CAN SCIENCE DRIVEN INNOVATION ENHANCE REGIONAL ECONOMIC PROSPECTS?

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ABSTRACT: The Waikato Innovation Park aims to be a primary driver in positioning Hamilton and the Waikato as a globally competitive region, and as a pre-eminent centre in New Zealand for life science and high-technology industries, as well as knowledge-based economic development. The Waikato region accounts for 8 percent of the New Zealand economy but it has been losing out to other parts of the country. This paper seeks to assess whether establishment and successful management of an innovation park will significantly increase the rate of economic activity in life science and high-technology industries in the Waikato region. The analysis uses project plans and cost data along with an economic model of the region constructed from data originating with Statistics New Zealand. The regional economy has been categorised into 87 sectors which capture all economic activity along with imports into and exports out of the region. The model provides detailed information on the structure of the regional economy and the regional impact of the Waikato Innovation Park in terms of both input-output and net present value analysis.

1. INTRODUCTION

The idea that science driven innovation can enhance regional economies is popular amongst many scientists and regional development advocates. The concept is given credence by successful industrial clusters such as Silicon Valley (Saxenian, 1991), science based clusters around Cambridge, England (Castells & Hall, 1994) and biotechnology clusters in Germany, the United Kingdom and the USA (Cooke, 2002). However the challenge for analysts is to evaluate the possibility of successful regional development flowing from proposed developments of this type. This paper takes up the challenge by evaluating the Waikato Technology Foundation's (WTF) proposal to establish the Waikato Innovation Park (WIP) on land close to the University of Waikato, in Hamilton, New Zealand. The park is intended to support the commercialisation of technology by creating an environment which fosters technology-driven enterprise development. It aims to foster the creation of consortia between

businesses and research organisations and to provide support and accommodation for start-up businesses in a technology incubator (Arrow International, 2000, p. 63).

The Waikato Technology Foundation was founded in 1988 with the goal of creating a superior environment in Hamilton for generating, accessing and transferring technology. This was to be achieved through the establishment of a science park. The WTF decided that any development of this type should be located next to the research organisations and the university rather than in any of Hamilton's business or industrial zones. In 1989, the WTF successfully sought to have 35.4 hectares of land zoned as a 'science and technology park'. A detailed science park proposal was completed in 1990, but uncertainty over ownership of the land stymied progress at that time. In 1996 a feasibility study was completed, however unresolved issues relating to the proposed site and other matters meant that only limited progress was made until 1999. Renewed interest in the Waikato Innovation Park was sparked by the dairy industry's decision to invest $150 million in biotechnology research over five years. It also became clear that there were a significant number of companies who would be keen to locate their businesses on a science park. A detailed feasibility study was undertaken in 2000 (Arrow International, 2000) followed by an economic evaluation of proposed funding (Marsh et al., 2001). Sufficient funding and a suitable site next to the Ruakura research centre were eventually secured, construction started in 2003 and phase 1 was finally opened for business in 2004.

The idea that businesses can receive major benefits from being located in what are now called clusters is not at all new (Marshall, 1920). Since then much work has been done to investigate the determinants of cluster success and the benefits that firms gain from clustering together namely economies of intra-industry specialisation, labour market economies, enhanced communication among firms (and other organisations) and public inputs tailored to the particular needs of local industries (Baptista, 1998). Science parks may be seen in part as an attempt to create clusters in order to enable more firms to receive these benefits.

The case for science parks is also based on the assumption that technological innovation stems from scientific research and that Parks can provide an environment that encourages the transformation of 'pure' research into production. Networking of firms engaged in related research and sources of novel scientific knowledge in universities and public research facilities plays an important role in this process. Science parks also provide a variety of other business support services (e.g. incubator facilities, venture capital and mentoring) which aim to reduce business failure rates and help businesses to grow.

Given this view of innovation the case for the WIP assumes that growth of high-technology industries and commercialisation of research and technologies in the Waikato Region is constrained by insufficient cooperation and interaction between businesses, universities and research organisations; by lack of accommodation of a type, cost and location that encourages this interaction, and by a lack of support of the kind which will be provided in the proposed incubator

and park. This paper seeks therefore to address the implied hypothesis: that a mix of measures, including establishment and successful management of WIP, will address the above constraints, and in doing so will significantly increase the rate of economic activity in life science and high-technology industries in the Waikato region.

The remaining sections of this paper describe the conceptual framework for our analysis (Section 2), followed by a review of the rationale for science parks (Section 3) and some background information about the Waikato Region (Section 4). Sections 5 and 6 explain our economic model of the Waikato Region and its application to investigate the impact of the WIP.

2. CONCEPTUAL FRAMEWORK

The framework for our analysis is applied benefit cost analysis (BCA). We identify all the benefits and costs that occur in the region – both direct (e.g. rental and employment income) and indirect flow-on effects and seek to identify the determinants of those benefits and costs. This process draws heavily on an understanding of how science parks work, an understanding of the regional economy and the empirical information available concerning both the WIP and the regional economy.

