Supporting Material is available for this work. For more information, follow the link from the Table of Contents to "Accessing Supporting Material".

National Medicines Use Dynamics: Influencing Health Policy with System Dynamics

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ABSTRACT:
The Australian Government is required to report every five years on the impact of current fiscal policies on future generations. The first Intergenerational Report (IGR) in 2002 projected future Federal income and expenditure for the next forty years based on expected demographic changes due to the baby boomers effect of increased fertility rates from 1946-1973. The projected growth in GDP was 2.5 times while the federal Government outlays on prescription medicines through the universal Pharmaceutical Benefits Scheme (PBS) was expected to grow fifteen-fold by 2042. We developed with The National Healthcare Alliance a system dynamics model of a broader view of future medicines use. This joint model replicated the IGR case as context, with additional detail on drivers of new drug use, feedback of benefits of medicines use on macroeconomics, and structural changes in over, under and mis-use of medicines over the next four decades. Main findings are:
IGR projections are sensitive to assumptions, especially workforce participation and productivity growth; effective medicines use contributes to National Health and Wealth, and this contribution depends on the level of under-use, overuse and misuse of medicines.
The results from this System Dynamics modelling formed the basis for a 2004 Federal Budget Submission to Treasury from the Alliance.

KEYWORDS: HEALTH POLICY, SYSTEMS SIMULATION, MEDICINES USE

Background

Australia's first Intergenerational Report (IGR) was produced by the Treasury Department of the Federal Government in 2002; it provides a basis for considering the Commonwealth's fiscal outlook over the long term, and identifying emerging issues associated with an ageing population (1). The IGR projected future Federal income and expenditure for the next forty years based on expected demographic changes due to the baby boomers effect of increased fertility rates from 1946-1973. The projected growth in GDP was 2.5 times while the federal Government outlays on prescription medicines through the universal Pharmaceutical Benefits Scheme (PBS) was expected to grow fifteen-fold by 2042.

Australia has a well-developed national medicines policy, based on a "free medicines scheme" introduced in 1948 to ensure new expensive lifesaving drugs like penicillin were available to all citizens (2). Since 1993 new drug subsidies have required evidence of relative cost-effectiveness in addition to safety and efficacy criteria. There is also a Quality Use of Medicines Program for more appropriate prescribing and taking of medicines (3). Participants in the Australian Health Care System considered

the fiscal view of medicines use in the IGR was too narrow to be the main basis for policy making; a coalition of health care organisations called the National Health Care Alliance (NHA) resolved to develop a system dynamics model to broader the debate about the sustainability of the PBS and include this in a Budget Submission to the Federal Government in 2004 (4).

Conduct of the Project

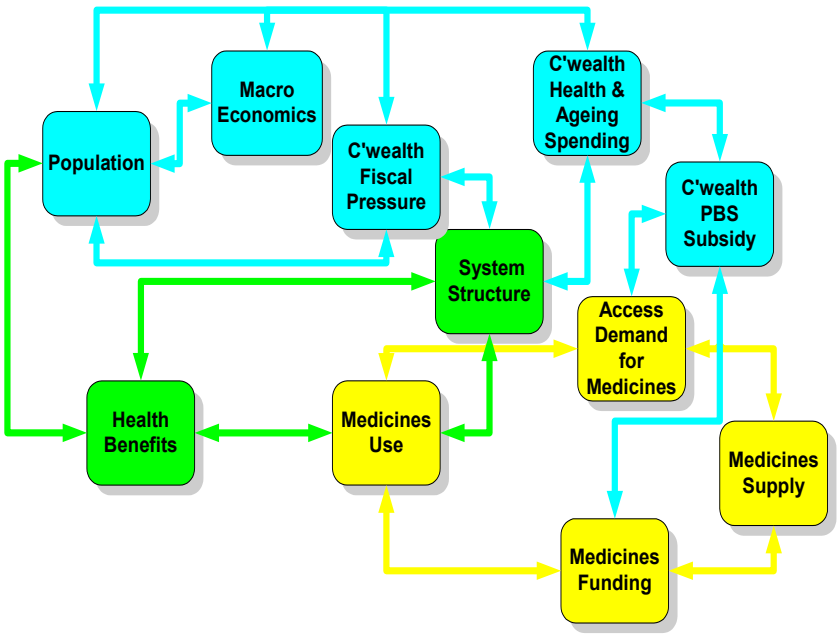
We jointly captured the relevant context of the IGR & the detail of medicines use in a series of joint interactive workshops with a range of healthcare alliance members, experts and front-line health workers over several months. We used available recent estimates from the IGR and relevant literature to calibrate the model, supplemented by consensus estimates for remaining parameters. We moved through multiple model versions and developed and simulated several Case Scenarios.

The indicative model and scenarios were presented at a national symposium in June 2003. The model was handed over to NHA members to conduct their own what-if simulations after an initial training session. Based on these simulations, a modelling section was included in the NHA Budget Submission.

