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SUBMISSION TO HOUSE STANDING COMMITTEE ON ECONOMICS

Inquiry into Raising the Level of Productivity Growth in the Australian Economy

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CONTENTS

SUMMARY

- In recent years Australia's productivity growth has been only moderate in comparison with that of other industrialised countries.
- The rate of growth of productivity in the manufacturing sector has been particularly low, particularly in the period since 2002. It is largely for this reason that Australia achieves such a mediocre level of productivity growth.
- The rate of growth of productivity in the manufacturing sector appears to be strongly associated with the level of research and development(R&D) in that sector.
- Australia occupies the seventh lowest place among the 30 OECD member countries in terms of the proportion of GDP devoted to manufacturing R&D. Currently the proportion of Australia's GDP devoted to manufacturing R&D is one-third of the OECD average.
- There is a direct equivalence between expenditure on manufacturing R&D and the number of researchers in the manufacturing sector. In Australia's case $400,000 of R&D expenditure equates to one researcher year.
- An increase of Australian manufacturing R&D to the median OECD level would, broadly speaking, necessitate the provision of an additional 20,000 researchers. Assuming that the structure of Australia's manufacturing industry was largely equivalent to that of other industrial countries, about 16,000 of those researchers would be engineers.
- There are no strong reasons to doubt that Australia's ability to provide this number of engineers would be severely constrained by the relatively limited supply of new of engineering graduates in this country.
- The number of per capita new engineering graduates in Australia is the third lowest in the OECD region.
- Currently the number of new engineering graduates appears to be declining although it is difficult to be absolutely certain of this because of deficiencies in the statistical data emanating from the Department of Education, Science and Training.

1. INTRODUCTION

This submission addresses some aspects of items (h) and (i) of the terms of reference of the Committee's Inquiry into raising the level of productivity growth in the Australian Economy. Item (h) relates to "the level of resources devoted to research and development" (R&D) and item (i) relates to "the adequacy of resources devoted to the training and development of the labour force".

As the Committee is aware a general definition of productivity is the ratio of the amount of output of goods and services to the inputs of production. Labour productivity is the ratio of output to the input of hours worked by employees. Capital productivity takes account of inputs of machines or land. In this submission I will focus on labour productivity.

Generally, labour productivity is measured by one of two approaches. The first of these involves a calculation of the value of net sales less the cost of bought-in goods and services. The result of this calculation is referred to as Value Added. The other approach to estimating Value Added involves the estimation of the total of four quantities:

- Profit before tax;
- Total employee costs;
- Depreciation; and
- Amortisation

Some of these four factors would appear to be more easily controlled than others. For example employee costs may be reduced by reducing the number or the salaries of employees. One approach could be to increase profits by increasing the price charged for the products of the firm. In a competitive market this could only be successful if the products could maintain a high sales volume because of the attractiveness of the products to the buyers.

The attractiveness of products depends on sufficiently appealing features being designed into the products. Generally the introduction of competitive designs in consumer and industrial products results from research and development and industrial design unless the products are very simple in nature.

In the light of this it would appear to be likely that R&D could make a contribution to the profitability of producers and therefore to the level of value added of those firms. Other things being equal this would result in greater productivity. It is for this reason that one might expect that R&D in the manufacturing sector might have a positive influence on productivity growth. While some analyses have failed to find any such effect I believe that many of these analyses have failed because they have not disaggregated the variables to a sufficient extent.

The performance of R&D is labour intensive and expensive. It demands highly educated researchers with appropriate skills. As will be outlined in this submission the skills required are in the areas of engineering, the sciences and information technology. Contrary to the common perception, R&D in the manufacturing sector involves persons educated in engineering to a much greater extent than those educated in the sciences. It is for this reason that the very low level of professional engineering graduations in Australia might be a matter of concern to the Committee.

2. AUSTRALIA’S PRODUCTIVITY GROWTH

In recent years Australia’s productivity performance has been only moderate in comparison with that of many other industrialised countries. The OECD on-line data base indicates that in the period 2000 – 2008 Australia’s rate of productivity growth was less than the OECD average and approximately equal to the OECD median. A perusal of the comparative performance of industrial nations indicates that this lag is largely a consequence of the poor productivity performance of Australian manufacturing industry.

If our manufacturing sector had displayed the growth in productivity that has been achieved in many other OECD countries our aggregate productivity growth rate would have been more respectable. In a recent comparison between sixteen industrialised countries by the U.S. Bureau of Labor Statistics, only three countries exhibited lower growth rates in manufacturing productivity than Australia. In the period 2000 to 2007 Australia’s manufacturing sector has achieved a productivity growth rate of only 1.9% per annum. In contrast, countries such as Korea, Taiwan, and Sweden have demonstrated labour productivity growth rates of 7.6%, 6.4% and 6.0% respectively in the same period. Those countries have all devoted a much greater proportion of GDP to manufacturing R&D than Australia.