In seeking to come up with a robust methodology by which data could be obtained and analysed in a limited time frame, this study combines the advantages of conventional BCA and input-output analysis. The advantage of benefit cost analysis is that it produces results which can be understood by many people. The language of net present values and internal rates of return is widely used and accessible. The main difficulty lies in identifying ways to accurately estimate benefits and costs. Regional input-output analysis enables us to characterise the flow of economic activity through a region and reveal linkages. It has the disadvantages that the underlying model is never completely up to date, and although the models produce quantitative results, they are hard to interpret given that they do not have the same benchmark characteristics as a net present value or internal rate of return.

Using a combined approach we present the results of a benefit cost analysis which draws on the regional input output analysis to come up with estimates of indirect benefits. These indirect benefits when combined with the direct benefits and costs allow the calculation of total benefits and costs for the region. In this way the study provides evidence about both value added in the region and the efficiency with which this is obtained.

3. THE RATIONALE FOR AND SUCCESS OF SCIENCE PARKS

There are now more than 500 science parks world wide, and the numbers continue to grow. There is some scepticism in the literature as to whether they have been good investments, but there is also continuing enthusiasm for them and a concern that failure to develop this type of link between research and industry exposes whole regions to the risk of being bypassed by new developments. Table 1 summarises some of the main purposes of science parks.

Table 1. Purposes of Science Parks

Purpose/ Identified by:	1	2	3	4	5	6	7
Local development	✓	✓	✓	✓		✓	✓
Job creation	✓	✓		✓	✓	✓	✓
Spin off companies		✓		✓	✓		✓
Attract high tech companies		✓	✓				✓
Promote synergies			✓	✓			✓
Technology diffusion		✓			✓	✓	✓
Improved regional profile				✓		✓	✓
Raise university income			✓				

Source: 1 Dekker (1985), 2 Kirk & Jackman (1996), 3 Lowe (1986), 4 Luger & Goldstein (1991) , 5 Monck et al (1988), 6 OECD (1987), 7 Westhead & Batstone (1999).

The outcomes of science parks worldwide have been extremely varied. A few have been spectacular successes, and many modest regional science parks also appear to have been worthwhile. For instance: *"50 per cent of start-ups fail, and 50 per cent of surviving parks change their focus"* (Luger & Goldstein, 1991, p. 181). Table 2 shows some of the most frequently identified ingredients for success. Highest on the list is the necessity for one or more local universities, preferably with a strong science and technology component, for example: *"the primary driver is the presence of a top research university. People like the environment in Cambridge and can tap into the University's knowledge base very easily…"* (Fairbrother quoted in Anon, 1999) and *"the most successful parks are those where there is a strong relationship between park management – whether private or local authority – and the associated higher educational institute (HEI), and where the latter is closely involved in management"* (Sunman, 1987, p. 19).

Different authors emphasize different measures of success, and these are summarized in Table 3. Broadly they divide into those who view success in the long-term outcomes of regional development and job creation, and those who concentrate on technology diffusion and the creation of synergies.

Success is partly determined by government policy. The 1999-2002 Coalition Government in New Zealand put significant stress on science policy interventions and defined four goals for research, science and technology that focussed on the development of capacity to innovate, enhancing enterprise competitiveness, maintenance of a healthy environment and the development of 'social capacity'[1] (Foundation For Research Science and Technology, 2000). The Labour led government has continued to focus on innovation and in 2002 released the Growth and Innovation Framework (GIF), which aims to deliver the long-term sustainable growth necessary to improve the quality of life of all New Zealanders. The 2004/5 budget allocated NZ$34 million for initiatives aimed at achieving the goals of GIF. Funding was split between the innovation,

[1] "*a society in which all New Zealanders enjoy health and independence and have a sense of belonging, identity and partnership*".

international connection and skills and talent themes (Ministry of Research Science and Technology, 2004). Funding for technology and cluster initiatives such as science parks is also channelled through New Zealand Trade and Enterprise[2], which in 2002 provided funding for phase 1 of the WIP.

Table 2. Ingredients of Success

Factor Identified by:	1	2	3	4	5	6	7	8	9
Local commitment		✓		✓		✓			
Local university	✓	✓	✓	✓	✓	✓	✓	✓	✓
Major research facilities			✓	✓	✓	✓			
Developed infrastructure		✓		✓		✓			
Image and prestige	✓			✓			✓		✓
Major airport close by	✓			✓		✓			
Good transport links	✓			✓			✓		✓
Skilled labour supply	✓		✓	✓	✓			✓	✓
Skilled management				✓					
Start up capital				✓					
Significant industry interest		✓		✓					
Diversity of local industry				✓					
Close to economic nodes	✓					✓			
Pleasant place to live		✓	✓		✓			✓	
Cost of premises	✓						✓		
Key founder locally based	✓						✓		✓

Source: 1 Bathelt & Hecht (1990), 2 Bower (1992), 3 Cox (1985), 4 Kirk & Jackman (1996), 5 Lowe (1986), 6 Luger & Goldstein (1991), 7 Monck et al. (1988), 8 OECD (1987), 9 Westhead & Batstone (1999).

