Priority Areas of Australian Clinical Health R&D

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Abstract

The study found that Australian expenditure on clinical health R&D aimed at improving treatment to various forms of cancer, including prostrate and breast cancer, and heart disease is likely to realise relatively high returns to Australians. These diseases are relatively large causes of premature mortality in Australia, and are relatively large causes of premature mortality in Australia compared to other OECD countries. Resources allocated to developing better antiasthmatics are also likely to realise a relatively large return due to the relatively large number of asthmatics in Australia. Finally, using these results to evaluate the existing composition of Australian expenditure on clinical health R&D revealed that increasing the share of R&D to these areas might improve Australian health and thereby welfare.

Contents

1. Introduction

The objective of this paper is to identify the areas in which Australian expenditure on clinical health R&D will realise the greatest returns to Australians. This information might constitute a valuable input into the public funding of clinical health R&D in Australia, and in the design of government programs such as the Factor f program aimed at assisting the development of a pharmaceutical industry in Australia.

Clinical health R&D aims to find better ways to directly treat illness, and is thereby linked to the development of new pharmaceuticals. This contrasts with public health R&D and health and support services R&D, whereby the former investigates health issues associated with a particular group (i.e. women's health) or issue (i.e. social structure and health), while the latter investigates issues relating to supporting health services such as nursing. Since the aim of the paper is to evaluate Australian expenditure on health R&D in a global context, it mostly relates to clinical health R&D due to the global nature of the pharmaceutical market. However, to the extent that the paper investigates Australian health characteristics, the results also have implications for expenditure on the other two types of health R&D.

The Australian welfare maximising composition of Australian expenditure on clinical health R&D is a function of both demand and supply conditions. In this study we focus solely on the demand side, while suggesting how future work might incorporate supply-side factors. Determining the demand for clinical health R&D requires combining an understanding of Australian health characteristics, the effectiveness of existing treatment to illness, and the composition of OECD clinical

health R&D. Each of these elements is difficult to measure and requires various assumptions.

The paper is structured as follows. Section 2 outlines the conceptual framework. Sections 3 and 4 describe the data and methodology respectively. Section 5 outlines the results. Section 6 uses the results to identify priority areas of Australian clinical health R&D, and to evaluate the existing composition of R&D. Section 7 presents the conclusions.

2. Conceptual Framework

Welfare is assumed to be a positive function of the health of the population. A disease reduces health. Clinical health R&D aims to find better ways to directly treat illness, and is thereby linked to the development of new pharmaceuticals. Clinical health R&D is assumed to exhibit constant returns to scale so that the marginal product of R&D is equal across diseases regardless of the amount of R&D previously undertaken.[1] The marginal benefit of clinical health R&D relative to public health R&D is such that some health resources need to be allocated to clinical health R&D to maximise welfare. Hence, the benefit from clinical health R&D is a positive function of the number of individuals which suffer from the disease under investigation and the ineffectiveness of existing treatment. Then to maximise welfare, the distribution of clinical health R&D across diseases should correspond to the distribution of this algorithm. Finally, due to the global nature of the pharmaceutical market, OECD clinical health R&D is assumed to benefit all OECD countries which suffer from a relevant disease equally, regardless of the country in which the R&D is carried out.

Following these assumptions, the disease composition of Australian expenditure on clinical health R&D which maximises Australian welfare is a positive function of the disease composition of the above mentioned algorithm for Australia, and the difference between this and the composition of OECD clinical health R&D, with the former factor weighted by the share of Australian R&D in OECD R&D and the latter by one minus this. Given that Australian clinical health R&D is a small share of OECD R&D, the second factor will have the greatest weight. The small share of Australian clinical health R&D also means that ignoring the impact of changes in the composition of Australian R&D upon the composition of OECD R&D will not significantly affect the results. Both factors are likely to point to the same diseases for which a relatively large share of Australian expenditure on clinical health R&D should be devoted to maximise welfare. Finally, I assume that the disease composition of OECD clinical health R&D is welfare maximising, and thus corresponds to the above algorithm for the OECD.[2]

Two indexes are outlined to proxy the above algorithm. If the effectiveness of treatment of disease is assumed to be equal across different types of disease, then

[1] It is possible in future work to control for increasing returns by including in the analysis. clinical health knowledge, measured using R&D capital stock variables.

