An Analysis of the Macroeconomic Effects of Higher Productivity Using the TRYM Model

Andrew Johnson
Craig Louis

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This document is based on the research and development work undertaken in recent years in the Modelling Section of the Treasury. It has been released in the interests of evaluating the research results embodied in the model and to encourage public discussion.

The authors are employees of the Australian Treasury. The views expressed in this paper are those of the authors and are not necessarily those of the Government or the Treasury.
This paper is a modified version of an earlier paper by Bruce Taplin and Craig Louis presented at the *June 1993 Treasury Conference* on *The TRYM Model of the Australian Economy*.

A series of papers describing the Treasury Macroeconomic (TRYM) model were presented at the June 1993 Treasury Conference on *The TRYM Model of the Australian Economy*. The papers presented at this Conference included:

- *An Introduction to the Treasury Macroeconomic (TRYM) Model of the Australian Economy*

  (TRYM paper no. 1)

- *Documentation of the Treasury Macroeconomic (TRYM) Model of the Australian Economy*

  (TRYM Paper No. 2)

- *Employment, Investment and Productivity: Decisions by the Firm*

  (TRYM paper No. 3)

- *Exports, Imports and the Trade Balance*

  (TRYM paper No. 4)

- *Savings, Dwelling Investment and the Labour Market: Decisions by Households*

  (TRYM paper No. 5)

- *Australia's Trade Linkages with the World*

  (TRYM paper No. 6)

- *The Macroeconomic Effects of Higher Productivity*

  (TRYM paper No. 7)

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1. INTRODUCTION

This paper has been prepared for the Fifth Australian Economic Modelling Conference, EMBA/EPAC Model Comparison Conference. The focus of this conference is not only upon the macroeconomic impact of greater productivity, but on a comparison of outcomes from a variety of economic models. To facilitate this comparison, this paper differs from our earlier work[1] with respect to the magnitude and timing of the assumed increase in efficiency and fiscal policy assumptions, naturally the discussion of economic mechanisms within the TRYM model of the Australian economy are similar.

The first part of this paper examines the long run benefits of increases in efficiency and productivity in the macroeconomy using the TRYM model of the Australian economy.

The second part of the paper examines any short term costs of the increases in efficiency. If these prove to be prolonged or relatively large, then the case for increasing efficiency is weaker than the long run results suggest. A dynamic simulation of the TRYM model provides a useful perspective on this issue.

A broadly based increase in the level of labour's efficiency is modelled under certain assumptions which, though plausible, tend to emphasise the short run adjustments. Even so, the TRYM model simulation described here shows that any short run costs in the labour market are comparatively short lived and are small relative to the long run gains and cyclical variations.

Most models of the macroeconomy have been used to investigate these general issues.

The ORANI model has been used to investigate this type of issue for a long period of time. Recent studies include the 1988-89 and 1989-90 Industry Commission Annual Reports, which examines the consequences of a number of different types of microeconomic reforms. These detailed various microeconomic reforms and their relative importance. The ORANI model has considerable industry detail, is based on neo-classical optimising principles and its results under various closures are essentially static.

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[1] This paper is a modified version of TRYM Paper No. 7, *The Macroeconomic Effects of Higher Productivity* by Bruce Taplin and Craig Loius, presented at the *June 1993 Treasury Conference on The TRYM Model of the Australian Economy*.

More recently, the ORANI model has been used to examine the short run consequences of increased efficiency under various assumptions in Adams and Parmenter (1992). These simulations were static, general equilibrium and represented the short run in the sense that capital was fixed.

The IMP model has been used by the National Institute of Economic and Industry Research to examine the effects of higher productivity under a number of assumptions. These are reported in EPAC (1991). The IMP model also has considerable industry detail, is dynamic and has a much more Keynesian flavour in its construction than some other models.

This topic has also been examined using the AEM model. A description of a simulation of higher efficiency is contained in Chapter 5 of the documentation supplied with the AEM model. A description of some earlier work and an attachment exploring some of the effects of factor efficiency are contained in EPAC (1990). The AEM model is quarterly, econometric and embodies rational (model consistent) expectations in financial markets.

This paper examines the ways in which higher underlying productivity affects the macroeconomy using the current version of the TRYM model as documented in TRYM Paper 2 (1993). The simulation results give us an opportunity to discuss both long and short run responses to higher efficiency while illustrating some model properties of the TRYM model.

The implementation in the long run of the increase in underlying efficiency is relatively straightforward. However, the implementation of the increase in efficiency during the transition phase is not clear cut and requires more careful judgment. The way that efficiency improvements feed through the macroeconomy in the short run affects the adjustment path of the economy.

If agents fully anticipate the long run increase in GDP and incomes then activity could rise quickly. For example, if households perceive that lifetime incomes will rise then consumption can rise immediately, and if firms anticipate the long run increase in the profit maximising capital stock then they can start investing immediately. In this case an increase in efficiency is more likely to lead to higher output for the same number of employed.

In contrast, if agents do not anticipate the long run rise in activity then demand might not necessarily rise by very much in the short term. For example, households may need to see a rise in their actual incomes before they raise their consumption, or firms may need to see a rise in aggregate demand before investing. In this scenario higher efficiency has the potential to produce a situation where output remains broadly unchanged, but fewer persons are employed due to the increase in efficiency.

It is this second scenario of slow adjustment to the long run gains that the second part of this paper explores, once the long run results have been established.

Section 2 outlines the nature of the efficiency simulation and provides some background to the TRYM model. Section 3 discusses the long run results of an increase in efficiency. Section 4 discusses the possible range of assumptions concerning the adjustment to the long run equilibrium and details the assumptions actually chosen. Section 5 examines the implied adjustment path in the short run and medium term. Section 6 summarises some key findings.

2. BACKGROUND TO THE EFFICIENCY SIMULATION

The TRYM model is a quarterly, macroeconometric model that has been developed in Treasury. It has been built as a vehicle for conducting policy simulations, analysing the past behaviour of the economy and aiding the forecasting process. The version used in this paper is that documented in TRYM Paper 2 (1993)[2].

Productivity is determined in any year by the level of underlying efficiency and the state of the business cycle. A sustained increase in productivity needs to be generated through an increase in the efficiency of some or all of the factors of production. Therefore the simulations examined in this paper are all initiated by an increase in efficiency that results in an increase in productivity.

The TRYM model uses a CES production function with Harrod neutral technical efficiency for labour in both private and public enterprises. This implies that any increase in efficiency will improve labour productivity and leave capital productivity unchanged. Further discussion of the approach taken in modelling the production sector of the TRYM model is contained in TRYM Paper 3 (1993).

The use of Harrod neutral technical progress in the TRYM model ensures that the economy can evolve along a balanced growth path.

It is also consistent with the conceptual measurement of investment used in the National Accounts. Investment deflators for important components such as motor vehicles, computers and dwellings are adjusted for quality improvements. In this way improvements in capital goods are reflected in lower prices, and in greater quantities per unit value. Improvements in the quality of ADP equipment, for example, will thus be reflected in higher constant price levels of investment and a higher capital stock even though nominal expenditure is unchanged. Conceptually there should be no change in the efficiency of the measured capital stock from this source. A discussion of these issues is contained in Australian National Accounts: Concepts, Sources and Methods (ABS Cat No 5216.0).