Table 3. Measures of Success

Measure/ Identified by:	1	2	3	4	5	6
Job creation		✓	✓			✓
Local development	✓			✓		
Attraction of private investment	✓	✓			✓	
Take-up of leases					✓	
Number of spin-offs	✓	✓				✓
Failure rates	✓					
Expansion of young firms	✓					
Reasons for moving	✓	✓				
Increased university income	✓					
Increased reputation	✓					
Company/university interaction		✓			✓	
Technology diffusion		✓	✓	✓		

Source: 1 Bower (1992), 2 Varga (1998), 3 Dept of Industry, Technology and Commerce (1989) , 4 Joseph &Saunders (1992), 5 Lowe (1986), 6 Shearmur & Doloreux (2000).

[2] New Zealand's Economic and Trade Development Agency.

4. THE WAIKATO ECONOMY

The Waikato region has traditionally been one of New Zealand's most productive primary regions. Waikato Maori supplied the Auckland region and even Sydney with vegetables and other food in the mid-nineteenth century. Currently dairy farming and processing is the major activity and directly and indirectly accounts for 30 percent of the region's gross regional product. Productivity in dairy farming has increased significantly with an annual growth rate of 2.8 percent over the ten years to 2004 (Dexcel Limited, 2004). At the same time average farm supply to Fonterra[3] increased from 38,000 kg of milk-solids in 1991 to 92,000 kg in 2000 an increase of about 9 percent per year over the period.

New Zealand's GDP for the year ended March 2005 was $149.2 billion of which an estimated $12.5 billion or 8.4 percent originated in the Waikato. The Waikato Region represented 8 – 9 percent of the New Zealand economy in 2005, whether measured by population (9.4 percent), gross regional product (8.4 percent) or retail sales (8.8 percent). See Table 4. This proportion has been falling in recent years as other regions, particularly Auckland have grown faster.

Table 4. Relative Importance of Waikato for the New Zealand Economy

	NZ	Waikato	Waikato (% of NZ)
Population (June 2005)	4,098,90	384,800	9.4%
GDP or Gross Regional Product (Year to March 2005)	149.2	12.5	8.4%
Retail Sales (Year to March 2005)	56.09	4.96	8.8%

Source: Statistics New Zealand and input-output model data.

Analysis of key economic indicators suggests that the Waikato region is falling behind neighbouring regions. Over the five years to 2005 annual population growth was 2.4 percent in Auckland and 1.3 percent in the Bay of Plenty but only 1.0 percent in the Waikato; below the national growth rate of 1.4 percent. Similar trends are revealed in employment and retail sales where growth rates for the Waikato region are below the New Zealand growth rate and significantly below the competing regions of Auckland and the Bay of Plenty. Unless the Waikato can raise its performance, new initiatives will be required to restore comparability with neighbouring regions. However existing capacity in the building, manufacturing and engineering sectors together with high-level educational and research institutions endow the region with many of the necessary skills to leverage investments in business areas seen as having growth potential.

Regional prospects are strongly influenced by attributes such as; natural

[3] Fonterra Co-operative Group Ltd is a multinational company owned by 11,600 New Zealand dairy farmers.

resources, human capital, location, infrastructure, cost factors, quality of life and recent economic performance. Each of these attributes influences the propensity for firms to invest in a region and for people to come to a region and stay there. They are also factors that may be impacted by the WIP. Table 5 characterises the Waikato region in terms of the some of the key location factors identified by Hodgkinson et al (2001). The advantages and disadvantages indicate where some of the challenges lie in encouraging investment in the region. The potential impact of the WIP reveals the extent to which it may take opportunities and address regional disadvantages.

Table 5. Waikato Region Strengths and Weaknesses

Factor	Advantages	Disadvantages	Impact of WIP
Natural resources	Land, agricultural, & forest resources, Hydro and geothermal resources	Limited growth prospects for these sectors	Limited impact but potential for significant new developments leveraged off old technology
Human capital and labour resources	Significant number of University and polytechnic graduates	A limited number of high value added jobs	Increased opportunities support a broader skill base and easier retention of critical skills
Locational factors	Half NZ population within 2 hours drive	Difficult commute to Wellington and SI Many specialists in Auckland – not Hamilton	Minimal effect due to limited impact on manufacturing and trade in short term
Cost and infrastructure factors	Relatively inexpensive land and buildings Good utilities	Not yet the critical mass of related activity to maximise growth rate	Immediate enhancement at the WIP with gradual enhancement city wide
Quality of life factors	Good schools Minimal congestion problems	Limited city life (though growing fast)	More high value added jobs will lead to more social amenities.
Recent economic performance	Opportunities for improvement exist	Slow growth in GDP and employment	WIP focuses on sectors with higher growth potential

5. AN ECONOMIC MODEL OF THE WAIKATO REGION AND ITS APPLICATION

An economic model of the region was constructed using data originally compiled by Statistics New Zealand in the form of a national input-output table for the year to March 1995. Regional tables were derived using a 177-industry

level of disaggregation and the tables were then re-aggregated into 87 industries for all regions. Changes in labour productivity and labour cost over the 1995-1998 period were used to update the model to the 1998 year. The change in the All Groups CPI over 1998-2000 was used to update prices. The resulting model, used to derive results presented here, depicts 1998 technology at 2000 prices.