Further development and calibration of the model is intended.

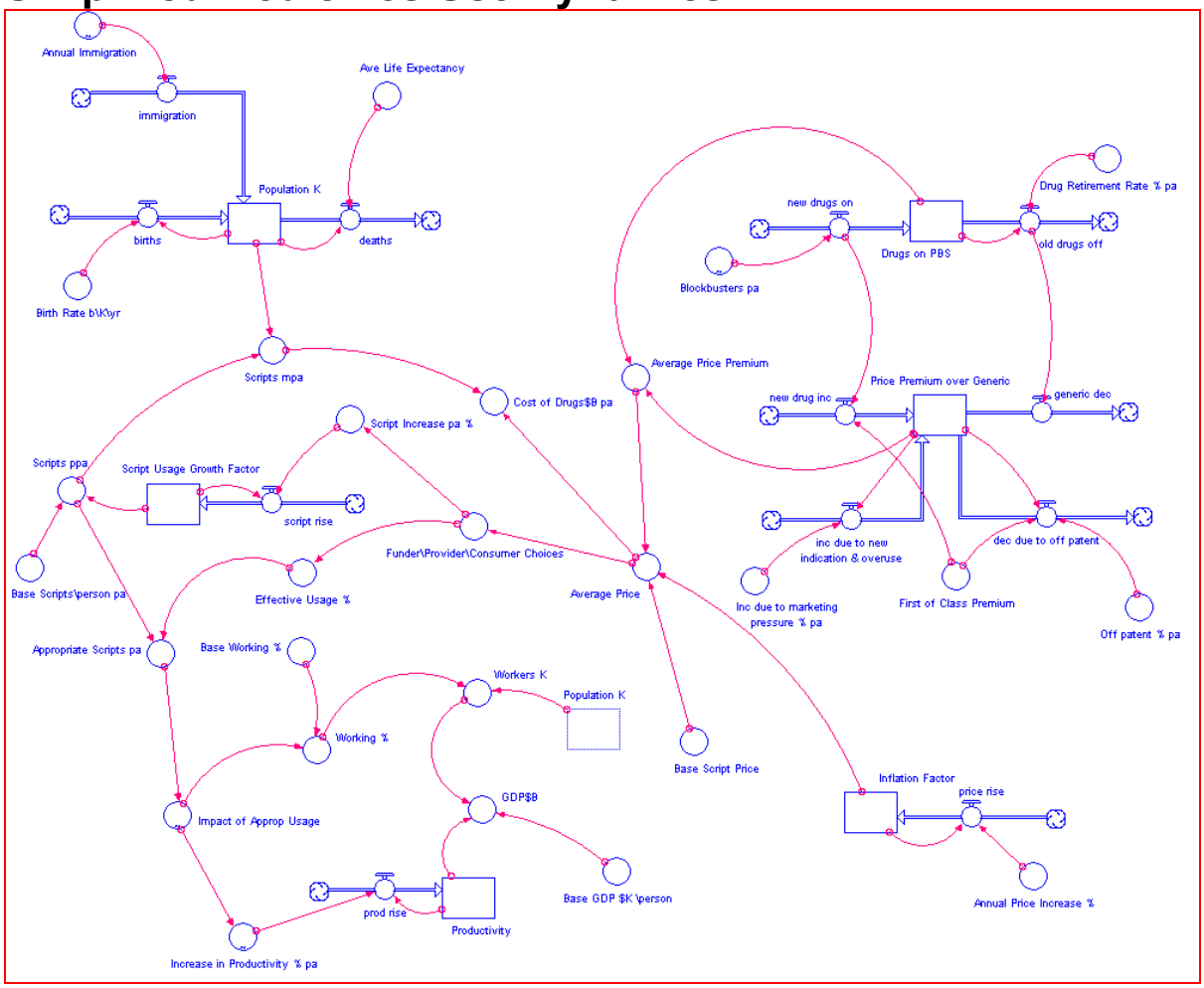
Model Description (see also attached NMUD.itm file)

The Model combines the IGR Fiscal view (blue) with an operational Medicines Use view (yellow). In order to link the two views additional segments addressing Health System Structure and the Health Benefits of Medicines Use were required (green).