[2] Its plausible that economic forces result in the composition of OECD expenditure on clinical health R&D corresponding to the demand for clinical health R&D in the OECD.

the algorithm is equal to the number of individuals which suffer from the disease. This is proxied by pharmaceutical consumption. This implies that Australian expenditure on clinical health R&D should be directed to improving the treatment of diseases for which Australians consume an absolute and relatively large quantity of pharmaceuticals compared to the OECD.

If it is assumed that treatment of disease is perfectly effective if nobody dies from the disease, then the algorithm is equal to the number of deaths or potential years of life lost. This implies that Australian expenditure on clinical health R&D should be allocated to diseases from which Australians suffer an absolute and relatively high rate of mortality or premature mortality compared to the OECD.

3. Data

OECD Health Data 98 includes estimates of pharmaceutical consumption measured by 'defined daily dosage' (DDD) as defined by the World Health Organisation (WHO) Collaborating Centre for Drug Statistics Methodology. DDD provides a consistent measure of the volume of pharmaceutical consumption per thousand adult population across OECD countries. Pharmaceutical consumption is broken down between 21 Anatomic Therapeutic Classification (ATC) categories, defined on the basis of a pharmaceuticals site of action and therapeutic and chemical characteristics.

OECD Health Data 98 also contains time series of the number of deaths and potential years of life lost by people who die prematurely per 100 000 population by main International Classification of Diseases (ICD) categories from 1960 to 1996 for OECD countries. Estimates of potential years of life lost are derived by weighting mortality statistics by the difference between the age of death and 70 years of age. For mortality the estimates are disaggregated by gender and between 34 disease categories, some of which are minor aggregates. Estimates of potential years of life lost are disaggregated by gender and by 13 disease categories.

Small adjustments made to these time series in the current analysis are explained below. Generally, some ICD categories which do not contribute significantly to mortality or which are not treated by consuming pharmaceuticals are omitted due to the paucity of the data. For the same reason some OECD countries are omitted from the calculation of a population weighted OECD average. Further, minor aggregates are omitted and an 'other' category derived to represent residual mortality not measured at the lowest level in the disease classification. Finally, mortality statistics which are defined in terms of the population of one gender, such as Neoplasm of the breast, are divided by two so that they are consistent with other statistics defined in terms of the total population.

4. Methodology

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I begin by outlining the average annual daily dosage of pharmaceuticals by therapeutic category in Australia between 1990 and 1996 for which data is available. Time series of pharmaceutical consumption in Australia are available for 19 of the 21 therapeutic categories, with Corticosteroids and Morphine consumption being unavailable.

Secondly, a forecast of pharmaceutical consumption in Australia at 2000 is produced using an estimated time trend derived by regressing each time series of pharmaceutical consumption by therapeutic category against a constant and time over the 1990-96 time period. Both linear and non-linear functional forms were tried, with the functional form with the highest R squared (generally between 0.8 and 0.9) settled upon. In general, a linear functional form produced the best results for therapeutic categories of pharmaceuticals for which consumption was increasing during the 1990s, and a non-linear functional form was best suited for cases of declining consumption. The forecasts should be interpreted cautiously given the shortness of the time series which forms the basis of the forecasts.