The regional economy is categorised into 87 sectors. These comprise the farming sectors such as dairy farming, beef farming and sheep farming etc. as well as horticulture, fruit growing and cropping sectors. Sectors related to these farming activities are fencing, livestock services and topdressing etc. Related follow-on sectors that are important for the Waikato region are livestock processing and dairy manufacturing. Altogether, there are 44 such manufacturing sectors in the model including metal products, machinery, wood mills, clothing and shoes etc. The three utility sectors are electricity, gas and water. Construction is sub-divided into three sectors. Finally, the model uses 27 sectors covering wholesale and retail trade, accommodation, 7 transportation sectors, 8 finance and business service sectors, central and local government sectors as well as education, health, welfare, and recreation sectors. All economic activity in the region is captured in one of the 87 sectors of the model along with imports into and exports out of the region involving other New Zealand regions or overseas countries.

This comprehensive input-output model is one of a class of general equilibrium models. Each sector in the model quantifies the inputs it receives from other sectors in order to produce a given quantity of output (good or service) in a given period. Also quantified are the inputs of labour and capital equipment needed to produce the given output level. The model can be used to analyse the factors that limit sectoral growth and can provide detailed insight into the structure of the regional economy and the impact of change in one sector for related sectors and for the regional economy as a whole. Consequences for regional employment and income from major changes such as a significant rise or fall in agricultural exports can also be examined.

In this paper the model is used to examine the implications for the region of a major new development such as the Waikato Innovation Park. The model is focused on economic impacts using the following variables: total sales or output, net household income after tax, superannuation and savings, value added for the region and employment in full-time equivalents.

The research sector in the model most closely resembles the expected activities in the Waikato Innovation Park. This comprises all Crown Research Institutes in the region such as those located at the Ruakura Agricultural Centre (adjoining WIP), the National Institute of Atmospheric and Water Research, Landcare Research and similar organisations. Linkages between research and the other 86 sectors of the economy comprise inputs from these sectors into the research sector or services demanded by the other 86 sectors from research. Accordingly, two types of linkages can be estimated. First, the dollar value backward linkage can be estimated for any sector. This measures the impact in the economy resulting from an increase/decrease in the output of the sector in question. The higher this value, the more valuable is the sector as a driver of the

economy in question. For example, if research output increases by $1 the model can estimate the total dollar value of output required from other sectors as inputs into research to bring about the $1 research output increase.

Secondly, the dollar value forward linkage can be estimated for each sector. This measure estimates the value of a sector as an input producer for other sectors in the economy. The higher this value, the more valuable this sector is for the regional or national economy in question. Alternatively, the higher this value is, the greater the chance that this sector could be a constraining sector on economic growth. The highest linkage values for the Waikato economy and the corresponding values for the New Zealand economy are listed in Table 6.

Table 6. Backward and Forward Linkages in the Waikato Economy

Backward Linkages			Forward Linkages		
Sector	Waikato	NZ	Sector	Waikato	NZ
Research	2.72	4.70	Electricity	3.49	4.08
Building	2.41	3.10	Water	3.35	1.21
Ham & Poultry Process	2.36	3.75	Finance	3.24	4.36
Dairy Manufacturing	2.35	3.45	Insurance	3.23	4.10
Meat Processing	2.22	3.53	Communications	3.08	3.59
			Research	1.01	1.06

Note that the ranking in Table 6 is determined by the Waikato economy. The corresponding NZ values are shown for comparison purposes. For backward linkages, the New Zealand values must necessarily be at least as great as the Waikato values. This is not true for the forward linkages. For example, the water sector's forward linkage for Waikato is much higher than for New Zealand. Water is therefore a more valuable sector for the Waikato region than for New Zealand generally. Table 6 shows research to be the least valuable sector for both the Waikato and New Zealand economies as an input producer. However, it is the most valuable sector in the Waikato economy as an output driver, even exceeding building which is usually one of the highest driving sectors of any economy. This is a somewhat unexpected result and may derive from historic activity in Waikato's research sector. It may not necessarily be replicated for activities proposed for WIP.

