MULTIFUNCTION POLIS, NEW GROWTH THEORY, AND PATH DEPENDENCE IN THE ECONOMY[1]

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ABSTRACT The Multifunction Polis (MFP) Australia is a multidimensional project intended to be a showcase for economic, scientific and technological developments of international projection with core activities in Adelaide. In relation to MFP there appears to be two central (and awkward) questions: what would be achieved which could not be done without MFP, and how to give impetus to the MFP project? These are important questions that have received little attention from economists interested in Australia's industrial organization and economic growth. The present paper shows that the preceding questions are answerable within the conceptual framework emerging from the New Growth Theory (NGT) and the Path Dependence Approach (PDA) to the economy. The argument is developed in three steps. The first step lies in characterizing NGT along the line of reasoning Romer (1990) - Grossman and Helpman (1991) - Aghion and Howitt (1992), and making contact with concepts present in the case made for the 'path-dependence' aspects of technological change and the role of history in economics by Arthur (1994). The second step in the argument lies in reducing the vagueness of the MFP's goals and demarcating the economic dimension of the MFP project. The third step involves the central claim of the present paper, namely: there exists a nontrivial policy recommendation, based on NGT and buttressed by the PDA, able to act as MFP's catalyst. Specifically, at this stage of the project a catalytic subsidy to R&D may be an appropriate policy instrument to drive the process towards the ultimate economic goal of MFP Australia.

> *While it may appear to the casual observer that knowledge always flows rapidly and costlessly around the globe, the reality is sometimes different. The concentration of high technology industries in particular locations such as the Silicon Valley and Route 128 suggests that some benefit exists from physical proximity to other researchers. Perhaps this is because new ideas are spread by skilled personnel whose geographic mobility is somewhat restricted, or because firms that are geographically close are exposed more often to the products of their nearby rivals.*
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> *G.M. Grossman and E. Helpman (1994)*

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[1] An earlier version of this paper was presented at the *1995 Industry Economics Conference*, Melbourne, 6-7 July, 1995, and at *Increasing Returns and Economic Analysis. An International Conference in Honour of Professor Arrow*, Melbourne, 7-8 September, 1995. I am indebted to John Hatch, Bob Hawkins and two anonymous referees for their constructive comments. The usual disclaimer applies.

1. INTRODUCTION

The economics of the *Multifunction Polis* (MFP) has yet to be written. As a first step in this direction, the present paper looks at the MFP through the prism of some recent contributions to economic growth and path dependence in the economy. The treatment is deliberately schematic in order to focus on the economic fundamentals underlying the MFP model.

It is well known that the MFP project has evolved over distinct phases.[2] While a full account of these numerous and complex events would take us too far afield, a selective presentation is useful to highlight the long gestation of the project:

1. The MFP idea was proposed to Australia by Japan in January 1987. MFP was primarily conceived as a multifunctional "City of the Future" which would contribute new ideas for new knowledge-based industries.
2. In late 1988, an agreement was reached between the two Governments to undertake a feasibility study, and a *Joint Steering Committee* was established to oversee the project. The Australian Government formulated several tenets to govern the deliberations of the Committee, including the following guiding principles: MFP should be developed in line with the structural transformation of the Australian economy, should be "based around international traded information, education and training, leisure and tourism, and research and development activities", and there would be no location-specific subsidies. BIE (1994, p. 24).
3. In July 1990, Adelaide was selected as the core site of the MFP, and the formation of the *Adelaide Management Board* was announced.
4. In December of 1990, an *International Advisory Board* was established to promote the project internationally, and to create links with abroad organizations and potential investors.
5. In July 1991, the Federal and South Australian Governments formally agreed to develop the MFP. The Federal Government allocated $12.275 million over three years to 1993-94 to help meet the initial start-up costs, service the MFP's International Advisory Board, and developed MFP-related opportunities in other States.
6. In October 1991, the name of the project was changed from 'MFP Adelaide' to 'MFP Australia' in order to signal the "national" projection of the project.
7. The *MFP Development Act* was proclaimed in October 1992. This legislation laid down the objectives of MFP Australia, and established and set out the *MFP Development Corporation.*
8. In April 1994, the Bureau of Industry Economics presented its *'Research Report 58: Evaluation of Commonwealth Support for the Multifunction Polis'.* The funding mentioned in 5 was the object of the review.
9. In mid 1994, the Federal Government announced continued endorsement, funding and assistance for MFP Australia, under a revised agreement with the

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[2] For a comprehensive review of the relevant literature, see BIE (1994, esp. Ch. 2).