3. PRODUCTIVITY GROWTH IN MANUFACTURING

In recent years the rate of growth of productivity in Australian manufacturing has been lower than it was in the early 1990's. As pointed out in the preceding section, in the period 2000 to 2007 it has averaged 1.9% per annum. In 2005-2006 this rate had declined even further to 1% per annum.

The OECD publication "OECD Compendium of Productivity Indicators – 2006" states that :
The manufacturing sector has traditionally been main driver of aggregate productivity growth in OECD countries. ... (OECD, 2006)

Notwithstanding this it has not been the policy of Australian governments to seriously attempt to foster manufacturing until the advent of the current government.

Some industries display higher rates of productivity growth than others. The OECD has pointed out that :

Within manufacturing large differences can be observed. High- and medium –high technology industries ... such as machinery, electrical and optical equipment, chemicals and motor vehicles have typically experienced relatively high rates of productivity growth ... .Electrical and optical equipment is among the manufacturing industries with the highest rates of productivity growth. (op. cit.)

This suggests that the most effective way to increase manufacturing productivity would be to concentrate on fostering the high-tech and medium to high-tech manufacturing industries. Unfortunately the only medium -to- high tech industry that remains reasonably robust in Australia is the automotive industry. Such activity that had occurred in other high-tech segments of Australian manufacturing has declined to an almost insignificant level. This is reflected in the decline in the level of R&D expenditure in Australian manufacturing industry. While never very high in comparison with the level of performance attained elsewhere, it has declined to the point that Australia occupies the seventh last place in a comparison of 30 OECD countries.

4. THE CONTRIBUTION OF R&D TO MANUFACTURING PRODUCTIVITY GROWTH

The competitiveness of a manufacturing firm is dependent on it developing and producing innovative products that meet the needs of its customers in some unique way. The development of innovative products results from research and development.

Research and development (R&D) is normally described as consisting of three elements :

1. Basic research, which may be broadly defined as the disinterested search for knowledge;

2. Applied research which may be broadly defined as investigation undertaken to acquire new knowledge but that is directed to towards some specific practical purpose; and

3. Development (more fully experimental development and design) broadly defined as the design and development of products and processes for commercial purposes.

The very great proportion of R&D expenditure in the manufacturing sectors of industrialised nations as well as Singapore and Taiwan is devoted to the development component of R&D. Very little basic research is undertaken in manufacturing industries; universities are the major contributors to national basic research.

While basic research should be undertaken for a number of reasons, its performance has yet to be justified in terms of its contribution to economic growth of the performing nation. One has only to think of the American invention of the transistor and the laser. Asian nations such as Japan, Korea and Taiwan have benefited greatly from these two inventions, arguably to a much greater extent than the United States.

One study that I have undertaken investigated the contribution of basic research to the national economies of 17 OECD countries over a period of 22 years following the performance of that research. Statistical analysis showed that there was no significant contribution of basic research to the economies of those countries(Rice, M,R., 1993). From this one could conclude that Australia's long term strong performance in basic research may not be expected to be of very great advantage to the national economy and that increasing our basic research effort is unlikely to have benefits to Australia in the short term.

In an unpublished study I assessed the contribution of R&D in the manufacturing sectors of 16 OECD countries. The analysis indicated that there was a very strong association between the level of R&D and the rate of productivity growth in the period 1995 to 2007. The correlation coefficient was 0.77 which was statistically highly significant and indicated that 60% of the variation in the rate of productivity growth was attributable to manufacturing R&D. Other studies that I have undertaken have provided support to this proposition. For example I have demonstrated that there is a very strong association between the number of engineers and the number of patents in the United States.

An earlier study examined the relationship between the number of R&D personnel per million manufacturing employees and the rate of growth of productivity in 14 OECD countries over the period 1983 to 1989(op. cit.). The correlation coefficient was 0.64. That result was also statistically highly significant. I should add that the number of R&D personnel may be regarded as a proxy for the number of engineers and the level of R&D expenditure.