Because Harrod neutral efficiency is used, the increase in efficiency applies to labour only. The effects of an increase in the efficiency of capital are also interesting, particularly since increases in productivity from this source are more likely to improve the

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[2] Two minor modifications have been made to the version of TRYM used in this paper. These changes have no impact upon long run outcomes, and only a very minor impact on the dynamic path.

external accounts. However, the effects of higher capital efficiency are beyond the scope of this paper.

The simulation experiment reported consists of an increase in the underlying level of Harrod neutral efficiency of labour over a period of five years building to an eventual improvement of 5 per cent (see Chart 1 in Section 4 below). Over this period the growth rate of underlying labour productivity is higher; subsequent growth rates of efficiency are unchanged. This rise in labour's efficiency is broadly based affecting the private business, government business enterprise and general government (by assumption) sectors.

The source of the increase in efficiency simulated is not explicitly identified; this paper examines the macroeconomic consequences of an increase in efficiency, not its microeconomic origins. This increase could be generated in a variety of ways; for example, it could represent the results of a broad program of work place or industrial relations reforms that increase the general level of efficiency. However, it does not represent developments in variables that are explicitly modelled, such as a reduction in tariffs (which have been left unchanged).

There are other features of this model simulation that affect the nature of the long run results.

- Fiscal policy operates so that public real expenditure broadly remains a constant proportion of GDP.

  – The increase in efficiency flows into increased labour services and therefore higher general government output (part of general government consumption), while general government and government business enterprise investment are assumed to grow in line with GDP and private business investment respectively.

  – Transfers and indirect tax rates are unaffected by the efficiency gain. The rates of tax on household and business incomes adjust to target an unchanged ratio of public debt to GDP.

- Monetary policy operates with the target value of nominal transactions (or, equivalently, the money supply) unaffected by higher efficiency.

  - Therefore an increased level of real GNE, with nominal transactions unchanged, implies a lower price of GNE.

- Wages are determined, in the long run, by market forces and are set at a level that ensures that the unemployment rate is equal to its NAIRU.

- Perfect capital mobility in the long run ensures that Australia's real interest rates will eventually return to world rates.

These settings are a plausible set of assumptions that may affect the details of the simulation. However, the results presented here are indicative of the broad pattern of the effects of higher efficiency under a variety of similar assumptions.

Other assumptions are needed to simulate the adjustment to the long run effects of the increase in efficiency. These are detailed in Section 3 after the long run results have been analysed.

3. THE LONG RUN EFFECTS OF HIGHER EFFICIENCY

Table 1. Long Run Effects from 5% Higher Labour Efficiency.

Deviations from Baseline (per cent)

Consumption.	5.4
Business Investment	5.2
Dwelling Investment	6.0
Public Final Demand	5.4
GNE	5.4
Exports	5.9
Imports	4.3
GDP	5.7
Employment	0.8
Labour Supply	0.8
Unemployment	0.0
Productivity (L)	5.0
Nominal Wages	-0.8
Consumption Deflator	-5.6
GDP Deflator	-5.6
Terms of Trade	-1.1
90 day Bill rate	0.0
10 year Bond rate	0.0
Exchange Rate	3.5
Private Wealth	-0.1
CAD/GDP (per cent)	0.0

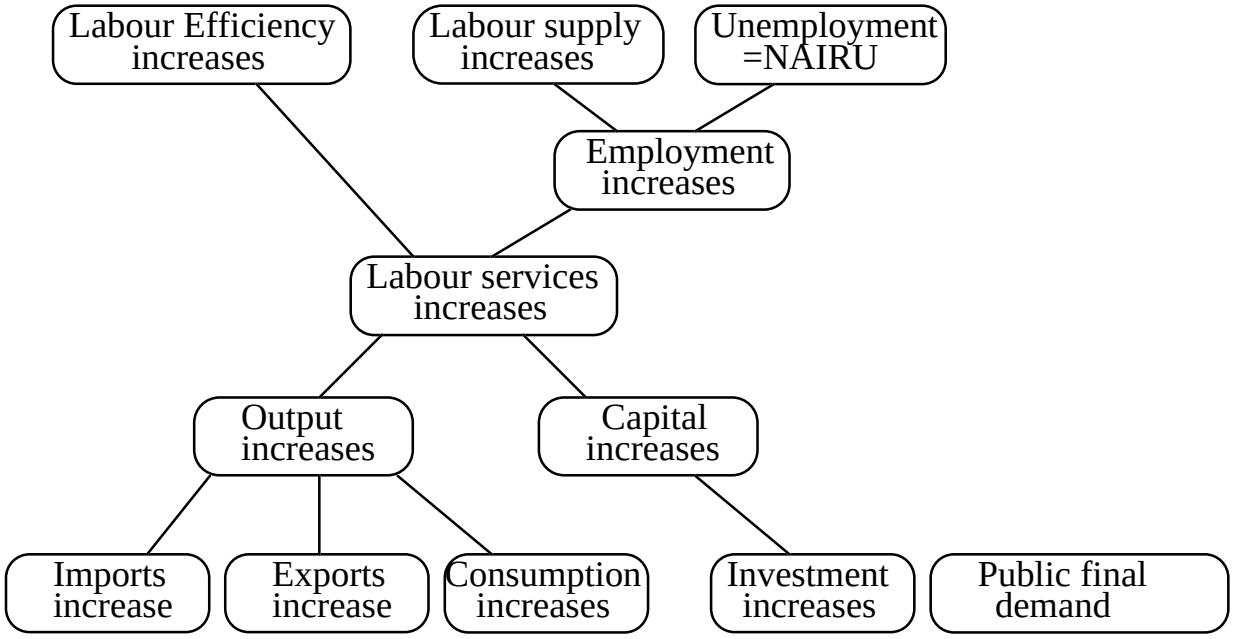
NB Productivity (L) refers to labour productivity.

Interest rate and unemployment rates are expressed in percentage point deviations.

The specified period of temporary increases in the growth rate of efficiency and permanent increase in its level does not affect the economy's long run growth rate. This is determined by factors such as population growth and the growth rate of efficiency. None of these growth rates are assumed to change permanently. However, a higher level of efficiency does affect the size and shape of the macroeconomy.

The following diagram depicts the major long run effects of the efficiency shock. While the diagram is not all encompassing, it does show the more important relationships in the model.

Figure 1. Long Run Effects from the Increase in Productivity



Higher labour efficiency raises the real wage since the wage level is determined by the marginal product of labour in the long run. This increase in wages increases labour supply by 0.8 per cent. In the long run, the unemployment rate is set by the NAIRU.

The level of employment is determined by the participation rate and the unemployment rate. Since labour supply has risen by 0.8 per cent, and the unemployment rate is unchanged, employment will also rise by 0.8 per cent.

A higher efficiency of labour increases the quantity of labour services per employed person. Output therefore increases due to this supply side boost. The capital stock also increases in line with output, since its real cost remains unchanged. Therefore output, the capital stock and the level of investment all increase in the business sector and the aggregate economy.

Exports also rise because of the increase in export supply. The increase in efficiency is assumed to be broadly based and therefore includes farm and mining production, which is largely exported. Imports increase because of the rise in domestic expenditure, although the impact is partly dampened by the improvement in international competitiveness.