Thirdly, the distribution of pharmaceutical consumption across 19 therapeutic categories between 1990 and 1996 in Australia is compared with the OECD. A reasonably complete set of observations of pharmaceutical consumption by therapeutic category during the 1990s is available only for six OECD countries. They are Australia, Denmark, Finland, Hungary, Norway and Sweden. Given the relatively small size of these countries a population weighted mean is unlikely to significantly improve the representativeness of the sample for the OECD population using a simple mean. Further, this would weight Australian observations relatively heavily. Hence, a simple OECD average is calculated to estimate the average annual daily dosage of pharmaceuticals by therapeutic category in the OECD between 1990 and 1996, and should be interpreted cautiously given the small number and size of the countries in the sample. The distribution of pharmaceutical consumption is calculated by dividing the 1990-96 average annual daily dosage of pharmaceuticals in each therapeutic category for Australia and OECD by the total 1990-96 average annual daily dosage of pharmaceuticals.

Index 2

I outline current and future estimates of the number of deaths and years of life lost due to premature mortality in Australia in 27 and nine disease categories respectively. Current estimates of each variable are represented by an annual average estimate for the 1992-96 period. Forecasts of mortality and potential years of life lost at 2010 are produced using an estimated time trend derived by regressing each mortality time series against a constant and time over the 1960-96 period. *A priori*, I am unable to justify a particular functional form of the time trend. Hence, I choose between functional forms on the basis of their in-sample explanatory power measured by the R squared of the regression. Similarly, the choice over the starting point of the observations used in each regression is

determined by the explanatory power of the regression. In most cases a sub-period of the mortality time series was used, suggesting that there are structural breaks in the series. All of the settled upon time trends were able to explain a good deal of the in-sample intertemporal variation, evidence by the R squared of the regressions being at least 0.9. Finally, in a few cases where no time trend could be detected forecasts were set equal to the average value of observations for the full period or a sub-period.

To compare the disease distribution of mortality and potential years of life lost in Australia with the OECD I first derive population weighted OECD time series of mortality and potential years of life lost from time series for individual OECD countries. Observations are missing across disease categories, and over time, in the mortality time series for some OECD countries. This means that I am forced to calculate population weighted OECD mortality time series using those nine OECD countries for which there is a complete set of observations for 23 major disease categories for each year between 1980 and 1995. These nine countries are Australia, Canada, Czech Republic, Germany, Hungary, Ireland, Italy, Mexico and United States. The current estimate is represented by an average annual estimate for 1992-95, while a forecast at 2010 is derived as outlined above.

Estimates of potential years of life lost by gender are more complete across OECD countries and over time than mortality because they are only disaggregated between nine and eight pharmaceutical R&D related disease categories for men and women respectively. This means that population weighted OECD time series of potential years of life lost for 1963 to 1993 can be derived using all OECD countries excluding Belgium, Iceland, Korea, Luxembourg, Poland and Turkey. The current estimate is represented by an average annual estimate for 1992-93, while a forecast at 2010 is derived as outlined above. The distribution of mortality and potential years of life lost for Australian and OECD across disease categories is calculated by dividing the estimate for each disease category by the sum of mortality and potential years of life lost respectively.

5. Results

Index 1

Figure 1 outlines the average annual daily dosage of pharmaceuticals in Australia per 1000 adults between 1990 and 1996 for 19 therapeutic categories of pharmaceuticals. This reveals significant variation in pharmaceutical consumption across therapeutic categories. There is relatively high consumption of Antiasthmatics and Diuretics, and relatively low consumption of Antiacids, Anticoagulants and Cardiac stimulants.

Figure 2 outlines forecasts of pharmaceutical consumption in Australia in 2000 for 19 therapeutic categories of pharmaceuticals. It reveals significant changes in the composition of Australian pharmaceutical consumption by 2000 reflecting significant variation in consumption trends over the 1990s across therapeutic categories of pharmaceuticals. For example, consumption of Diuretics is forecast to

fall significantly in the future, while the consumption of Antipeptic treatments, Psychoanaleptics, Cholesterol reducers and Antiasthmatics is forecast to increase significantly by 2000.