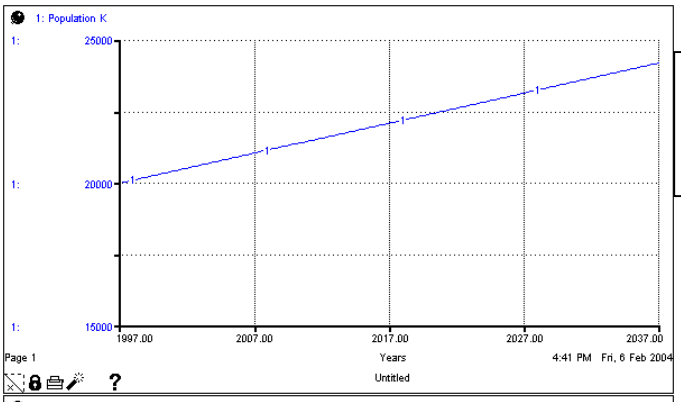


A simplified overview model showing the main feedbacks appears below

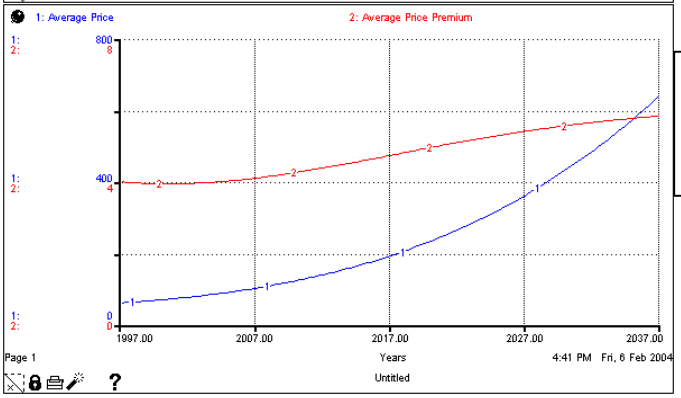
Simplified Medicines Use Dynamics



Base case of Government spending on medicines outstripping the growth in GDP and taxpayers in the workforce.

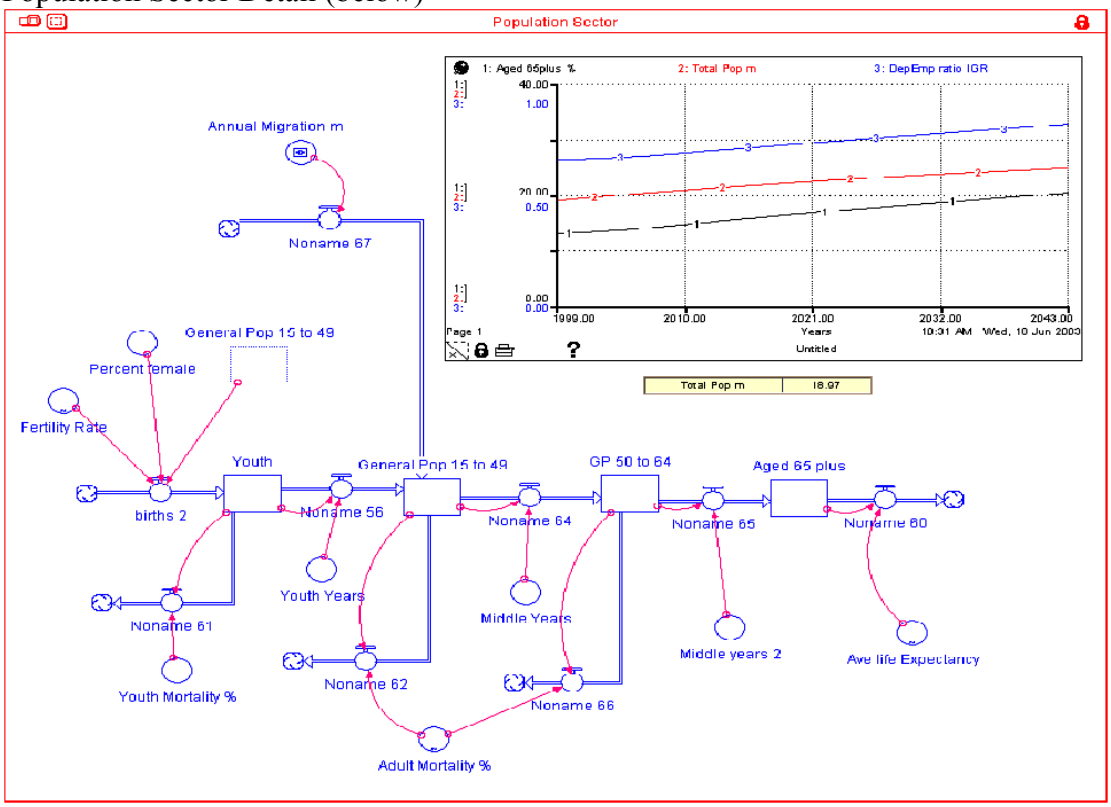


Population growth over the next 40 years, with increase due to net migration.