Incomes rise in line with output, bringing corresponding increases in consumption and savings.

Higher after-tax wages per person, increase the willingness of people to participate in the labour force. The supply of labour increases by about 0.8 per cent as discussed above, as does employment. This allows an increase in GDP of more than the efficiency gain of five per cent. Income, consumption, investment and most real variables can therefore also increase by more than five per cent.

The general price level through the economy will fall. This occurs because the monetary reaction function is specified such that the monetary authorities are assumed to hold the target level of nominal transactions (or the money supply) unchanged. Higher quantities of real GNE therefore necessitate lower prices in the long run. This is not surprising, given that the simulation involves an increase to the supply side of the economy.

Little change is apparent in the long run levels of both the current account deficit and net foreign liabilities. Neither the aggregate savings to GDP ratio nor the aggregate investment to GDP ratio have changed very much, though the private savings and investment ratios have increased marginally. As the general price level falls, so too does the price of non-commodity exports, increasing export volumes and lowering the terms of trade. The net effect of the price fall and the increase in volumes causes the exchange rate to appreciate in the long run.

To some extent the 4.8 per cent increase in real wages understates the increase in the average living standards of Australians. Private consumption rises by 5.4 per cent in real terms. The private wealth of Australians has also increased by 5.5 per cent in real terms.

The boost to GDP from the increase in labour efficiency is not as strong in results presented here compared with our earlier work in Taplin and Louis (1993). This reflects a difference in fiscal policy assumptions. In this paper, maintaining government expenditure as a proportion of GDP (compared with unchanged government expenditure), does not permit as great a fall in direct tax rates and therefore allow as strong an increase in after tax wage rates. This implies the labour supply response is smaller and therefore a lessor increase in GDP.

3.1 Summary of Long Run Effects

There are a number of long run results in this simulation that can be summarised.

- Employment and the labour force are 0.8 per cent higher. Unemployment is unchanged.

- GDP is 5.7 per cent higher, exceeding the efficiency gain due to labour responding to higher post-tax wage incomes.

- The price level is about 5.6 per cent lower, implying a lower rate of inflation on average during the transition path to the long run.

- The current account deficit is little changed, though the Australian economy is more open with both exports and imports higher.

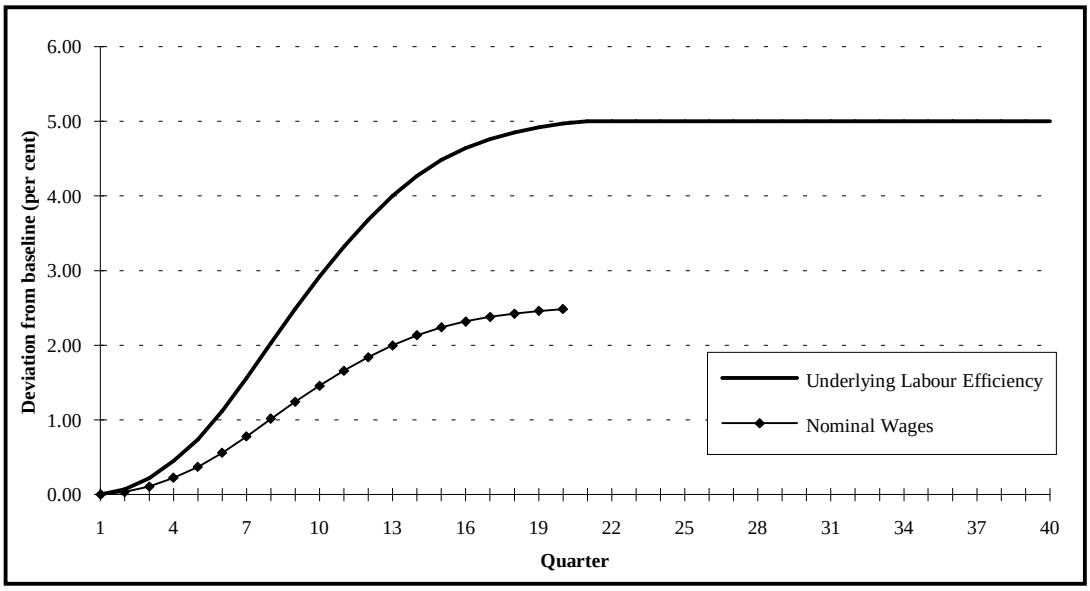
- The average living standard of Australians is higher. Real consumption has increased by 5.4 per cent. Real wealth rises by 5.5 per cent and real wages by 4.8 per cent.

4. ASSUMPTIONS CONCERNING THE ADJUSTMENT TO HIGHER EFFICIENCY

More information is needed about the adjustment path to higher efficiency before a dynamic simulation can be undertaken. This section describes the assumptions that have been chosen, some of the options and the reasons for the choices.

4.1 The Increase in Labour Efficiency and the Dividend to Labour

Chart 1: Shocks to Underlying Labour Efficiency and Wages (ceteris paribus)



The chart above shows the ceteris paribus impact of the increase in underlying labour efficiency and associated dividend to labour in the form of higher nominal wages. These assumptions **do not** necessarily reflect how we feel an efficiency *would* occur in practice, and in particular, how labour *should* be compensated for greater efficiency. The assumed shocks are just one plausible set accepted to facilitate comparison of various models.

The improvement in the level of underlying labour efficiency is assumed to build up over a five year period, and eventually be permanently higher by 5 per cent. In the TRYM simulation, measured labour productivity will be different to this profile to the extent that the efficiency shock sets off a cyclical response in labour productivity.

There is a variety of plausible wage assumptions that could be made. For example, wages could be unchanged initially if the higher efficiency arose through improved training or they increase if the efficiency gain occurred through better work practices. In this simulation, half of the improvement in efficiency is assumed to flow into wages so as to lie between the cases of a full 'one for one' wage increase and the 'no compensation' case,

both of which are entirely plausible given different types of productivity improvements. This accompanying wage shock is temporary and does not affect the long run outcomes, though it does affect the adjustment path to the new equilibrium. In the TRYM simulation, wages will be different to this profile to the extent that the shock alters labour market conditions to which wages respond.

4.2 The Formation of Expectations

A number of assumptions are required to implement this simulation in the dynamic version of the TRYM model.

- Do agents recognise that the efficiency of labour has increased?
- Do agents understand the macroeconomic consequences of these changes?
- Do agents incorporate this information into their decision making in a forward looking way?

If economic agents are fully informed and forward looking then they will be aware of the long run consequences of an increase in efficiency for the whole macroeconomy. They will know that the size and shape of the economy may adjust. However, if economic agents are less than fully informed about the full macroeconomic consequences of higher efficiency, or if they are relying on backward looking rules to determine their expectations, then they will make different decisions.

These sorts of assumptions have a large bearing on the outcome of the simulation. For example, if agents expect that the adjustment will be largely completed within one quarter then it is reasonable to expect that the economy will tend to shift more quickly to its new long run level. Households, knowing that their incomes will be higher, will tend to increase their consumption. Firms, knowing that the profit maximising level of the capital stock will be higher, will tend to increase their investment. These expectations could be self-fulfilling because the higher levels of expenditure will tend to increase incomes and demand.