Figure 3 outlines the distribution of pharmaceutical consumption across 19 therapeutic categories of pharmaceuticals for Australia and the OECD between 1990 and 1996. This reveals that Australians consumed a relatively high level of Antiasthmatics, Diuretics, Antipeptic treatment, Systemic antibiotics and Cholesterol reducers compared to other OECD countries during the first half of the 1990s. Conversely, Australians consumed a relatively low level of Psychoanaleptics, Benzodiazepine, Analgesics and Hypotensives over the period.

Index 2

Figure 4 reveals that Heart disease, Neoplasms (cancer) and Diseases of the circulatory system are the largest cause of mortality in Australia, while Complications of pregnancy, Tuberculosis and Perinatal disease are the lowest. Figure 5 outlines forecasts of mortality in Australia at 2010 based upon historic trends. It indicates a significant increase in mortality in the future from various forms of cancer, Diseases of the circulatory system and Mental and behavioural disorders. However, forecasts relating to cancer need to be treated cautiously, since the increasing historic trend stopped over the last couple of annual observations, implying that forecasts based upon all but the last two observations might be misleading. The forecasts also indicate a significant decline in mortality in Australia from Heart disease, reflecting the significant decline exhibited in recent years. However, Heart disease is forecast to remain the largest cause of mortality in Australia at 2010.

The relative impact of various diseases upon mortality in Australia compared to the OECD is outlined in Figure 6. This reveals that Heart disease is a relatively large cause of mortality in Australia compared to the OECD, whereas Diseases of the circulatory system are a relatively small cause. Figure 7 outlines the impact of various diseases upon mortality in Australia and the OECD at 2010 based upon historic trends. This reveals that the above mentioned current differences in the causes of mortality between Australia and OECD are eroded in the future. The forecasts also reveal that Prostrate and Breast cancer and Mental and behaviour disorders will be relatively high causes of mortality in Australia compared to the OECD by 2010, reflecting relatively different historic trends. Similarly, the growing difference in the relative impact of Diabetes and Other infectious diseases might reflect limitations in the OECD time series. These series exhibit long cycles, evidenced by the time series of these statistics for Australia and incorporated in Australian forecasts. However, this cyclical behaviour is not incorporated in OECD forecasts because the OECD time series only begin at 1980.

Figure 8 outlines current and future estimates of potential years of life lost by Australian females by cause. It reveals that cancer, Disease of the circulatory system and Heart disease are currently the largest causes of premature female mortality, while Tuberculosis and Liver cirrhosis are the smallest. Further, it reveals that while premature mortality from Diseases of the circulatory system and Heart disease will decline significantly by 2010, the impact of Breast and Lung

cancer remain relatively stable over time, resulting in an increase in their relative impact upon premature mortality at 2010. This is due to the relatively small historic declines in premature mortality from these diseases.

The relative impact of various disease upon premature mortality of Australian women compared to the OECD is outlined in Figure 9. This reveals that Breast and other forms of cancer are relatively large causes of premature mortality of Australian women compared to the OECD, while Diseases of the circulatory system are a relatively small cause. Figure 10 indicates that these relative differences in the causes of premature mortality between Australia and OECD are going to widen by 2010 if premature mortality trends continue along historic time paths.

Figure 11 outlines estimates of current and future potential years of life lost by Australian males by cause. It reveals that cancer (presumably largely comprised of Prostrate cancer), Disease of the circulatory system and Heart disease are currently the largest causes of premature mortality of Australian men, while Tuberculosis and Liver cirrhosis are the smallest. Further, it reveals that while premature mortality resulting from Diseases of the circulatory system and Heart disease will decline significantly by 2010, the impact of cancer will remain relatively stable, thereby becoming the largest cause of premature mortality. This forecast is due to the relatively small historic decline in premature mortality from this disease.

The relative impact of various diseases upon premature mortality of Australian men compared to the OECD is outlined in Figure 12. This reveals that cancer and Heart disease are currently relatively large causes of premature mortality amongst Australian men compared to the OECD, while Diseases of the circulatory system and Liver cirrhosis are relatively small. Figure 13 indicates that relative differences between Australian and OECD men in premature mortality from Liver cirrhosis and Disease of the circulatory system will remain relatively stable in the future. Whereas, the relatively large impact of cancer upon premature mortality of Australian men is going to significantly increase by 2010. Conversely, the relatively large impact of Heart disease upon premature mortality of Australian men is going to be eroded away if premature mortality rates continue along historic time paths.