5. R&D IN AUSTRALIAN MANUFACTURING

In the mid 1990's Australia ranked 22nd out of 30 OECD member countries in terms of the percentage of GDP devoted to R&D in manufacturing. By 2004 we had slipped back to the next lower place. In 1996 Australia's manufacturing sector devoted 0.46% of GDP to R&D; by 2006 manufacturing R&D expenditure represented 0.36% of GDP or one-third of the average for the nineteen OECD countries for which data are available. This level of expenditure is no greater than the level attained in 1991. Bearing in mind the great increase in R&D expenditure by car manufacturers over the last ten years, the implication is that manufacturing firms in other sectors of manufacturing now expend even less, relative to GDP, than they did 15 years ago. Could this be one of the reasons for the decline in the rate of growth of productivity in Australian manufacturing?

If the relationship between R&D and the rate of growth of manufacturing productivity referred to in Section 4 above does in fact apply there would appear to be an argument for action on the part of governments to encourage a greater commitment to R&D by manufacturers, particularly in the higher tech industries.

In 2003 – 2004 the average level of expenditure on R&D in the 19 OECD countries for which data are available was 1.1% of GDP. As indicated above, the most recent figure for Australia is 0.36% of GDP and is one third of that average. If the Australian level of manufacturing R&D were to increase to the OECD average, the relationship demonstrated by my analysis would indicate, hypothetically that the consequent level of productivity growth would increase to 2.6% of GDP per annum.

Such an increase in R&D expenditure would generate an increase in the resources devoted to manufacturing R&D to an amount equivalent to 1.1% of GDP. Currently Australia's GDP is 1,084 billion dollars. Consequently the required increase in expenditure would be 0.7 % of GDP which is equivalent to approximately 7 billion dollars or $7,000 per annum per manufacturing employee. The current level of R&D expenditure is approximately $3,500 per employee. To put those amounts in perspective, in the United States manufacturing R&D expenditure is approximately $(A) 20,000 per employee in those manufacturing companies that undertake it. In the computer industry the level of R&D expenditure equates to over $50,000 per employee. In the pharmaceutical industry the figure is much higher at approximately $110,000 per employee. That is what Australian manufacturers are up against.

The foregoing has discussed the financial burden associated with an increase in R&D expenditure to a level that by any measure would represent a fairly moderate amount. Countries such as Taiwan, Finland and Sweden expend six to seven times the proportion of GDP on R&D in their manufacturing sectors as does Australia. Japan and Korea also commit similar proportions of their national income to this activity. It does not seem to have hurt their economies to have done so.

6. HUMAN RESOURCES IN MANUFACTURING R&D

R&D is, by its nature, labour intensive. The relationship between R&D expenditure and the required number of research personnel is such that a high proportion of the cost of doing R&D relates to wages and salaries. In the case of the manufacturing sector of the United States, manufacturing R&D expenditure per research engineer or scientist in 2007 was $(US)261,400. In 2006 the average salary of a electronic engineers was between $(US)89,000 to $(US)93,000 and that of mechanical engineers was $(US)84,000. I estimate that the average salary of technical support personnel would be 50% to 60% of that of research engineers. There would be rough parity in the numbers of researchers and their support personnel so that the total wages cost per researcher would be of the order of $(US)140,000 per researcher. That represents over 50% of the total cost per researcher for R&D in the American manufacturing sector.

In Australia direct labour costs represent 42% of the total cost of R&D (ABS, 2008). The total outlay on R&D per manufacturing researcher is equivalent to approximately $400,000 or $(US)328,300). Surprisingly this is greater than the equivalent figure for America. Considering the much higher salaries of American engineers, the disparity is difficult to explain in the absence of an analysis that is beyond the scope of this submission.

The equivalence between expenditure on manufacturing R&D and the human resources required to undertake it implies that an increase in expenditure would entail a commensurate increase in the number of researchers. On the basis of the current cost of $400,000 per researcher, an increase of 1% of GDP in manufacturing R&D would equate to the deployment of an additional 27,000 researchers approximately.

So far as the major industrialised countries are concerned, the great majority of researchers in manufacturing are engineers. Principally, they are electronic and mechanical engineers. This may be determined relatively easily by indirect or direct methods. In 2007 in the United States there were 717,100 researchers in the manufacturing sector. At that time that sector employed approximately 34,000 chemists, 1,100 physicists and 11,900 biologists or a total of 47,000 scientists. There were also 120,200 computer software engineers (information technologists). Even if all of these personnel were engaged in R&D activities, a most unlikely situation, more than 75% of researchers were not scientists or information technology specialists. It is therefore reasonable to conclude that at least 75% of the researchers were engineers. This finding is consistent with data that may be ascertained for several other countries. This issue has been discussed in more detail in other publications such as a study that I undertook some time ago (Rice M.R, 1994).