In contrast, if agents expect little change in the underlying growth rate of the economy, either because they believe that the rate of adjustment will be very slow or because they are unaware of the increase in efficiency or its long run effects, then agents will wait until actual conditions justify decisions to increase expenditure. For example, households will wait until either incomes or wealth actually increase before raising their consumption.

Firms will wait until demand actually increases or some other signal for higher investment actually occurs before undertaking higher levels of investment. These expectations will also tend to be self-fulfilling since activity will adjust much more slowly to its new long run level.

An alternative perspective on the options available can be gained by considering how to implement the increase in efficiency in a typical equation. Most of the TRYM equations have an error correction model specification. Consider a general equation where a variable Y is a function of X in the long run.

$$\Delta Y - y = a*[\Delta Y(-1) - y(-1)] + b*[\Delta X - x] + c*[\overline{Y}(-1) - Y(-1)]$$

$\overline{Y}$ is the desired value of Y conditional on X. The variables y and x are the underlying or expected rates of growth for Y and X respectively and their inclusion is necessary to ensure balanced long run growth of Y and X.

Suppose that Y and X will be increased in the long run due to a higher level of efficiency. The underlying growth paths of Y and X will be higher over some period of time. If the adjustment is expected to occur quickly then y and x will be significantly higher initially. This will then lead to higher growth in Y. However, if agents expect the adjustment to be small or non-existent then y and x will change by little, if at all. In this case any increase in Y will depend upon an increase in $\overline{Y}$. Initially this will only occur if the level of efficiency is a direct determinant of $\overline{Y}$.

For the purposes of this paper we have assumed that, unless otherwise specified, agents make no adjustment to their expectations of the underlying growth paths of variables such as X and Y, ie y and x are initially unchanged. We believe that this represents a plausible assumption for the reaction of real world agents for this simulation. It serves the purpose of illustrating the macroeconomic consequences of a general improvement in labour efficiency. Where a more specific reason for the efficiency increase was being modelled that suggested a different formation of expectations, a more tailored set of assumptions could be made.

The assumption that we have made can also be examined in terms of the earlier discussion about how informed and forward looking agents are. Unless otherwise specified, agents are assumed not to understand that efficiency has risen generally, fail to

appreciate its macroeconomic implications or fail to incorporate this information into their decisions. This assessment is based on the following considerations:

- recognisable and measurable changes in the general level of efficiency are relatively uncommon;

- the macroeconomic consequences of an increase in efficiency are difficult to calculate and conditional on other information not readily observable (even for macro-modellers); and

- most economic agents (ie most households and firms) have little incentive for incorporating the above information into their decisions, even if it were available, because it is often of relatively small importance compared to other considerations, such as movements in the business cycle.

One exception to this general approach is for agents in financial markets. They have considerable incentive to understand changes in the economy, work out the implications for variables such as expected inflation and the exchange rate, and incorporate this information into their decisions. Therefore we have assumed that the long run values of the exchange rate and the price level adjust when efficiency increases.

4.3 The Speed of Adjustment

All agents understand the implications of the higher efficiency as it directly affects them. For example, firms change their employment decisions taking account of the higher efficiency through:

- the lower desired level of employment for any level of demand; and
- the lower real wage after adjusting for higher efficiency.

The effect of the efficiency increase depends upon the rate at which agents change their decisions. This is very difficult to measure because historically most movements in productivity are cyclically induced, whereas here a permanent increase in efficiency is being simulated.

Our solution to this difficulty is to assume that agents react as quickly to a change in, say, labour costs due to changes in efficiency as they do to changes in labour costs for other reasons. In this way the size of the parameters b and c in the specification above are an

important determinant of the rate at which the economy adjusts. While our solution is both practical and plausible, it is important to understand its effect.

4.4 Other Assumptions

Monetary policy is assumed not to accommodate the permanent increase in activity caused by higher efficiency. Since the quantity of nominal transactions rises, while the value of nominal transactions remains unchanged, this implies that the authorities are targeting a lower price path. This may be a reasonable assumption in the long run. There are difficulties in deciding how any possible accommodation of monetary policy should be phased in during the adjustment phase.

To facilitate comparison with other model results to be presented at this conference, the standard default fiscal policy in TRYM has not been used. Real public final demand expenditure has been assumed to broadly remain a constant proportion of GDP[3], rather than the standard TRYM assumption of unchanged in levels. Implicit indirect tax rates are unchanged and direct tax rates target an unchanged share of GDP in the usual default manner.

These assumptions are simple and transparent. They are not intended to represent situations that would occur or should occur, but to illustrate transmission mechanisms within the economy in a plausible scenario.

4.4 How Does Higher Efficiency Impact on the Economy?

The details of the introduction of the efficiency shock within the TRYM model are now considered.

The general consideration is that only the desired levels of variables are adjusted and only if directly affected by the level of efficiency. The higher level of efficiency affects the desired ratio of employment to output, the calculation of supply and the level of real labour costs after adjusting for efficiency.

The desired level of employment changes in :

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[3] In particular, government market demand and general government investment have been tied to GDP, government business enterprise investment has been tied to that of the private business enterprises, and while general government employment has remained unchanged, assumed efficiency gains in this sector raise general government consumption (or the general government input/output of labour services).

- the private enterprise employment equation; and
- the public enterprise employment equation.

The higher level of supply affects:

- the price equation;
- the investment equation (through the capacity utilisation term); and
- the government final demand equation (through general goverment output of labour services).

The higher level of efficiency reduces the effective cost of labour in:

- the private employment equation; and
- the public enterprise employment equation;
- the business investment equation (through the Q-ratio).

These eight adjustments to five equations, and the changes in the equilibrium exchange rate and price level, constitute the only ways in which higher efficiency initially affects the economy. Other agents make no changes to their decision making processes. Changes in their behaviour await changes in economic circumstances arising as a consequence of the adjustments described above.

The simulation results themselves can now be discussed, having listed at some length the additional assumptions concerning the adjustment path to equilibrium.

5. SOME SHORT TERM AND MEDIUM TERM EFFECTS OF HIGHER EFFICIENCY

This simulation, described in the previous section, examines a scenario for the transition to the long run gains from higher efficiency.

Key variables from the simulation are summarised in Table 2. Charts of some of these variables are attached at the end of the paper.

Table 2. Effects of Higher Efficiency under Slow Adjustment Assumptions.

