates such as the current account as a percentage of GDP and the unemployment rate should not be thought of as equilibrium or optimal levels. The values largely refect the most recent observations in history. For example, the steady-state unemployment rate equals the model-estimated NAIRU, which has a strong tendency to follow the most recent level of the unemployment rate.

reduced proportional to the number of deaths. The 20 per cent decline in demand is intended to encompass both the reduction in economic activity in trading partners and interruptions in economic linkages between Australia and its trading partners, including the closure of transport linkages.

The movement in the exchange rate is difficult to judge and will depend on the impact of the pandemic on Australia relative to its trading partners. The experience of SARS epidemic suggests that impacts might vary considerable across countries. As a first approximation we have assumed no change in the exchange rate

The results of the 20 per cent fall in trading partner GDP in the TRYM model are summarised in the column of table 4.1 labelled step 1. There is an 8.9 per cent reduction in export growth over the first year (export volumes decline by 5.3 per cent with the shock, compared with 3.6 per cent growth on the equilibrium path). Non-commodity exports account for the majority of this change.[13]

The resulting slower business-output growth affects employment and household income, which in turn reduces household consumption growth. There is a one-half percentage point increase in the unemployment rate, and GDP growth through the first year slows from 3.6 per cent in the steady state, to 2 per cent with the shock.

13 In the TRYM model equations, commodity export volumes react relatively slowly to changes in Australian-dollar prices, reflecting the historical tendency of volumes to be set by contracts and price changes to be due to exchange-rate movements (rather than the US-dollar prices specified in the contracts). The relatively small impact on commodity exports volumes in the simulation results from this. In the case of a pandemic, the effects on volumes might be larger than indicated, particularly if there are disruptions to output and transport in the short-run.

4.2 Step 2 — Deaths

We next add in the effects of 40,000 deaths in the first quarter of the first year. The deaths are assumed to be evenly distributed across all age groups so we see a proportional 0.2 per cent decline in the working age population.

While the TRYM model undoubtedly misses some of the indirect effects of deaths, such as on family members, the overall direct impacts on GDP to emerge from the modelling are small. The impact of deaths is more evident in the long-run as the level of GDP falls, though per capita GDP and the growth rate of GDP are unchanged by assumption (labour productivity levels are assumed to remain unchanged in the long-run).

These results illustrate the point that domestic deaths have little *direct* short-run economic impact and represent only a small part of the total economic effects of a pandemic.[14]

4.3 Step 3 — Labour force

Next we add in the effects of work absenteeism, as workers seek to avoid infection by staying away from their workplaces. This is particularly likely to happen in the service sectors where contact with the public is required. These industries (excluding health and community services) comprise around 34 per cent of total employment and 25 per cent of total employee incomes.

Here we assume that around 20 per cent of the labour force is absent from work over the first quarter. Participation is then assumed to recover over the subsequent quarters. By the end of the first year a significant number of previously employed people remain out of the labour force, reflecting possibly

ongoing responsibilities for caring for family members and caution about possible second and third waves of infection.

The result of the fall in the labour force is that employment also declines but by less than the labour force so the unemployment rate falls. Lower employment means lower income, and therefore lower household consumption and lower GDP. Interestingly we see that firms lift investment as wages climb and they substitute capital for labour. This effect will be unwound in Step 5.

We also see strong wages growth as a result of the fall in the supply of labour. This wages growth flows through to higher general inflation to which the standard TRYM model monetary policy reaction function responds by increasing interest rates substantially.[15] This reaction is also completely unwound when allowance is made for confidence effects in the steps that follow.

4.4 Step 4 — Confidence effects on consumption

The domestic outbreak of a pandemic is likely to have very significant confidence effects. In this step we allow for confidence effects on consumption; in the next step we look at investment.

Even with only a small number of deaths, the confidence effects on consumption are likely to be large and immediate and are likely to overshadow all other factors in the short-run. However, the confidence effects are also the most difficult to quantify. The sectors that are most likely to be affected are the service-related sectors like hotels, restaurants, and cultural and sporting events.

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14 We have also modelled a scenario in which the mortality rate is similar to the 1957 and 1968 pandemics: 0.65 per cent of the population, or 130,000 deaths. The higher number of deaths has little effect on the results reported in Table 4.1.

15 The version of the model used in this paper incorporates a standard Taylor Rule for the monetary policy reaction function. The Taylor Rule acts to change interest rates if the inflation rate deviates from a target rate, and/or if output deviates from potential output.

The recreation and culture and hotels, cafes and restaurants sectors together account for around 20 per cent of total household consumption.

Another effect on consumption, but one that we do not model, is the effect of a fall in household wealth — both dwelling wealth and financial wealth. It is very likely that we would see large falls in both house and equity prices under a scenario such as this.

In this step we reduce household consumption by 10 per cent in the first quarter of the scenario before allowing it to recover of its own accord over the subsequent quarters.[16]

The result of this shock is that household consumption declines by 6.3 per cent through the year (compared with positive growth of 0.6 per cent without the confidence shock). The large fall in consumption results in a recession and an increase in the unemployment rate which exacerbates the fall in consumption. When allowance is made for confidence effects, the model's monetary policy reaction function dictates a decrease in interest rates, in contrast to the rise in the previous step.