South Australian Government, until 30 June 1996.

10. The Federal Government, in the course of implementing new cuts on its expenditure, ceased its funding commitments at 30 June 1996.

But, what is the MFP? The MFP concept has evolved in such way that *MFP Australia* means different things for different people, for different Australian organizations, and even for different countries.[3] This suggests that we all talk about the same entity, but we have not yet agreed what it is we are talking about. It is true that nowadays there is a consensus in Australia about the following (ideal) definition: 'MFP Australia is a multidimensional project intended to be a showcase for economic, scientific and technological developments of international projection with core activities in Adelaide'. But it is true, too, that this is an excessively broad definition encompassing multiple (undefined) aims.

Apparently, the most important source of confusion has been the lack of understanding about the MFP nitty-gritty. This has recently been recognized by the Chief Executive Officer of the MFP Development Corporation, Dr. Laurie Hammond:

> "In MFP Australia, I found individuals of great expertise and skills that represent a unique capability in South Australia and indeed Australia. I also find a community, a bureaucracy, a political system, a private sector - in fact, a State of South Australia - that has a very limited and sometimes confusing understanding of MFP Australia, its purpose and achievements. Therefore, one of the most important tasks will be to create a single, common understanding about 'what is the MFP?' We need to establish that MFP Australia is not a place (though the Corporation certainly owns and has improved and developed large tracts land in the inner northern region of Adelaide). We need to establish that it is also not simply a project (though the MFP Development Corporation has planned or implemented a number of large, complementary projects, outlined in this Annual Report). Rather, MFP Australia is an organisation that has developed a *model* for designing and managing cities of the future, based on our knowledge of the best available technologies in all relevant areas - environmental management, energy management, information and communication, health services, etc. It is in this *model* - this assembled set of knowledge and skills - that constitutes the intellectual capital and the value of MFP Australia." [italics added]
>
> (MFP Development Corporation, *Annual Report*, 1995/1996, p. 3)

However, this definition remains very broad and begs major questions, including: what is the economic dimension of the "model"? The starting point of any meaningful economic analysis of MFP should be recognition that it is necessary to unearth the economic paradigm underlying the "model". Assuming that this is possible, there still remain two central (and awkward) questions: what would be achieved which could not be done without MFP, and how to give impetus to the MFP project? These are important questions that have received

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[3] This wide range of perceptions has been pointed out in BIE (1994, esp. pp. 139-141).

little attention from economists interested in Australia's industrial organization and economic growth.

In order to understand a complex phenomenon it is often necessary to use a simplified framework for organizing thought about the problem being analysed. The present paper argues that the *New Growth Theory* in conjunction with the *Path Dependence Approach* to the economy harmonizes perfectly with the MFP nitty-gritty. It is also argued that the alluded conceptual framework answers the policy question: how to attract (and retain) innovating firms in high-growth high-powered product fields to generate spillovers to South Australia in particular and to Australia as a whole?

The argument is developed in three steps. The first step lies in characterizing the conceptual framework (Section 2). The second step lies in reducing the vagueness of the MFP goals and demarcating the economic dimension of the MFP project (Section 3). The third step involves the central claim, namely there exists a market-friendly industrial policy able to drive the process toward the ultimate economic goal of MFP Australia (Section 4). Finally, Section 5 offers a summary and some concluding remarks.