Deviations from Baseline (per cent)

	Number of Years after Initial Efficiency Rise							
	1	**2**	**3**	**4**	**6**	**8**	**10**	**Long Run**
Consumption.	-0.1	0.0	0.4	1.4	4.1	4.7	3.8	5.4
Bus. Invest.	-0.2	-2.3	-3.5	0.3	9.6	5.4	0.9	5.2
Dwelling Invest	-0.5	-1.5	0.9	6.2	5.6	-1.5	-0.9	6.0
Public Demand	0.1	0.7	1.9	3.3	4.9	4.6	4.1	5.4
GNE	-0.1	0.3	0.9	1.2	0.7	0.6	0.6	5.4
Exports	0.2	0.7	1.6	2.9	5.3	6.1	5.5	5.9
Imports	-0.4	-1.2	-1.1	1.1	4.7	3.7	2.7	4.3
GDP	0.0	0.1	0.9	2.7	5.5	4.8	3.7	5.7
Employment	0.0	-0.4	-0.9	-0.6	1.6	1.5	0.3	0.8
Labour Supply	0.0	-0.2	-0.4	-0.2	1.0	1.1	0.5	0.8
Unemployment	0.0	0.2	0.5	0.4	-0.6	-0.3	0.2	0.0
Productivity (L)	0.0	0.5	1.8	3.3	3.9	3.3	3.4	5.0
Nominal Wages	0.2	0.2	-1.0	-2.9	-3.2	0.1	0.8	-0.8
Cons. Deflator	0.1	-0.5	-2.2	-4.5	-5.5	-2.9	-2.1	-5.6
GDP Deflator	0.1	-0.6	-2.5	-4.9	-6.1	-3.5	-2.7	-5.6
Terms of Trade	-0.3	-0.7	-1.4	-2.1	-2.2	-1.3	-0.8	-1.1
90 day bill rate	0.0	-0.6	-1.5	-1.7	-0.3	0.8	0.4	0.0
10 year bond	-0.5	-0.5	-0.5	-0.4	-0.1	-0.1	-0.1	0.0
Exchange Rate	-1.3	-1.7	-1.6	-0.3	2.9	2.9	2.0	3.5
Private Wealth	-1.1	0.5	2.8	3.2	0.0	-0.3	1.6	-0.1
CAD/GDP	-0.1	-0.5	-0.9	-0.7	0.2	0.0	-0.4	0.0

NB Productivity (L) refers to labour productivity.

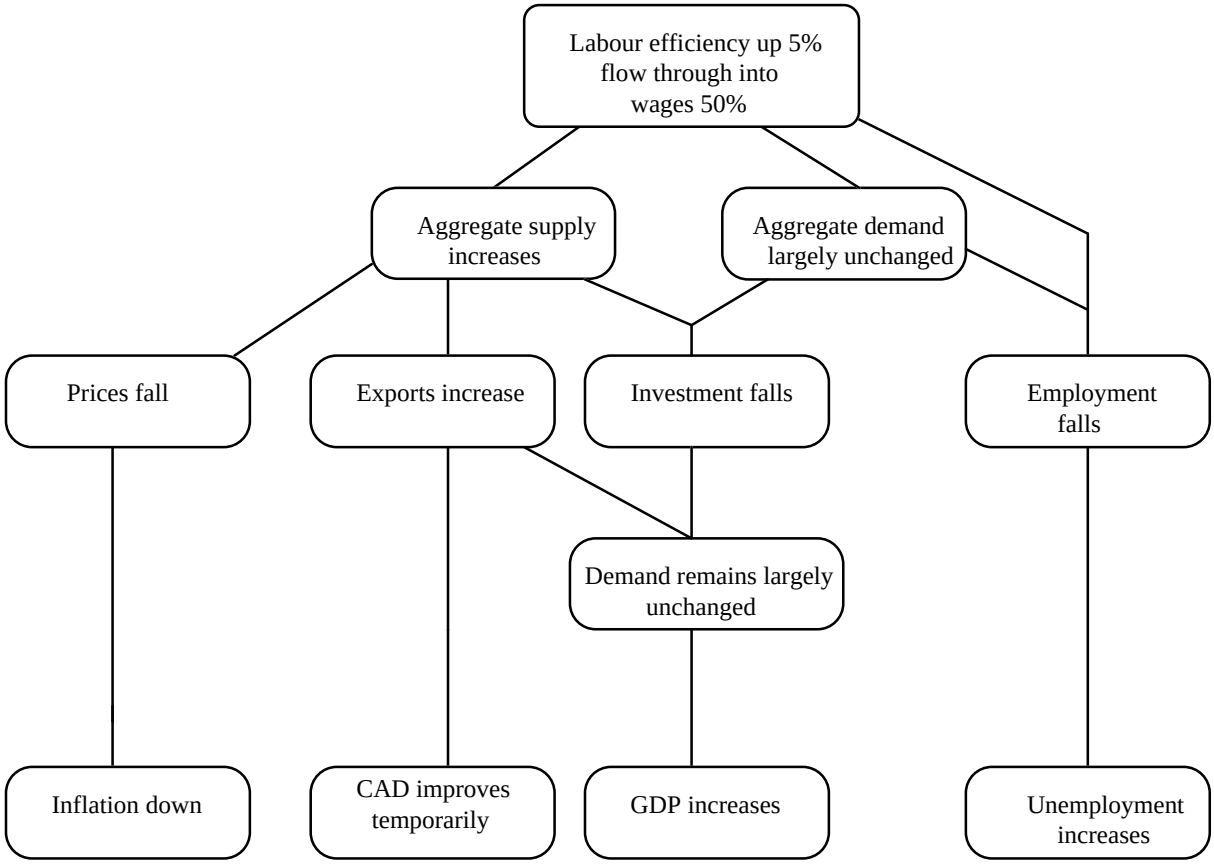
Interest rates and unemployment rate are expressed in percentage point deviations.

CAD/GDP is expressed in percentage point deviations.

5.1 Short Run Effects from the Increase in Labour Efficiency

The diagram below outlines the initial effects of the efficiency shock on some of the main aggregates in TRYM as they evolve over time.

Figure 2 : Initial Effects from the Shock



The increase in underlying efficiency is phased in relatively slowly. While the households and firms react slowly as their own circumstances and economic conditions evolve, the financial sector recognise the long run implications of the increase in efficiency and factor it into their behavoiur immediately.

Inflationary expectations fall immediately, as agents recognise that prices are lower in the long run and therefore expect lower average inflation in the intervening period. Lower inflationary expectations lead to a fall in long bond yields.

Factors affecting the current exchange rate in the initial stages of the increase in efficiency are the fall in long bond yields (narrowing the interest rate differential with the rest of the world), and the rise in the long run exchange rate. The former influence is

stronger initially and the exchange rate depreciates immediately. As time passes and the interest differential is unwound, the exchange rate appreciates towards the higher long run level.

The steady improvement in labour efficiency increases the desired level of supply immediately.

This extra capacity increases commodity exports, because these are supply determined.

The increase in capacity also leads to a fall in investment, since not all capital needs to be used to satisfy demand.

Prices start falling in response to the situation of both excess supply and the lower unit cost of labour after adjusting for efficiency.

The increase in output per unit of labour and the virtually unchanged level of demand causes employment to fall. The participation rate falls initially in response to the weaker labour market, despite the rise in real wages. This contraction in labour supply is smaller than the reduction in employment so that the unemployment rate increases. This causes wage restraint. However, prices fall faster than wages so that real wages are always higher after the shock.

Lower prices reduce the level of nominal transactions, enabling interest rates to fall in the first four years.

Consumption falls slightly initially (for the first two years) in response to lower real wealth reflecting a slight rise in real interest rates dampening the market valuation of wealth. The slight rise in real interest rates reflects the fall in inflationary expectations not being fully passed on into nominal long bond yields initially.

Similarly, dwelling investment also falls initially (also for the first two years), in response to the slight rise in real interest rates. The response is stronger than that of consumption, dwelling investment being the most interest sensitive component of demand.

Business investment falls most heavily initially (for three years), reflecting both the slight rise in real interest rates and importantly, the excess capacity created by stronger supply in the face of little changed demand.