If, for the sake of argument, one were to seek to increase the level of manufacturing R&D in Australia to a level equivalent to that attained in the average OECD country, that is 1.1% of GDP, the required incremental increase would, as indicated in the forgoing, be 0.74% of GDP. If Australia’s industrial structure were to replicate that of other nations that would imply an increase in the number of researchers of approximately 20,000 researchers. That number has been estimated on the basis of the above assumption that an increase in R&D of 1% of GDP would imply an increase of 27,000 and then proportioning the number appropriately. Of those 20,000 researchers approximately 16,000 would need to be electronic and mechanical engineers.

The issue that needs to be addressed is whether, at current graduation levels, Australia would have a sufficient number of engineers with the qualifications in the appropriate specialisations, that is electronic and mechanical engineering, to enable the immediate fulfilment of a target of 20,000 additional researchers. Clearly, meeting of the additional requirement for science graduates would not present great difficulties. Currently more than 11,600 Australians graduate per year with qualifications in the natural sciences, a level that, relative to population, exceeds that of any other country. Countries such as the United States, Finland, Sweden and Korea have no difficulty maintaining their very high levels of R&D while producing one third to one half as many science graduates per head as Australia.

In the case of engineers there would be considerable difficulty in providing for any marked expansion of the number of engineering researchers in the manufacturing sector. Currently Australia graduates approximately 5,000 engineers each year. Relative to population that number of Australian engineering graduates is third lowest in the OECD. Of those5,000 graduates, 2,500 to 3,000 are electronic, electrical and mechanical engineers. Thus the requirement for a notional increase in R&D expenditure of 0.74% of GDP would require five to six times the number of electrical, electronic and mechanical engineers graduating each year. Bearing in mind that the economy requires many of the mechanical and electronic/electrical graduates for other engineering functions than R&D and that losses from the engineering profession are accelerating because of the demographics of that profession, there would seem to be little hope of achieving the required increase in the immediate future. I have pointed this issue out in submissions to various parliamentary inquiries (Rice, M.R., 1993; Rice, M.R., 1995; and Rice, M.R., 2001). If action had been to taken to alleviate a situation that was quite predictable many years ago the shortage of engineers that Australia has faced and will continue to face would not be so serious.

I should add that the problem cannot be rectified by the substitution of science graduates for engineers any more than university scientific research may be substituted for the type of R&D undertaken in the manufacturing sector. The formation of engineers is entirely different from that of scientists with the result that scientists are not capable of undertaking engineering design and development functions without considerable further education and subsequent on the job training. The U.S. Defense Department sponsored a study (National Science Foundation,1984) that among other things, demolished the argument that scientists could be readily substituted for engineers.

The fact that action to attract more students to engineering courses will not produce significant results for several years should not be regarded as a justifiable excuse for inaction. The problems arising from a continuing shortage of engineers will, in the future, not only continue to inhibit the expansion of industrial R&D but may well act as a constraint on the preservation of such R&D at the prevailing level.

7. CONCLUSION

The reasons for Australia's relatively low level of manufacturing R&D require investigation. There has even been an apparent decline in the level of R&D in some segments of manufacturing industry. Strangely, it appears that this feature of our economy has yet to be recognised let alone acted upon.

Some commentators have justified the mediocre level of manufacturing R&D in Australia on the basis of the structure of our industries. I have two comments to make regarding that belief. First, even when allowance is made for the poor representation of high-tech industries in this country, the level of R&D activity compares badly with the expected level that would result from an industry by industry comparison with other countries. Second, the attitude reflected in such comments, indicates that acceptance of the status quo should continue to prevail.

Australia's failure to recognise the contribution that manufacturing industry makes to national economic well-being as well as employment in other sectors of the economy has led to inattention to the vital topic of manufacturing R&D. Whereas the great majority of industrial nations have increased their level of commitment to manufacturing R&D Australia has done the reverse. This is not likely to increased the competitiveness of Australian products.

In addition, the general unawareness of the crucial contribution that engineers make to manufacturing R&D in other countries has resulted in a lack of concern regarding the inadequacy of the supply of engineers with the appropriate education and skills for the performance of R&D in the manufacturing sector in Australia. Furthermore, any attempt to expand manufacturing R&D would be likely to be constrained by the lack of suitable professional engineering human resources. In fact it might very well prove to be difficult to maintain the level of R&D at the prevailing 0.36% of GDP.

Policy moves to encourage high-tech manufacturing industries and the concomitant R&D expenditure would need to go hand in hand not only with measures to encourage more students to embark on professional engineering studies but also the consideration of the adequacy of the engineering education system to cope with the expanded human resource requirements.

At present, the engineering education system is under strain. Staff-student ratios have been declining for many years. This situation has not been helped by the influx of . foreign engineering students. Nearly 30% of graduates in the educational field of "engineering and related technologies" are overseas students.

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