6. Priority Areas of Australian Clinical Health R&D

Assuming that the value of clinical health R&D corresponds to the number of individuals suffering from a corresponding illness, then the results outlined above suggest that a large share of Australian expenditure on clinical health R&D should be directed towards developing better antiasthmatics and diuretics, since these are clearly the most highly consumed pharmaceuticals in Australia. Further, consumption of the former is likely to increase significantly by the year 2000. Similarly, there is likely to be a significant increase in the relative consumption of antipeptic treatments, psychoanaleptics and cholesterol reducers in Australia in the future, suggesting that there should be an increase in the share of Australian expenditure on clinical health R&D devoted to improving such products.

However, the market for pharmaceuticals is global, which implies that foreign expenditure on R&D also benefits Australians. Hence, the evaluation of the optimal composition of Australian expenditure on clinical health R&D requires a global context. Importantly, except for Psychoanaleptics, each of the pharmaceutical categories consumed at a relatively high rate in Australia, plus Systemic antibiotics, are consumed at a relatively high rate in Australia compared to the OECD. This suggests that from an Australian perspective, assuming that the therapeutic composition of OECD pharmaceutical consumption influences the composition of OECD clinical health R&D, these categories of pharmaceuticals are likely to be under-represented in OECD clinical health R&D, and thereby should constitute larger shares of Australian expenditure on clinical health R&D than otherwise.

If the assumption that the treatment of disease is equally effective across different diseases is replaced with the assumption that the effectiveness of treatment differs, and corresponds inversely with the rate of mortality, then the value of clinical health R&D is equal to the number of deaths caused by the disease under investigation (assuming the marginal product of clinical health R&D is equal across diseases). Accordingly, the mortality statistics outlined above suggest that a large share of Australian expenditure on clinical health R&D should be devoted to improving the treatment of Heart disease. This is currently the largest cause of mortality in Australia, and while it is forecast to decline, it is expected to remain the largest cause of mortality at 2010.[3] Further, it is estimated to be a relatively large cause of mortality amongst Australians compared to the OECD currently and in the future.

Other major causes of mortality in Australia both currently and in the future are various forms of cancer, Disease of the circulatory system, Cerebro-vascular diseases, and Diseases of the respiratory system. Thus, a significant share of Australian expenditure on clinical health R&D should be devoted to improving treatment to these illnesses. Finally, in addition to Heart disease, Prostrate cancer and Mental and behavioural disorders are estimated to be relatively large causes of mortality amongst Australians compared to the OECD in the future, which implies devoting a larger share than otherwise of Australian expenditure on clinical health R&D to developing products which treat such illness.

The final and the most valuable statistic for evaluating the optimal composition of Australian expenditure on clinical health R&D is years of life lost. For females, the results outlined above suggest that various forms of cancer are currently and forecast to remain the major causes of premature mortality amongst Australian women. Further, these diseases are relatively large causes of premature mortality amongst Australian women compared to the OECD. This implies that a large share of Australian expenditure on clinical health R&D should be devoted towards developing products to treat various forms of cancer including Breast cancer.

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[3] Altering the composition of clinical health R&D may increase the rate of mortality from particular diseases than would have otherwise occurred in the same way as it may decrease the rate of mortality from others. However, estimating these effects is beyond the scope of the paper. Rather, the aim is to use mortality forecasts to identify important areas of clinical health R&D, while bearing in mind that reducing the share of R&D in one area to strengthen another may have negative as well as positive consequences.