The economic impact of research is detailed for both output and value added in Table 7. It can be seen that if research output increases by $100, then in the Waikato economy, output of $17.42 is required or stimulated in the 'other livestock & arable farming' sector. Cleaning services must also increase output by $7.11 and total resulting regional output including the original $100 from research is estimated at $272.49. Note that 272.49/100 or 2.72 is the backward linkage for research in Table 6. Similarly, a $100 output increase in research results in a value added increase of $35.91 from this sector and value added in Waikato gross regional product increases by $118.24.

The relative profitability of selected sectors in the Waikato economy is detailed in Table 8. The data are derived from 1995 data, adjusted for inflation and scaled to reflect employment changes from 1995 to 2000. The data can be

summarised as '1995 technology at year 2000 levels'. The data do not include some significant developments, for example, the lower NZ dollar in 2000 and the higher dollar value output for the export sectors that resulted. Profitability per FTE in these sectors for 2000 is therefore likely to be understated. The profitability of each sector is shown as Value Added per FTE. This figure covers the gross salary of a FTE employee plus his/her contribution to gross operating surplus before tax and depreciation. This figure is higher for capital intensive sectors such as electricity ($329,550) as compared to more labour intensive sectors such as restaurants ($36,468). For the restaurant sector, much use is made of (relatively unskilled) part-time labour so the equivalent FTE salary before tax is low. Similarly, in the 'wholesale & retail trade' sector VA/FTE is a relatively low $45,378. As expected for the Waikato region, sectors such as forestry and dairy manufacturing show very high profitability. Note that research sector profitability (akin to activity in a science park) is a very low $22,828. The restructuring of this sector that commenced in 1991 has almost certainly raised this figure significantly. In our analysis of the distribution of benefits from WIP operations we have estimated outcomes using the Waikato's Advertising & Business Services sector as a model. We believe that this leads to better estimates for WIP than using historic data for the Waikato research sector.

Table 7. Detailed Waikato Linkages for Research

Output			Value Added		
Sector	$	%	Sector	$	%
Research	100.00	36.7	Research	35.91	30.4
Other Livestock, Arable	17.42	6.4	Other Livestock, Arable	6.04	5.1
Wholesale & Retail	17.00	6.2	Wholesale & Retail	9.18	7.8
Real Estate Services	10.48	3.9	Real Estate Services	7.27	6.2
Cleaning Services	7.11	2.6	Cleaning Services	4.38	3.7
Ancillary Construction	8.92	3.3	Health Services	3.03	2.5
Other 81 Sectors	111.56	40.9	Other 81 Sectors	52.43	44.3
Total 87 Sectors	272.49	100.0	Total 87 Sectors	118.24	100.0

6. REGIONAL IMPACT OF PROPOSED SCIENCE PARK

Our economic model of the Waikato economy is now used to estimate the economic impact of the Innovation Park. This impact is derived from the assumption that WIP will stimulate the creation of new technology based business. This may be in the form of new starts ups and spin off companies, new activities by consortia including research organisations, universities and other enterprises or new anchor tenants attracted by the locational advantages of New Zealand and WIP. Table 9 provides data relating to proposed building areas and staffing levels over the three stages of operation of the WIP. All data and prices relate to 2000/01 – the year in which this evaluation of the impact of WIP was initially carried out.

Table 8. Profitability of Selected Sectors and Sector Groups

	Total Sales	Sector Cost	Imports	Value Added	Employ-Ment	Sales Per FTE	VA Per FTE
	$m	Sm	$m	$m	FTE	$/FTE	$/FTE
Sheep Farming	146.69	54.10	30.59	62.00	1786	82133	34714
Dairy Farming	1398.83	484.98	213.45	700.40	14295	97854	48996
Beef Farming	196.72	60.01	59.39	77.32	1583	124270	48844
Agricultural Services	153.45	35.81	28.95	88.69	3150	48714	28156
Forestry & Logging	1122.14	495.51	114.54	512.09	1965	571064	260606
Forestry Services	12.79	6.25	3.50	3.04	35	365429	86857
Mining	171.33	59.42	33.70	78.21	910	188275	85945
Dairy Manufacturing	1397.82	973.51	183.93	240.38	1978	706684	121527
Wood Production	1639.82	827.33	320.32	492.17	4880	336029	100855
Electricity	535.27	220.89	116.65	197.73	600	892117	329550
Construction	1890.28	1006.78	437.53	445.97	10890	173579	40952
Wholesale & Retail	1676.35	472.46	298.60	905.29	19950	84028	45378
Restaurants & Cafes	381.84	123.20	93.44	165.20	4530	84291	36468
Education	356.85	52.71	24.83	279.31	9860	36192	28328
Research	31.28	4.89	5.16	21.23	930	33634	22828
Health	871.33	136.57	120.75	614.01	7460	116800	82307
Advertising & Business Services	420.76	109.66	101.03	210.07	3540	118859	59342

Note: Estimates for all 86 sectors are detailed in Marsh et al. (2001).