GNE initially falls marginally in the first year, with the falls in the private sector components of demand expenditure offset by assumed public final demand expenditure.

The current account deficit improves initially. The savings/investment explanation is that business investment falls initially. The export/import explanation relies upon higher commodity exports being driven by higher efficiency. Imports fall as domestic demand (particularly business investment which has a high import component) declines and as the exchange rate falls.

Overall, GDP remains little changed initially (over the first year).

5.2 Medium Term Adjustment

In the medium term the increase in labour efficiency continues to boost aggregate supply and slowly aggregate demand responds to lower interest rates and real wages in efficiency terms to match supply. Supply determined commodity exports continue to increase in line with increased supply potential. Business investment increases strongly from year 4 to year 6, due to the lagged impact of lower real wages in efficiency terms and the lower interest rates. Similarly, the lagged impact of lower real wages and increasing demand for output boosts employment and lowers the unemployment rate.

Dwelling investment also rises in response to the lower interest rates and stronger demand for housing. Consumption rises in response to rising real incomes.

This increase in demand leads to some medium term pressure on the current account as imports unwind their initial fall. Prices also stop falling in year 5 and rise due to excess demand.

Nominal transactions increase, which means that after three years, short term interest rates start to rise again.

Many of the variables of interest are a considerable distance from their long run equilibrium even after five or ten years. This is due to the capital stocks taking a long time to adjust to their new equilibrium levels. A considerable increase in investment is required to move business and dwelling stocks to their long run levels. Until capital has risen to its new equilibrium level, demand and other variables are constrained in their adjustment. It should be noted that the assumed increase in labour efficiency is not completed until the fifth year.

This simulation illustrates the short run advantages and disadvantages of higher efficiency and productivity. GDP and real wages are always higher. However, in the first four years unemployment is also higher as the labour market and the economy adjust to the new higher levels of efficiency. These same forces also temporarily reduce inflation and the current account deficit. While it appears that the aggregate economy is improved overall, not everyone immediately benefits, as shown by the initially higher unemployment rates.

5.3 Summary

A number of simulation results deserve emphasis.

- The short term adjustment costs are relatively modest in this simulation. Although employment is initially lower and unemployment higher these effects are small relative to:
  - changes in labour market conditions observed over history; and
  - the medium term and long run improvements in the labour market.
- GDP is higher in every year. This is despite the initial deterioration in the labour market.
- Inflation is lower for the first few years of the adjustment phase of the simulation. In the first four years the inflation rate (for consumption prices) averages 1.1 percentage points lower. In the medium term inflation rises with activity, though this rise is less than the initial fall.
- The current account deficit is lower initially due largely to higher net exports. As the economy grows more rapidly in the medium term the current account deteriorates somewhat. There is no long run effect on the CAD.
- The average standard of living improves slowly but smoothly.
  - Real consumption is higher after the second year.
  - Real wages are always higher.

6. CONCLUSIONS

The long run gains from the higher level of underlying productivity are considerable. They include higher GDP and incomes. If households respond to the higher wages by increasing their willingness to work, as in this simulation, then higher employment will also result. These results are broadly similar to the long run results of two other macroeconomic models AEM (Murphy) and ORANI-F as reported in EPAC (1990).

In the short run there could be costs in the macroeconomy, largely in the labour market, under particular assumptions about the nature of the increase in productivity. The deterioration in the labour market is a cause for concern, and would need to be addressed, but these labour market costs appear to be outweighed by the aggregate benefits.

- The fall in employment in the first four years appears to be relatively small compared with the long run increases in employment and incomes.

- By the fifth year the labour market is stronger than it otherwise would have been.

- By the fifth year the overall increases in employment and falls in unemployment have outweighed the initial deterioration.

The gains from higher efficiency are distributed widely.

- Owners of existing capital benefit from a capital gain.

- Labour benefits from a rise in real wages. It also benefits from an increase in employment if the higher post-tax wages raise labour supply.

- The community generally benefits from lower prices and lower inflation.

- Foreigners benefit as the relative price of Australia's exports falls, and this is a minor partial offset to the gains from the higher efficiency available to Australians.

On this basis, any short term macroeconomic costs of higher efficiency do not appear to outweigh the considerable medium term and long run benefits, particularly since any problems in the short term adjustment phase are likely to have been overstated in this simulation.

7. REFERENCES

Adams P., and B. Parmenter (1992), 'Microeconomic Reform and Employment in the Short Run', *Centre of Policy Studies Discussion Paper 154*.

Economic Planning Advisory Council (1990), 'Model Based Estimates of Investment in the 1990s', *EPAC Background Paper No 6*.

Economic Planning Advisory Council (1991), 'Distributing the Gains from Enhanced Labour Productivity: Macroeconomic Implications of Alternative Scenarios', *EPAC Background Paper No.12*.

Industries Assistance Commission, 'Annual Report' 1988-89.

Industry Commission, 'Annual Report' 1989-90.

Parameswaran P. and B. Taplin (1993), "Employment, Investment and Productivity: Decisions by the Firm", Treasury Conference on The TRYM Model of the Australian Economy, TRYM Paper No.3, June 1993.

Ryder B. and M. Upcher (1990), Modelling the Australian Trade Balance, presented at the *19th Conference of Economists, University of New South Wales, September 1990.*

Taplin B, Jilek P., Antioch L., Johnson A., P. Parameswaran and C. Louis (1993), "An Documentation of the Treasury Macroeconomic (TRYM) Model of the Australian Economy", Treasury Conference on The TRYM Model of the Australian Economy, TRYM Paper No.2, June 1993.

Upcher M. and B. Taplin (1990), Modelling the Supply Side in the NIF Model, paper presented to the conference *Economic Modelling in Australia, June 1990.*

Upcher M., Taplin B., Ryder B., M. Mangolini and P. Parameswaran (1991), An Overview of TRYM: The Redesigned Treasury Model, presented at the *Economic Modelling Bureau of Australia Conference, August 1991*.

8. CHARTS

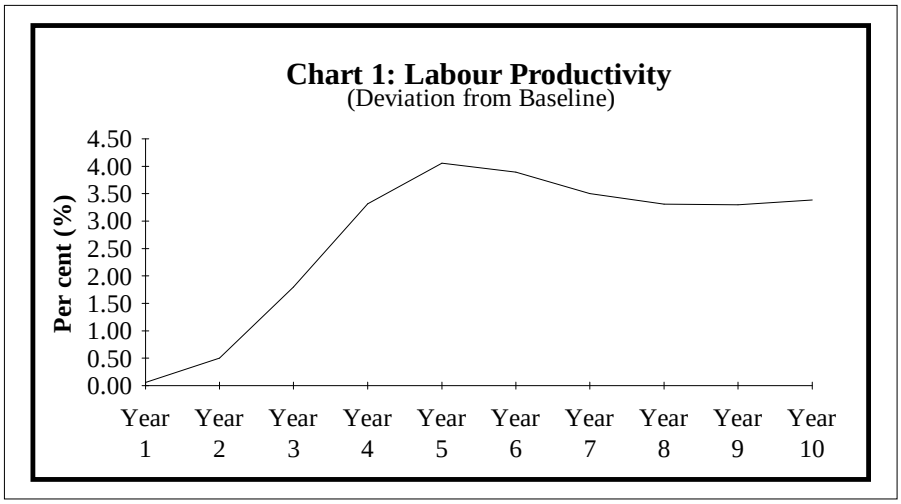


Chart 1: Labour Productivity
(Deviation from Baseline)
Per cent (%)
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Year 1
Year 2
Year 3
Year 4
Year 5
Year 6
Year 7
Year 8
Year 9
Year 10