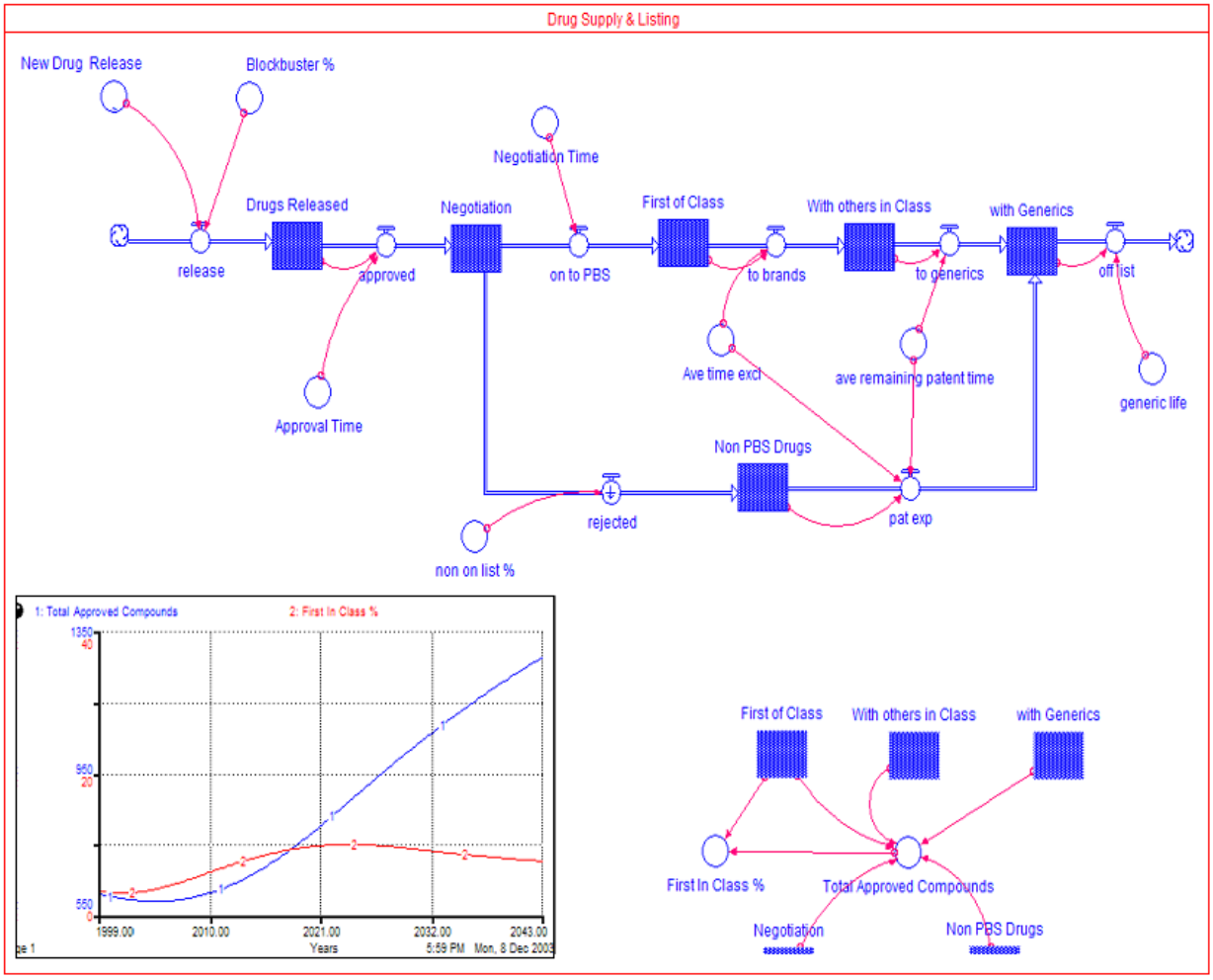


Drug cost inflation and the price premium due to expected new blockbuster drugs to be developed

Population Sector Detail (below)



Drug Development and Drug Patent Ageing Chain (below)



Overview of Model Dynamics

The major features are the interaction between a population ageing chain and a drug patent ageing chain. As people age they have more medicines-treatable health conditions, until death ends medicines consumption. New drugs take around 12 years to become available, and a year or so to be listed for Government subsidy; they enjoy a first in class premium position for a few years until competitors release similar drugs in that class; they remain with others in class for (6 years) until the patent expires after 20 years and then remain as generics until withdrawn (around 40 years).

There are two types of pressure to migrate people from no drugs or cheap drugs to new expensive drugs. The first is scientific evidence of effectiveness (and for the PBS subsidy cost-effectiveness) new proven indications where the new expensive drug is superior. The second pressure is for pharmaceuticals to induce prescribers and consumers to overuse medicines to meet expected sales and profit targets while they have premium pricing. This inducement is counteracted by competitor pressure to keep consumers on their own patented medicines within the same therapeutic class.

Overall limits to growth include the Government's and consumers' willingness to pay and the rate of release of new superior medicines. These will be explored further in future versions of the model.

Model Insights from the National Symposium

With the steady increase in the cost to the community of prescribed medicines it has become increasingly important to understand just what the impact of these apparently inevitable cost increases will be on medicines use, population health and the national economy in general.