For males, the results outlined above suggest that large shares of Australian expenditure on clinical health R&D should be allocated to developing products to treat various forms of cancer (presumably mostly Prostrate cancer) and Heart disease. These are currently the largest causes of premature mortality amongst Australian men, and the former is expected to remain the largest cause in the future. Further, cancer is currently a relatively large cause of premature mortality amongst Australian men compared to the OECD, and this trend is expected to strengthen in the future. Heart disease is also currently a relatively large cause of premature mortality amongst Australian men compared to the OECD, although this is expected to decline.

The final objective is to use these results to evaluate the existing composition of Australian expenditure on clinical health R&D. Figure 14 outlines Australian expenditure on clinical health R&D by organ/disease for 1996-97 and the average for 1992-93, 1994-95 and 1996-97. This represents R&D carried out in the higher education, private non-profit, state government and commonwealth government sectors of the economy. Thus, it excludes R&D carried out in the business sector because this is not available. A small part of the clinical health R&D carried out in the higher education sector was not classified to an organ/disease category and was thus omitted. Further, R&D in the higher education sector is only available for calendar years, which means making an additional assumption to produce estimates for financial years. For example, R&D expenditure for 1996 is used to estimate expenditure for 1996-97 by assuming that R&D carried out in the first half of 1997 is equal to R&D carried out in the first half of 1996.

Figure 14 reveals that the diseases responsible for a relatively large number of years of life lost (and a high rate of mortality) receive relatively large shares of Australian clinical health R&D. For example, Cancer and related disorders receive the largest share of Australian expenditure on clinical health R&D. Further, a relatively large share of expenditure is allocated to Cardiovascular system and diseases (corresponding to Heart disease and other Diseases of the circulatory system). However, the relative impact of cancer upon years of life lost still far outweighs its share of Australian expenditure on clinical health R&D.

On the basis of the extent of illness (proxied by pharmaceutical consumption), the low share of Australian expenditure allocated to the Respiratory system and diseases (including asthma) is problematic. As outlined above, Antiasthmatics are relatively highly consumed in Australia and relatively highly consumed in Australia compared to the OECD. Further, Figure 14 reveals a small share of Australian expenditure allocated to other relatively common illnesses such as Urogenital system (diuretics) and Digestive system disorders (antipeptic treatment).

Finally, Figure 14 reveals relatively large shares of Australian expenditure on clinical health R&D on three types of disease which do not rate highly using any of the criteria outlined above. These are Immune system and allergy, Nervous system and disorders, and Infectious diseases. Further, expenditure on each of these has increased over the 1990s. Hence, on the basis of the criteria outlined above, the share of Australian expenditure on clinical health R&D allocated to these diseases

should be reduced, and the share of expenditure allocated to cancer and asthma increased.

7. Conclusions

The paper sought to identify the areas in which Australian expenditure on clinical health R&D will deliver the greatest returns to Australians given the health characteristics of the Australian population, the effectiveness of existing treatment to illness, and the global nature of the pharmaceutical market. Given the theoretical and empirical complexities involved in such a study, it invoked a number of simplifying assumptions, which meant ignoring amongst other things the market return to R&D, and differences in productivity of clinical health R&D across diseases. Further, the study was based upon a very limited understanding of clinical health. Future research might focus on these issues.

The study found that Australian expenditure allocated to developing products to treat various forms of cancer, including Prostrate and Breast cancer, and Heart disease is likely to realise relatively high returns to Australians. These diseases are relatively large causes of premature mortality in Australia, and are relatively large causes of premature mortality in Australia compared to other OECD countries. Resources allocated to developing better Antiasthmatics are also likely to realise a relatively large return due to the the relatively large number of asthmatics in Australia.

Using these results to evaluate the existing composition of Australian expenditure on clinical health R&D revealed a number of changes that might improve Australian health and thereby welfare. Specifically, increasing the share of Australian clinical health R&D expenditure on cancer and asthma. Conversely, reducing the share of Australian R&D expenditure on the immune system, nervous system, and infectious diseases. Policy makers might consider these results when allocating public funds to clinical health R&D, and in the design of programs such as factor f meant to assist the development of a pharmaceutical industry in Australia.