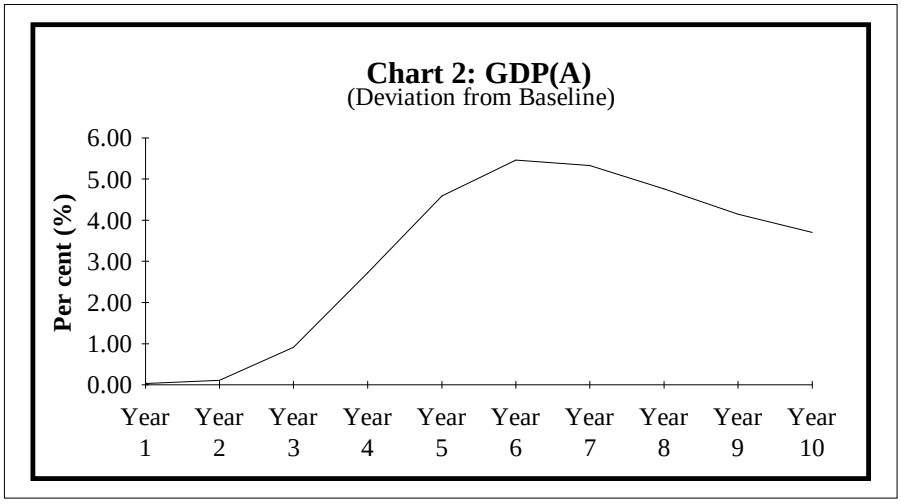


Chart 2: GDP(A)
(Deviation from Baseline)
Per cent (%)
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Year 1
Year 2
Year 3
Year 4
Year 5
Year 6
Year 7
Year 8
Year 9
Year 10

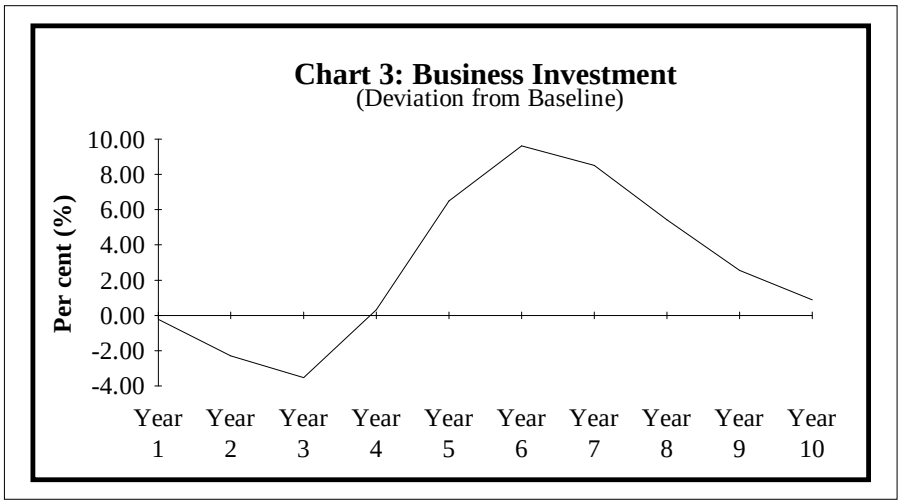


Chart 3: Business Investment
(Deviation from Baseline)
Per cent (%)
10.00
8.00
6.00
4.00
2.00
0.00
-2.00
-4.00
Year 1
Year 2
Year 3
Year 4
Year 5
Year 6
Year 7
Year 8
Year 9
Year 10

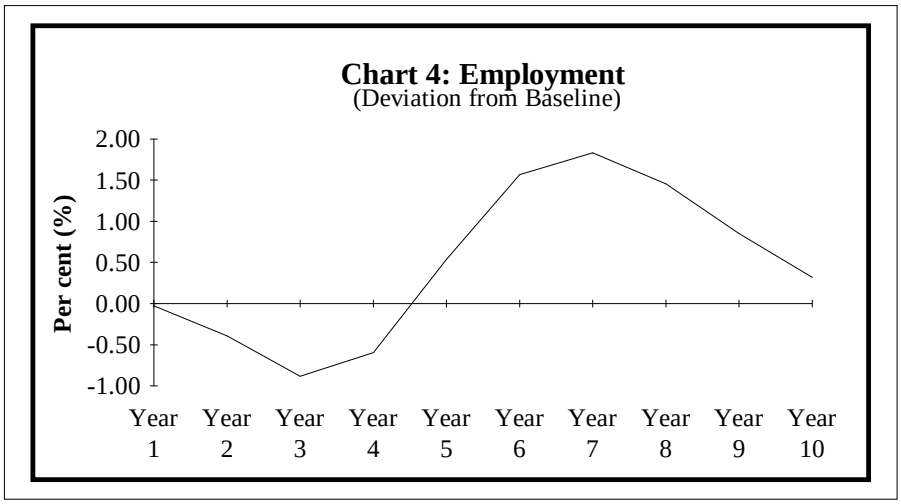


Chart 4: Employment
(Deviation from Baseline)
Per cent (%)
2.00
1.50
1.00
0.50
0.00
-0.50
-1.00
Year 1
Year 2
Year 3
Year 4
Year 5
Year 6
Year 7
Year 8
Year 9
Year 10

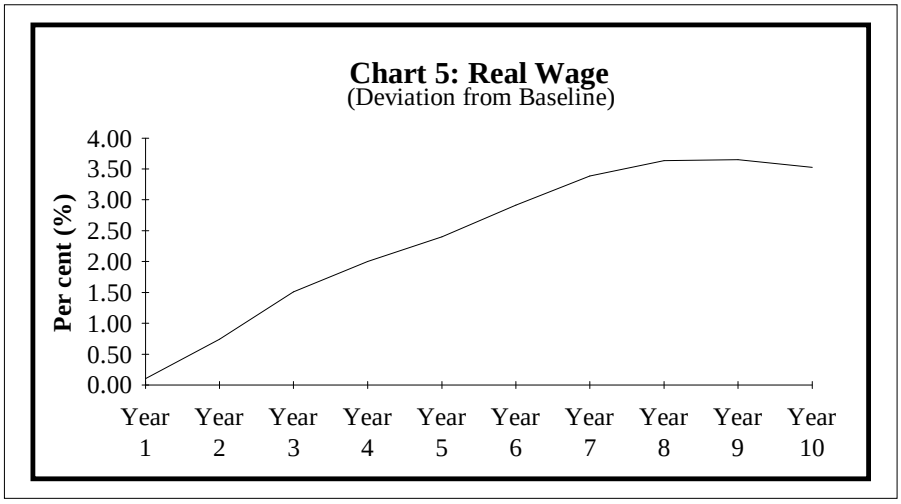


Chart 5: Real Wage
(Deviation from Baseline)
Per cent (%)
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Year 1
Year 2
Year 3
Year 4
Year 5
Year 6
Year 7
Year 8
Year 9
Year 10