The macroeconomic picture forecast by the IGR for the year 2042 is replicated in our the model by using the same assumptions about population life expectancy, net migration and fertility rate, labour force participation rate and employment rate and aggregate growth in GDP, Commonwealth revenue and demographic and non-demographic spending – verifying our understanding of the behaviour of this model.

This projected the annual Commonwealth expenditure on the PBS to rise from $4 Billion to $60 Billion by 2042, mainly due to an overall cost per PBS prescription increase of more than 5% per year. The model also reproduces Commonwealth fiscal pressure associated with an increase in the ratio of dependent to employed persons over aged 15.

Operational aspects of the PBS were also included in our model to show how usage and PBS items per user by age group could build up the resulting overall cost of $60 Billion. To explore the components of cost increase per item, the drug supply and listing processes were modelled. This showed that the number of approved compounds and first-in-class breakthrough PBS drugs more than doubled, based on the release of around 200 new chemical entities per year by 2020. The increase in migration of people from cheaper to more expensive drugs by known proven new indications for first-in-class drugs and overuse through marketing was also modelled; these assumptions, played out to 2042, show around a third of PBS use is expensive first-in-class drugs, contributing nearly three-quarters of the government costs.

The model also explores the impact of health benefits of PBS use on GDP growth by improvements in labour participation and productivity and by reducing the growth rate of public hospital expenditure due to drug prevention of hospitalisation.
To assign these health benefits to medicines use, the model separates overuse and misuse effects of drug use and explores the impact of changing overuse, misuse and under-use by structural improvements.

A Free Market (Free Trade Agreement) scenario was also modelled by applying a one-off increase in drug prices, bringing Australia closer to world parity pricing, plus an ongoing increase in drug cost escalation closer to that of the US. It also assumed an increase in the tendency to overuse through increased marketing effects and under-use due to reduced affordability for some households.

The additional work we have undertaken to extend and challenge the initial IGR projections has revealed a range of probable outcomes for the real world scenarios that imply less severe macro-economic effects than the IGR predicts and suggests a

number of policy directions which may be taken to improve the overall outcome while preserving a considerable element of medicine affordability over time. For instance, GDP growth can be increased significantly by targeting the impact of medicines use on productivity and labour force participation especially in people over the age of 50. Also structural improvements in subsidies, prescriber and consumer education and error reduction in medication management significantly increase the health benefits of appropriate medicines use.

Modelling Section in Federal Budget Submission

MODELLING HEALTH INVESTMENT

The Intergenerational Report sought to predict future health costs, with a focus on pharmaceuticals. The modellers made macrolevel economic assumptions about population growth and migration, participation in the workforce, productivity and the future price of pharmaceuticals. The IGR focused on three elements – population ageing, GDP, and the health cost to government.

In order to discuss the important issues raised by the IGR, the National Healthcare Alliance has taken the basic conceptual structure of the IGR as a starting point for a re-examination.

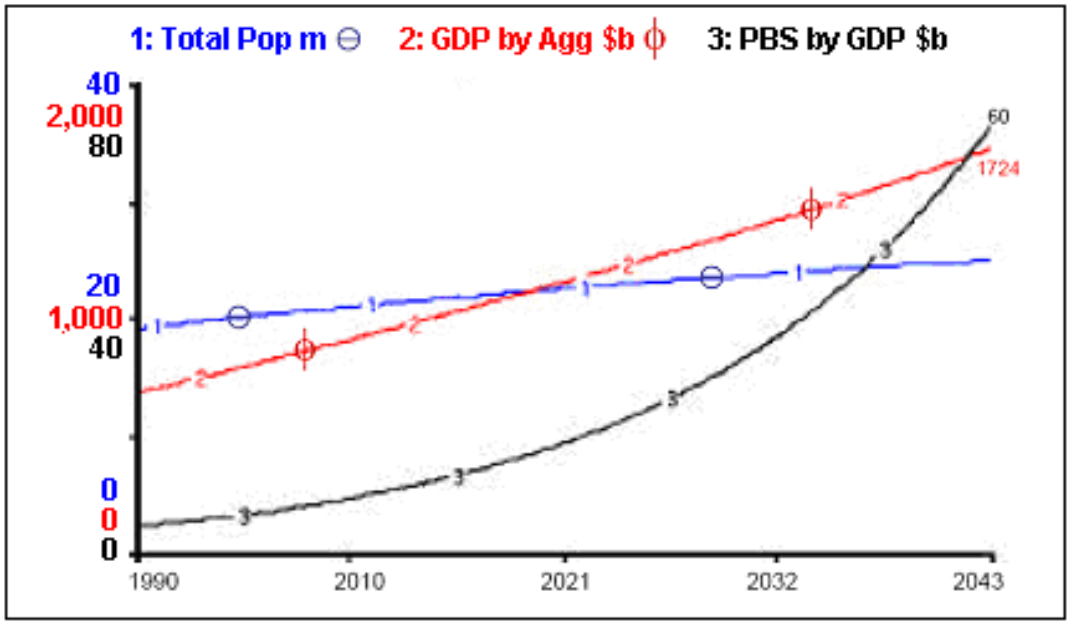
Our modelling replicates the same outcomes as the IGR model, when the same settings are used. It goes further and considers the productivity impacts of health investment, and estimates the potential for future quality improvement and transaction cost reduction in the health system.