Table 9. Potential Building Areas and Staffing over Three Stages

	STAGE 1	STAGE 2	TOTAL WIP
Office/Research Buildings			
Building Area	8000 m^2	34520 m^2	60000 m^2
Staffing	381	1644	2857
Industrial/Manufacturing Buildings			
Building Area		8630 m^2	30000 m^2
Staffing		144	500
Total Area of Buildings	8000 m^2	43150 m^2	90000 m^2
Total Staffing	381	1788	3357

Initially during Stage 1, only 8000 square metres of building were planned. At completion, 90,000 square metres were planned of which 67 percent Office/Research buildings reflecting the research focus proposed for the Park. In estimating the impact of the WIP on the Waikato regional economy we estimated that the Value Added per FTE for activities in the WIP would be in the range of $50,000 to $75,000 per year. Researchers working in the WIP may be paid high salaries by NZ standards almost certainly exceeding $50,000 per year. Other

technicians, supporting staff etc. may bring the average gross salary below $50,000. However, the range of $50,000 to $75,000 for VA/FTE is not inconsistent with the data in Table 8 for comparable sectors involving expert consulting such as Health ($82,307), Advertising & Business Services ($59,342) and Forestry Services ($86,857).

Linkage data from Table 6 is used to estimate the level of value-creating research activity that will spin off into other sectors of the regional economy creating additional value added in those sectors. In estimating the impact of WIP it is important to distinguish between additional activity and that which will be diverted from elsewhere in the region. Some tenants, who would otherwise locate elsewhere in the region, will choose to locate in a science park for "address" externalities. Analysis of the prospective Stage 1 WIP tenants suggests that the initial impact is mainly diversion; most tenants will move from other locations in the region, so activity generated by these tenants will not represent a net gain in regional activity. We assume that much more activity from Stages 2 and 3 (approximately 90 percent of total activity) will represent a net gain for regional activity. We use a base assumption that around half of this 90% would be a net gain to regional activity. We use existing estimates for research sector linkages to estimate the overall value of the WIP (See Table 10) and scale these estimates back by 45 percent to reflect the *net* gains to the region. Assuming the lower figure of $50,000 per FTE we estimate impact on gross regional production (GRP) of 2.4 percent.

Table 10. Net Economic Impact of WIP on the Waikato Economy

	Value Added $m @ $50k per FTE	Value Added $m @ $75k per FTE
Direct Value Added from WIP with 3357 FTEs	75.6	113.3
With flow-ons to other 86 sectors in region	173.0	259.5
Total addition to GRP in Waikato region per year	248.6	372.8
Value Added increment as percent of Current Waikato GRP of $10,320 million	2.4%	3.6%

Linkages from the Waikato Innovation Park are expected to be significantly different to the research sector estimates in the current model. There have been major changes in the research sector over recent years including an increased emphasis on commercialisation and less emphasis on research supporting the traditional farm sectors. Increased linkages with the business service sectors such as financial services and lesser linkages with the farming sectors could result. Interactions with visiting clients or suppliers etc. could see increased linkages with the tourist related sectors such as air transport. Accordingly, taking the existing 'advertising & business services' sector as our model, the proportion of value added distributed over the various inputs could follow the pattern as outlined in Table 11. We assume 1 percent value added to calculate the cost of WIP services demanded from the 'local government' and 'cleaning, sewerage & waste' sectors of the regional economy. As shown in the last line of

Table 10 above, the model estimates that at full capacity, WIP will contribute between $0.8 and $1.1 million annually to such services.

Table 11. Distribution of Net Benefits Arising from WIP Operations

Distribution of Value Added from WIP	Percent	$m VA @ 50k	$m VA @ 75k
Net Household Income after tax	55.7	42.1	63.1
Household tax, saving & super	23.9	18.0	27.1
Company surplus after tax, before deprec.	14.2	10.8	16.1
Company tax	3.2	2.4	3.6
Indirect tax	3.0	2.3	3.4
Total Value Added	100.0	75.6	113.3
Local Govt., Cleaning, Sewerage, Waste	1.0	0.8	1.1

Note: These estimates are based on data from the Advertising and Business Services Sector.

Note that Table 10 summarises only the *direct* annual benefits from the WIP. Staff from the WIP will spend their income in the Waikato region and beyond which will add to total turnover and further value added in the regions concerned. Total annual impacts are summarised in Table 12.

Table 12. Total Net Regional Impact from Annual WIP Operations

	Value Added $ m	Net Household Income $m	Employment IFTEs
Assuming 50k VA per WIP FTE			
Direct Impact from WIP operations	75.6	42.1	1511
Flow-on to other 86 sectors	173.0	21.1	1511
Total impact of WIP on economy	248.6	63.1	3021
Assuming 75k VA per WIP FTE			
Direct Impact from WIP operations	113.3	63.1	1511
Flow-on to other 86 sectors	259.5	31.6	2266
Total impact of WIP on economy	372.8	94.7	3777

Note: Estimates in Tables 10-12 are scaled back by 45% to reflect net gains to the region. For example net gain in employment is estimated to be 1511 FTEs (45% of 3357).