4.5 Step 5 — Business and dwelling investment

Traditionally business investment and dwelling investment are the two most volatile components of GDP. Indeed, during the 1990–91 recession, while consumption and GDP declined by only around 1 per cent below their pre-recession peaks, dwelling investment declined by 21 per cent and business investment by 31 per cent from their pre-recession peaks.[17] Another

16 That is, consumption is first reduced to account for a confidence shock, and then increases according to the dynamics of the consumption equation.

17 While it could be argued that the 1990–91 recession came on the back of an investment boom, the 1982 recession gives similar results. Consumption declined by 0.6 per cent and

distinguishing feature of both forms of investment is the relative length of slowdowns. In the 1990–91 recession consumption remained below its previous-peak for four quarters and GDP for seven quarters. In contrast, business investment and dwelling investment remained below their pre-recession peaks for 23 quarters and 16 quarters.

In this step we apply a negative adjustment to both dwelling investment and business investment. In Step 4, while business investment is already falling (due to weak domestic demand), dwelling investment, which is largely dependent on short-term interest rates, is still growing. The adjustments we apply in this step generate a 7.4 per cent decline in business investment and a decline of 12.6 per cent in dwelling investment. Consistent with the relative persistence of investment slowdowns in history, both of the investment adjustments are considerably longer than the one year we examine here.[18]

Despite the investment downturn being moderate by historical standards, its implications for GDP in the scenario are considerable with GDP now falling by over 5 per cent. This constitutes a recession that is about half the size of the Great Depression[19], and is therefore very severe by historical standards.

4.6 Step 6 — Business labour demand

In the final step of the scenario we apply a large negative demand shock to labour consistent with a substantial reduction in business hiring and a large number of temporary business shutdowns. The effect is a decline in household

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GDP by 3.7 per cent, while business investment declined by around 18 per cent and dwelling investment by 28 per cent from their respective peaks.

18 Both the business investment and dwelling investment shocks are assumed to have half lives of five quarters.

19 During the Great Depression in Australia real GDP declined by around 9 per cent in 1930–31, while between 1891 and 1893 real GDP is estimated have fallen by around 17 per cent.

income and a large increase in the unemployment rate. However, we also see a further decline in prices as the higher unemployment rate results in wage falls which feed general price deflation. This means that real wealth actually increases in this step, and this offsets the potentially negative effects on household consumption of falling labour income and unemployment.

4.7 Summing up

While quantifying the effects of confidence on household consumption and investment is difficult, it appears from the simulation that the confidence effects arising from a pandemic could be very detrimental to economic activity. With households reducing consumption, particularly of service-related goods, and with businesses curtailing both investment and employment, GDP could contract by over 5 per cent over the first year following an outbreak of a highly contagious pandemic.

Consequently, quickly re-establishing consumer and investor confidence is likely to be one of the important roles for governments to play. Governments might also consider policies that help viable businesses through the worst of the pandemic — in particular those businesses, such as restaurants, that are likely to be most severely affected by a pandemic. Lastly, there may be an important role for governments in stimulating growth in the economy. This would not only be in terms of monetary policy, but discretionary fiscal policy would also be important in stimulating demand and promoting improved confidence. In this simulation, even before discretionary fiscal policy, the government budget balance moves to significant deficit as a result of automatic stabilisers.

Table 4.1: Cumulative effects of a pandemic using the TRYM model (through-the-year growth unless otherwise specified)

	Step 1: Trading partner growth	Step 2: Deaths	Step 3: Labour supply	Step 4: Confidence effects on consumption	Step 5: Business & dwelling investment	Step 6: Labour demand	Steady state growth rates
Product market							
Consumption	3.3	3.2	0.7	-6.3	-6.8	-8.6	3.6
Dwelling investment	3.9	3.9	2.6	3.4	-12.6	-12.7	3.6
Enterprise investment	1.2	1.3	5.2	3.9	-7.4	-5.5	3.6
Net export(b)	-1.0	-1.0	-1.4	0.4	1.8	1.9	-0.2
GDP	**2.0**	**2.0**	**0.5**	**-2.5**	**-5.0**	**-5.7**	**3.6**
Commodity exports	0.2	0.2	-3.5	-3.4	-3.4	-4.3	3.6
Non-commodity exports	-16.2	-16.2	-16.5	-16.0	-15.8	-15.6	3.6
Total exports	**-5.3**	**-5.3**	**-7.8**	**-7.6**	**-7.5**	**-8.1**	**3.6**
Total imports	**-0.7**	**-0.7**	**-1.1**	**-8.1**	**-13.4**	**-14.5**	**3.6**
Price of commodity exports	-13.8	-13.8	-13.8	-13.8	-13.8	-13.8	2.5
Price of non-commodity exports	2.0	2.0	3.8	2.1	1.4	0.2	2.5
Price of imports	2.5	2.5	3.2	3.0	3.0	2.6	2.5
Terms of trade	-11.3	-11.3	-11.4	-11.7	-11.9	-11.9	0.0
Trade balance(c)	-3.2	-3.2	-3.6	-2.2	-1.1	-1.0	-1.3
Net income balance(c)	1.4	1.4	-1.8	0.1	0.5	-1.2	-5.3
Current account balance(c)	**-1.9**	**-1.9**	**-5.4**	**-2.2**	**-0.7**	**-2.3**	**-6.8**
Labour market							
Employment	-0.1	-0.2	-9.4	-10.4	-11.0	-16.3	1.4
Labour force	0.6	0.4	-12.2	-13.0	-13.5	-15.5	1.4
Unemployment rate(a)	**5.6**	**5.5**	**1.9**	**2.1**	**2.2**	**5.9**	**5.0**
Nominal wages	4.1	4.1	14.7	12.7	12.1	6.7	4.8
Real producer hourly wage	**5.8**	**5.8**	**11.8**	**12.8**	**13.6**	**11.1**	**2.2**
Prices							
Household consumption deflator	1.9	1.9	3.9	1.6	0.9	-0.6	2.5
GDP Deflator	**-0.5**	**-0.5**	**2.5**	**0.0**	**-0.8**	**-2.8**	**2.5**
Financial markets							
Private wealth (nominal)	3.9	3.9	1.9	0.8	-9.1	-10.1	6.2
Government budget balance(c)	-0.3	-0.3	-1.0	-1.8	-2.1	-3.5	0.0