Understanding health investment

The IGR modelling did not highlight the extent to which health expenditures are positively related to GDP, through enabling productivity. This is fundamental in the design of a national health policy. The model indicates, even within the narrow confines represented by the IGR, that there is a powerful economic impact of health investment with an ageing population.

Further, the extent of that investment payoff is linked to functional improvements in service delivery and a reduction of the transaction costs and waste associated with sub-optimal system management. The challenge for the health and aged care system will be how to respond effectively to the increasing numbers and expectations of older people as they become frail in their later years of life, using an appropriate mix of private and public funding sources.

Chart 1: IGR perspective on medicines



Modelling suggests that by 2043, on a 'business as usual' approach to healthcare, Australia with a population of 24.85 million will be spending around $60billion / annum on the Pharmaceutical Benefits Scheme alone, with a national GDP of around $1724 billion/annum.

Health investment with benefits considered

The NHA model considers medicines use taking into account:
a. the systemic effects of healthcare on productivity, and thence on GDP; and
b. the existing inefficiencies within that system (opening up the possibility of counting the economic impacts of reducing these).

It has been calculated that improved health from reduced cardiovascular disease alone benefits the US economy by over one trillion dollars a year.

If there is a greater GDP increase from health expenditure than the costs, then there is a case for that investment.

There are barriers to the effectiveness of medicines use that are not considered by the IGR, the reduction of which would improve the return on the investment in healthcare. Such limitations are relevant to all forms of health care, but modelled with respect to pharmaceuticals.

The three categories are:

a. Overuse. Overuse occurs when treatments are prescribed that are not essential to treatment outcomes. An example of this is prescription of anti-biotics for the common cold. The impact of overuse is avoidable waste of health resources. This form of waste is a result of poor diagnosis or prescribing, poor dispensing, or poor use of treatments. The key to reducing this cost (which could be as high as 20% of medicines purchased) is in the quality and availability of services surrounding the treatment

provision. Reducing investment in the quality or availability of advisory support has the (perhaps counter-intuitive) potential to increase the overuse cost of healthcare.

b. Misuse. This occurs when the wrong treatment is used, or when it is used in the wrong way. There is a number of possible forms of this effect, including the replacement of less expensive treatment with more expensive (a waste of health resources), or adverse health effects from misuse. Since the causes of this problem are found in the patient/professional relationship, and in the circumstances of the patient, then it is to these issues that effort must be directed to improve the outcomes. Once again, quality of intellectual input and support for the user is the pivotal consideration in reducing these inefficiencies.

c. Under-use. This arises when there is a treatment available that could relieve a medical condition, but where that treatment is not used. The result is preventable loss of quality of life and productivity, and frequently additional higher costs once the avoidable problems become critical. Under-use is attributable to causes as diverse as:
i. Unawareness of the health issue (such as where a low level chronic problem is accepted and not treated until it has matured);
ii. The inability to obtain diagnosis, perhaps due to access difficultly, affordability, or the absence of suitable diagnostic resources;
iii. Mis-diagnosis or mis-prescription of the treatment; and
iv. Inability or unwillingness to apply the treatment.
This can be attributable to a host of economic or social causes.
In none of these instances is the management of the cost of purchased inputs (pharmaceuticals) in isolation from other forms of knowledge input, or in isolation from management of the social context of treatment, the key to improved value for money.

Modelling possible strategies
Modelling of different strategies shows the marked range of possible outcomes from health investment. Again, the modelling is focused on the medicines aspect of healthcare but the conclusions can be extrapolated more widely to the health system as a whole.

	Description	**GDP $B.**	**PBS $B**	**Dependent/ employee impact**
1	Base case (reflecting IGR assumptions)	2143	60	0.75 dependents per employee
2	Adjusted for positive feedback and moderate system improvement	2221	58	Reduced by about 10%
3	Adjusted for feedback without systems improvement	2110	61	Increased by about 5%
4	A free market purchasing model for PBS (reducing government monopsony power)	2098	190	Increased by about 1%

The structural improvements in scenario 2 involve a reduction of overuse to 10%, underuse to 5%, and misuse to 5%.