In estimating the flow-ons to the Waikato regional economy from annual WIP operations, we used a household income multiplier of 1.5 (currently 1.48 for the Waikato's Advertising & Business Services sector) and 2.0 or 2.5 for the employment multiplier. This is more conservative than the comparable 4.5 to 5.3 values suggested in Arrow's *Feasibility Report* of November 2000. It should also be noted that we have not included the construction impact on the region, although this would be a significant construction project spread over three stages.

The backward linkages in Table 6 show the Waikato's research sector to be the greatest driver of regional economic activity, even ahead of the Building

sector. As noted above, this result may not be exactly replicated by WIP operations. However, it suggests that other sectors of the regional economy are geared to benefit from supplying inputs into the research activity expected in WIP, and will therefore capture most of these flow-ons as distinct from imports from other business units outside the Waikato region.

Table 11 shows that the WIP will contribute significantly to household income in the region. Flow-ons to household income emanating from linking sectors are approximately half those of the WIP in total. This result follows from the higher than average incomes of typical WIP employees. Tax revenue and local government will also benefit significantly from WIP operations as detailed in Table 11. The exact dollar value of these flow-ons cannot be directly estimated in detail. For example, WIP operations can be classified as labour/knowledge intensive with large benefits flowing as a result to the household sector. Conversely, the linking sectors such as electricity, are in some cases, extremely capital intensive. Thus, the flow-on to Company Surplus after Tax and before Depreciation will be a higher percentage than the 14.2 percent shown for WIP operations in Table 11.

The preceding section highlights the magnitude of the economic flows resulting from WIP. However these flows do not show the net economic gain and it is appropriate to calculate the conventional Net Present Value and Internal Rate of Return of the WIP. Our assessment of the economic viability of the Park compares expected income from rentals and other sources with the cost of building, running and maintaining the Park and the extra benefits that will accrue to the region in terms of employment and additional economic activity.

Tables 13 and 14 present the results of the BCA for the fully developed WIP. Results for the 'base case' have been derived from assumptions on occupancy rate (peaking at 90 percent), 'additionality' (peaking at 45 percent) and rental income ($160 per m2). Full development of WIP is expected to produce a net benefit to the regional economy of $257 million with an economic rate of return of 36 percent. Development of stage 1 only, has an NPV of $35 million and an economic rate of return of 29 percent.

Table 13. Base Case Results and Sensitivity Analysis

Base Case	*Stage 1 Only*	*Full Development*
Net Present Value of Benefits (NPV at 10%)	$35 million	$257 million
Economic Rate of Return	29%	36%
Sensitivity Analysis	*Value which would reduce rate of return to 20%*	
VA/FTE	$28,536	$18,702
Peak FTE's	196	1212
Peak Additional %	32%	21%
Peak Occupancy	55%	43%

These high rates of return are robust to large changes in the base assumptions. Table 13 records the level to which certain key variables can fall before the rate of return falls to 20 percent. In the base case it was assumed that

value added per additional full time employee (FTE) averages $50,000 per year. This can fall below $19,000 before the rate of return for the full development drops below 20 percent. The base case assumes employment of 3,240 full time employees, 45 percent of these being 'additional'. The number of full time employees can fall to around 1,200 or the 'additional' percentage can fall to 21 percent before the rate of return drops below 20 percent. Similarly occupancy could fall to 43 percent.

Our estimates do not take account of any step function taking the economy to a new level of operation associated with the new human capital and research results. Arguably this is the most important justification for public investment in science parks. However conservative analysis without these impacts is arguably the appropriate basis for evaluating risky public projects. Our estimates of the impact of WIP on the regional economy are necessarily based on a combination of the best available data used to construct the regional model, estimates relating to the size and structure of the park and a set of assumptions regarding occupancy, rentals and net benefits. In developing these estimates we have aimed to err on the side of caution and use assumptions which, if anything, underestimate potential impact of WIP. Given this cautious approach and the results of the sensitivity analysis we are confident that our benefit estimates are reasonable.

7. CONCLUSIONS

This paper highlights the potential for research activity to facilitate regional development. Regional model results indicate that the research sector is the most valuable in the Waikato economy as an output driver, even exceeding the building sector, which is usually one of the highest driving sectors of any economy.

The Waikato Innovation Park has the potential to be commercially viable and to significantly enhance the Waikato economy. The impact of the park on the region will initially be limited but will expand rapidly as the number of tenants increases. At full capacity of 3357 employees it could add 2.4-3.6 percent annually to the Waikato gross regional product and add around 2.5 percent to the Waikato workforce. Based on conservative assumptions, the project would produce a net economic benefit of $257 million with an economic rate of return of 36 percent. The economic rate of return from the project would be above 20 percent even if the number of 'additional' Park employees was halved. Potential economic benefits from the Park are significantly higher than for the other regional development mechanisms examined.