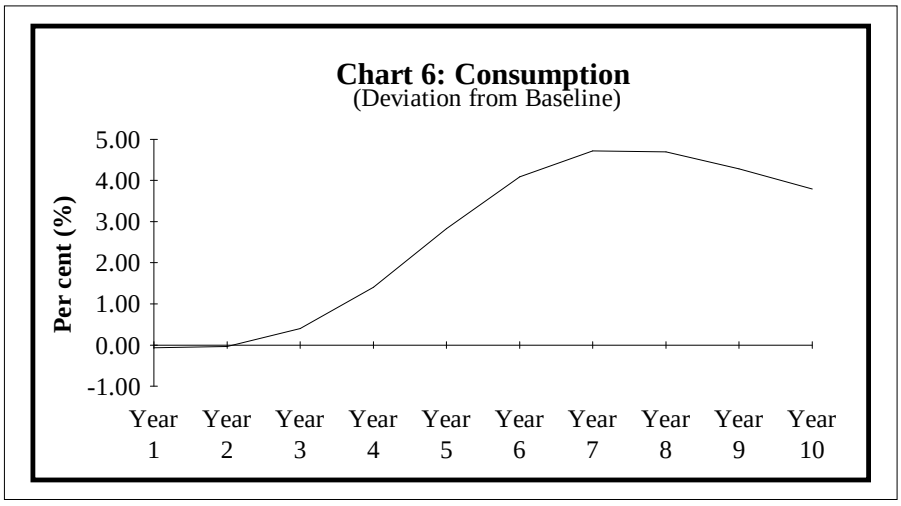


Chart 6: Consumption
(Deviation from Baseline)
Per cent (%)
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
Year 1
Year 2
Year 3
Year 4
Year 5
Year 6
Year 7
Year 8
Year 9
Year 10

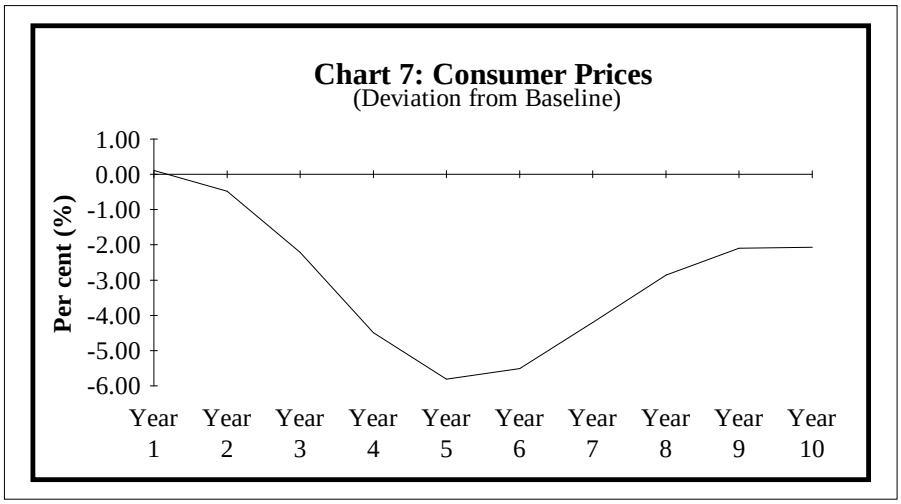


Chart 7: Consumer Prices
(Deviation from Baseline)
Per cent (%)
1.00
0.00
-1.00
-2.00
-3.00
-4.00
-5.00
-6.00
Year 1
Year 2
Year 3
Year 4
Year 5
Year 6
Year 7
Year 8
Year 9
Year 10

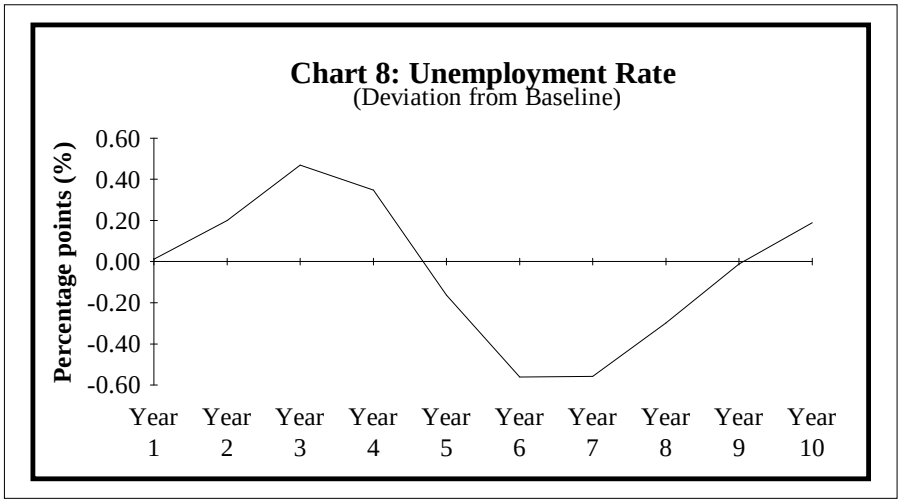


Chart 8: Unemployment Rate
(Deviation from Baseline)
Percentage points (%)
0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
Year 1
Year 2
Year 3
Year 4
Year 5
Year 6
Year 7
Year 8
Year 9
Year 10

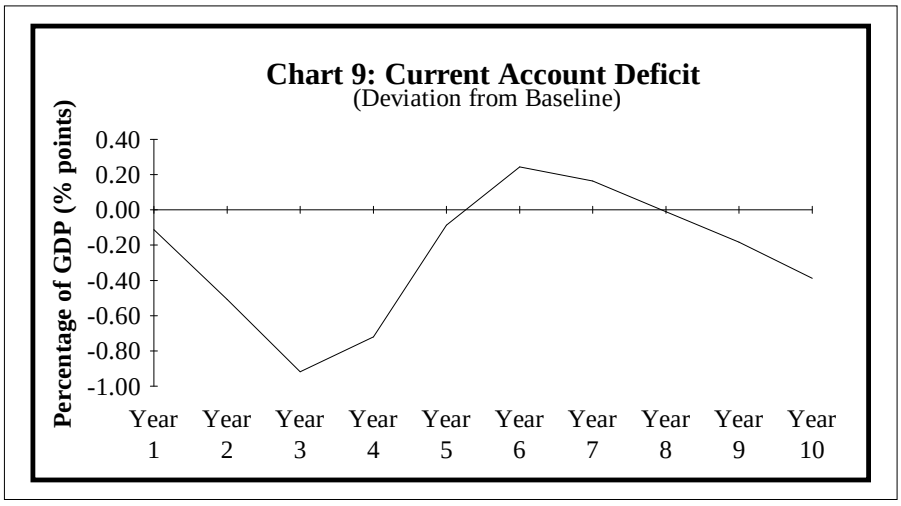


Chart 9: Current Account Deficit
(Deviation from Baseline)
Percentage of GDP (% points)
0.40
0.20
0.00
-0.20
-0.40
-0.60
-0.80
-1.00
Year 1
Year 2
Year 3
Year 4
Year 5
Year 6
Year 7
Year 8
Year 9
Year 10