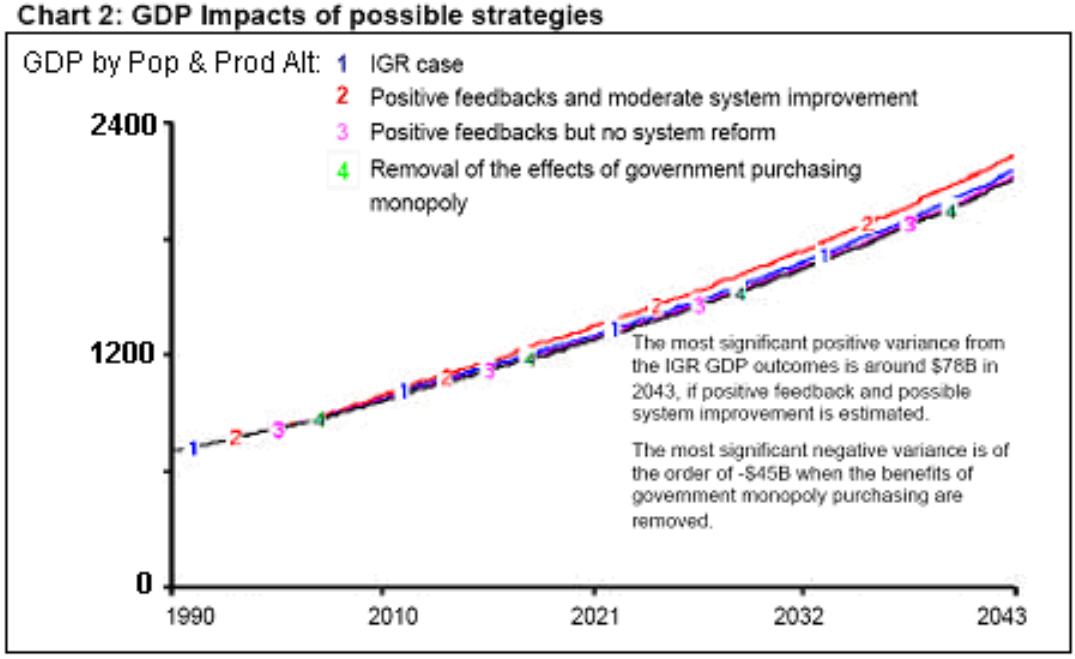
In scenario 3, these levels remain as per current estimates.

The model results in scenario 4 are highly adverse. This scenario is based on the input prices that arise from American purchasing of pharmaceuticals. The assumption is that the differences between Australian and US prices reflect the monopsony purchasing power delivered to Australian consumers by the PBS. This modelling indicates that government has a substantial value-adding role in the health system. This seems to suggest a substantial downside potential in the free trade negotiations between Australia and the USA, should the PBS be changed substantially in ways that move towards the American model.

Modelling GDP, PBS and dependency outcomes

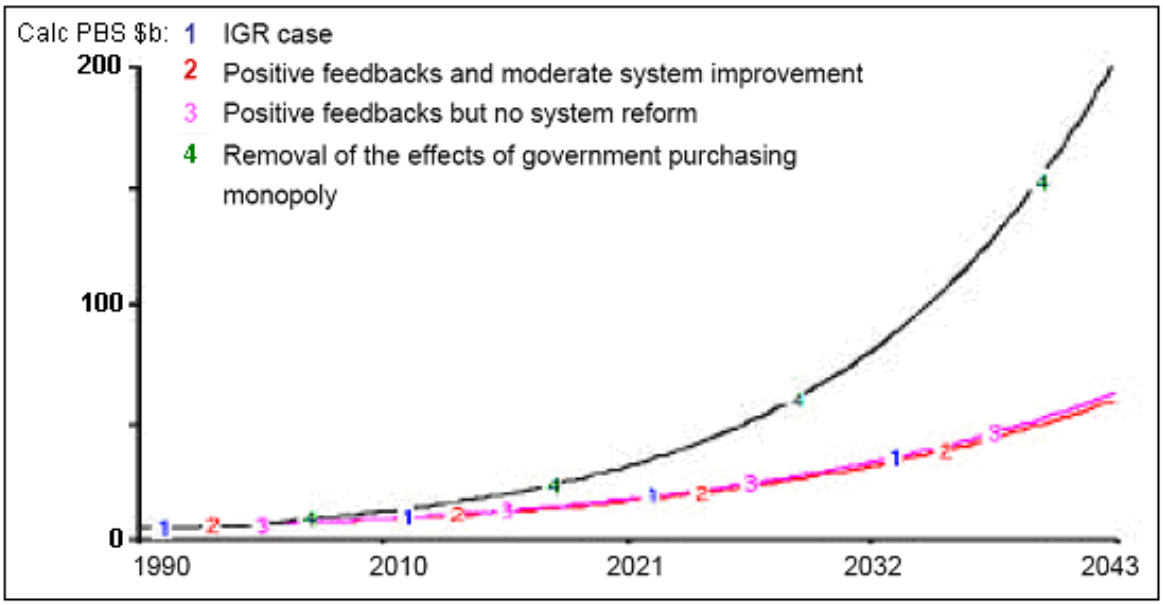
The GDP difference between the four modelled scenarios seems small in a graph, but in absolute terms is substantial. Scenario 2 (improving the effectiveness of the health service) delivers >$100 billion more in GDP than does the removal of the monopsony purchasing power of the PBS (creating an open market) By comparison the impacts on the PBS of different strategies pale into insignificance (with the exception of removal of monopsony power). The variation in PBS costs is only $3 billion between the first three scenarios.