This paper has shown that conventional techniques of input-output analysis and benefit cost analysis can successfully be used to examine the potential of science park developments. The key challenge for analysts is to accurately identify the sectors that the park will invest in, and to accurately identify the costs associated with park development.

Table 14. Benefit Cost Analysis – Full Development

Year	Rental Area	Constr-uction Cost	Manage-ment & Other Costs	Land Lease	Occu-pancy Rate	Rental Income	FTE's	% Add-itional	Add-itional FTE's
	m^2	$'000	$'000	$'000		$'000			
1	0	0	400	0	0%		0	0%	0
2	0	16083	350	200	0%		0	0%	0
3	8000	15000	350	200	60%	768	192	20%	38
4	16788	15000	300	200	70%	1868	467	23%	105
5	25575	15000	250	200	83%	3402	850	25%	213
6	34363	15000	250	200	90%	4948	1237	28%	340
7	43150	0	250	200	90%	6214	1553	30%	466
8	43150	0	250	200	90%	6214	1553	33%	505
9	43150	0	250	200	90%	6214	1553	35%	544
10	43150	19840	250	200	90%	6214	1553	38%	583
11	54863	19840	250	200	84%	7338	1835	40%	734
12	66575	19840	250	200	86%	9212	2303	43%	979
13	78288	19840	250	200	90%	11273	2818	45%	1268
14	90000	0	250	200	90%	12960	3240	45%	1458
15	90000	0	250	200	90%	12960	3240	45%	1458
16	90000	0	250	200	90%	12960	3240	45%	1458
17	90000	0	250	200	90%	12960	3240	45%	1458
18	90000	0	250	200	90%	12960	3240	45%	1458
19	90000	0	250	200	90%	12960	3240	45%	1458
20	90000	0	250	200	90%	12960	3240	45%	1458
21	90000	0	250	200	90%	12960	3240	45%	1458
22	90000	0	250	200	90%	12960	3240	45%	1458
23	90000	0	250	200	90%	12960	3240	45%	1458
24	90000	0	250	200	90%	12960	3240	45%	1458
25	90000	0	250	200	90%	12960	3240	45%	1458
26	90000	0	250	200	90%	12960	3240	45%	1458
27	90000	0	250	200	90%	12960	3240	45%	1458
28	90000	0	250	200	90%	12960	3240	45%	1458
29	90000	0	250	200	90%	12960	3240	45%	1458
30	90000	0	250	200	90%	12960	3240	45%	1458

Table 14 (continued)

Year	Off Site Benefit	Financial Net Benefit	Grants	Financial Net Benefit with Grants	Economic Net Benefit
	$'000	$'000			$'000
1	0	-400	400	0	-400
2	0	-16633	7186	-9447	-16,633
3	1,920	-14782	550	-14232	-12,862
4	5,253	-13632	1482	-12150	-8,379
5	10,630	-12048	1482	-10566	-1,418
6	17,009	-10501		-10501	6,508
7	23,301	5764		5764	29,065
8	25,243	5764		5764	31,006
9	27,185	5764		5764	32,948
10	29,126	-14076	1482	-12594	15,050
11	36,690	-12952	1482	-11470	23,738
12	48,939	-11078		-11078	37,861
13	63,413	-9017		-9017	54,396
14	72,900	12510		12510	85,410
15	72,900	12510		12510	85,410
16	72,900	12510		12510	85,410
17	72,900	12510		12510	85,410
18	72,900	12510		12510	85,410
19	72,900	12510		12510	85,410
20	72,900	12510		12510	85,410
21	72,900	12510		12510	85,410
22	72,900	12510		12510	85,410
23	72,900	12510		12510	85,410
24	72,900	12510		12510	85,410
25	72,900	12510		12510	85,410
26	72,900	12510		12510	85,410
27	72,900	12510		12510	85,410
28	72,900	12510		12510	85,410
29	72,900	12510		12510	85,410
30	72,900	12510		12510	85,410
	NPV@10%	-26,885		-17,145	257,048
	IRR	5.2%		6.5%	35.8%

Notes: Rental Area: Area of completed buildings available for rent; Construction cost: Gross Development Cost (includes consultants and contingencies): Management & Other Costs: Park Manager, marketing officer, support staff, business plan preparation and leasing arrangements; Land Lease: Cost of leasing entire site; Occupancy Rate: Average % of rental area which is rented out at assumed rental of $\$160/m^3$; Rental Income: Rental Area * Occupancy @ $\$160/m^3$; FTE's: # of Full Time Employees working in rental area (at density of $0.04/m^2$): % Additional: % of FTE's who are assumed to be 'additional' (ie not diverted from elsewhere in the region); Off Site Benefit: Additional FTE's * Value Added of $50,000 per FTE (Value added from 3357 FTEs is $167.9 million); Financial Net Benefit: Rental income minus construction, management and lease costs; Economic Net Benefit: (Off site benefit plus rental income) minus construction, management and lease costs.

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