(a) Level at end of year.
(b) Contribution to GDP growth.
(c) Per cent of nominal GDP.

4.8 Medium-term dynamic effects

Clearly a pandemic of the magnitude we have modelled will have effects beyond the one year we have presented above. The full TRYM model simulation shows that while consumption and GDP growth have both recovered by the end

of the second year, the unemployment rate does not start falling until the third year of the shock. This is largely because labour supply by households recovers very quickly while labour demand by business recovers relatively slowly. The higher unemployment rate means that nominal wages continue to fall over that period resulting in a sustained period of general price deflation. This means that the model's Taylor Rule for setting short-term interest rates holds the nominal interest rate low for an extended period, resulting in a strong bounce back in dwelling investment in particular.

In our simulation of a pandemic, government spending and tax rates are held constant over the first year. A more realistic scenario would allow for increased spending on pandemic-related measures and possibly fiscal policy used aggressively to stimulate the economy, particularly in the short-term. This would moderate the decline in GDP shown in the table, but the impact would be modest unless the policy change — tax cuts or increased spending — could significantly counter the effects of the pandemic on consumer and business confidence.[20]

5. POLICY IMPLICATIONS

Given the uncertainty around the size and evolution of a pandemic, let alone how a pandemic would affect the economy, it is reasonable to question the usefulness of pandemic modelling exercises. Indeed it would be foolhardy to focus on the numbers produced by economic modelling rather than on the thinking around how pandemics might affect the economy. In this paper we found that, by examining the pathways through which a pandemic might affect

20 In simulations, the total impact on GDP over the first year of an increase in spending or a cut in taxes is somewhat less than the size of the spending increase or tax cut. Both cause an increase in demand, but part of this increase leaks into imports.

the economy, we gained insights into the larger economic effects of a pandemic, and into where policy might be most effective.

We can consider economic policies according to the framework we used in section 3 — that is, policies that affect household behaviour, businesses and government.[21] In this paper, we found that confidence effects primarily affecting households' behaviour may be one of the more important avenues through which the economy is affected by a pandemic. Furthermore, confidence effects in combination with the short-term withdrawal of labour are likely to produce most of the short-term negative impact on the economy. The number of deaths from a severe pandemic need not be high — that depends on the virulence of the strain and the effectiveness of treatment. However, our modelling suggests that even if a relatively large number of people die, the direct economic effects through a permanent reduction in labour supply are relatively small in comparison with the other economic effects, despite the enormous personal distress caused. This does not mean of course that policy makers should encourage activities that reduce the effects of the withdrawal of labour but might lead to further deaths. However, it does suggest a role for government in promoting an environment in which people can quickly resume economic activity once a pandemic begins to dissipate.

Businesses would also be greatly affected by a pandemic, particularly those involved in tourism and delivering services more generally. Policies that might be effective in negating the economic effects of a pandemic relate to short-term

21 In this paper the policies that go to the emergency management aspects of a pandemic, such as the maintenance of essential services, were not considered as our focus is on broader economic issues. For a discussion of the emergency management issues see the Draft Australian Management Plan for Pandemic Influenza, 2005.

support to businesses most affected by the pandemic, perhaps through creative finance arrangements. This would enable viable businesses to adjust more rapidly once a pandemic passes.

Lastly, in the case of a large pandemic, monetary and fiscal policy responses that stimulate the economy will clearly be required. In addition to the fiscal measures that accompany the direct management of a pandemic, there is likely to be a need for expansionary fiscal policy to help stimulate demand and, most importantly, to restore consumer and business confidence. Of course, expansionary fiscal and monetary policies will only be effective if they are accompanied by a range of other policy measures that maintain financial stability and promote business continuity.

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