Chart 2: GDP Impacts of possible strategies



These outcomes are persuasive of a view that adopting a ‘cost to government’ measure of return on investment in the national health system is a poor management choice. It places one stakeholder interest above all others, and treats funding through government (a form of risk and financial pooling) as inherently undesirable rather than as one management option among a myriad of pooling possibilities. A more persuasive measure is the impact of health investment on the dependency ratio – a measure of how many people are supported by each person in employment. The various scenarios modelled show that there are marked differences in outcome depending on the management focus adopted.

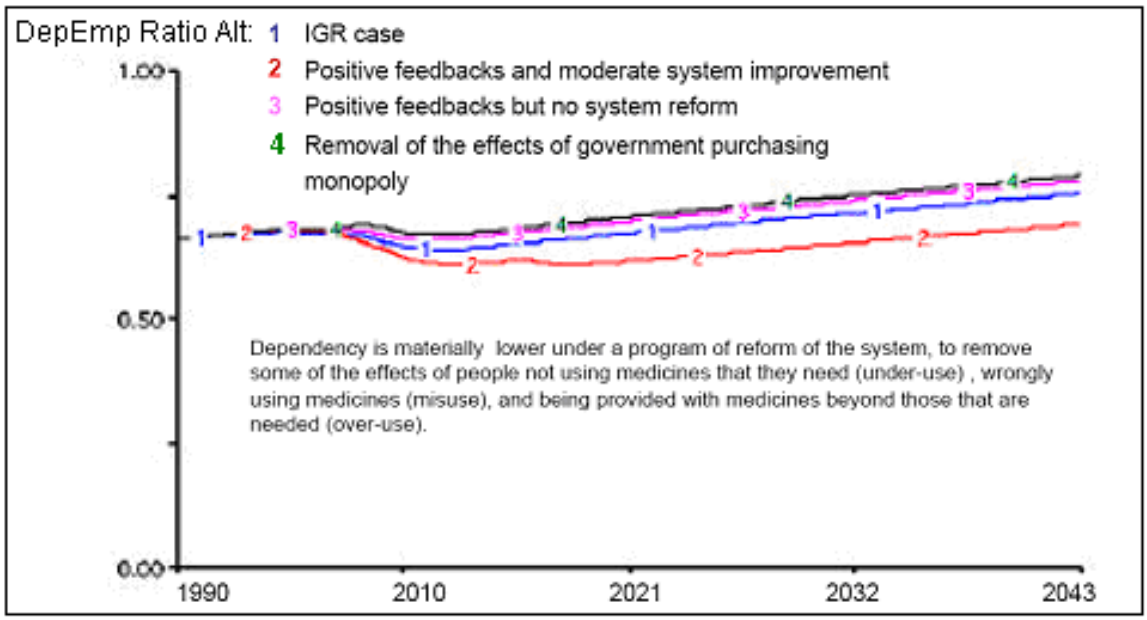
Chart 3: PBS cost under different assumptions



The most significant positive variance from the IGR PBS cost outcomes is around $2B in 2043, if positive feedback and possible system improvement are modelled. The most significant negative variation is of the order of -$130B if the benefits of government monopoly purchasing are removed.

Dependency is a fundamental measure of the social and economic potentials generated through health investment. The strategy represented by Scenario 2 provides the clearest benefit in this regard. In all instances dependency increases over the long term, but with a strategy of health system improvement but continued government investment the increase is marginal even over a 40 year time frame. As outlined in earlier discussions, dependency is important but is not necessarily disastrous. Provided that there is a sufficient working population to ensure that the consumption needs of the dependent people are met, and sufficient capacity to pay for these services, dependency does not equate to community impoverishment.

Chart 4: Dependency under different strategies



Conclusion and Future Work

System Dynamics Modelling of National Medicines Use for a coalition of groups interested in health policy produced a coherent economic argument that formed a significant part of a Treasury Budget Submission.

Several enhancements to this work are in the planning stages. They include:

- Addressing household fiscal pressures for out-of-pocket medicines expenditure;
- Quantifying the economic impacts of medicines use on informal carers;
- Exploring limits to expenditure growth due to Government and consumers' capacity to pay;
- More detailed drug therapeutic class and geographical region sub-group analysis using agent-based simulation; and
- Simulating the role of the pharmacist in the future health system.

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TOWARDS A HEALTHY AND PRODUCTIVE OLDER WORKFORCE

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