2. THE SETTING

The ideas encompassed in the New Growth Theory (NGT) have entered the academic literature with considerable speed and have evoked a flood of valuable research. It goes without saying that the literature on NGT is too extensive to be surveyed here.[4] NGT is an evolving field encompassing a variety of individual models. For the sake of definiteness, the paper follows the line of reasoning *Romer (1990) – Grossman and Helpman (1991) - Aghion and Howitt (1992)*, and others, which considers *industrial innovation* as an engine of economic growth. Rather than attempt the task of summarizing every formal model which relates industrial research to economic growth, this paper condenses the gist of such line of reasoning in a few paragraphs.

The best way of approaching the (predominant) new view of growth is to try to pin down the mechanics of the "megaprocess" of economic growth. Without striving for rigour, the *grand vision* underlying the current approach to economic growth can be reduced to the interplay among three manageable essentials, namely: ideas *I*, human capital *HC*, and nonhuman capital *NHC*. Specifically, the recurring interconnections between *I, HC* and *NHC*, generate the *megaprocess of economic growth*. More specifically, ideas constitute the crucial input to produce *HC* and *NHC*, and in turn, *HC* is the most important input to produce new ideas *NI*. This process is represented by a string of mutually reinforcing and complementary elements in Figure 1 (continuous arrows indicate *NI* helps

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[4] A symposium on NGT, recently published in the *Journal of Economic Perspectives* (1994, pp. 3-72), provides a panoramic view about the main contributions as well as numerous references. For a review of endogenous growth and its implications for Australian policy, see Dowrick (1993).

produce *HC* and *NHC*, while dotted strokes reflect *NI* that *HC* and *NHC* can produce). The metaphor invoked by this diagram tacitly assumes that *HC* and *NHC* are interconnected as well, and that ideas can be passed on from one generation to the next, whereby the stock of knowledge increases without bound. Since growth is a dynamic phenomenon, the essentials are dated, so $(HC)_t$ indicates *HC* at time t ($t = 0, 1, 2, ...$), and so on.

To be more precise, *I* and *HC* are regarded as the principal engine of growth. A rigorous and impeccable (nonmathematical) defence of this claim has been recently provided by Romer (1993a). In particular, he observes:

> " ... ideas are extremely important economic goods, far more important than the objects emphasized in most economic models. In a world with physical limits, it is discovery of big ideas (for example, how to make high-temperature superconductors), together with the discovery of millions of little ideas (better ways to sew a shirt), that make persistent economic growth possible. Ideas are the instructions that let us combine limited physical resources in arrangements that are ever more valuable".
>
> (Romer, 1993a, p. 64)

With this heuristic diagram in place, it is clear that both creation and diffusion of knowledge represent an integral part of the mechanics of economic growth. Moreover, it is also clear that there are many channels through which knowledge percolates through the economy, e.g. scientific research, formal education, on-the-job training, cost-reducing innovations, etc.

The new theoretical mainstream, which emphasizes *nonconvexities* and the *publicness* of ideas, seeks to provide an economic explanation of the linkages between these three essentials, with a view to influencing the long run growth rate of an economy.

Even though the microeconomic processes underpinning Figure 1 are vast and complex, there is a *broad* policy message that can be deciphered from Figure 1, namely: there may exist arguments in favour of subsidizing the production of new ideas and the accumulation of human capital, but of course not through intervention that promotes rent-seeking or political pork-barrelling. However, this general proposition is too vague to guide any industrial policy.[5]

It is important to bring out three key elements underlying the pictorial description given by Figure 1. First, knowledge is a factor of production. This means that nonrival inputs[6] enter the aggregate production function which, in turn, renders increasing returns to scale inevitable. Second, new ideas are generated by investment in, say R&D, but the benefits of such investment are not

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[5] At first glance, the *Australian 125% Tax Concession for R&D* fits into the alluded policy recommendation. But it should not be taken too literally because NGT does not suggest undiscriminating subsidies to R&D.

[6] An input is said to be *nonrivalrous* if it can be used simultaneously in different applications and different locations.

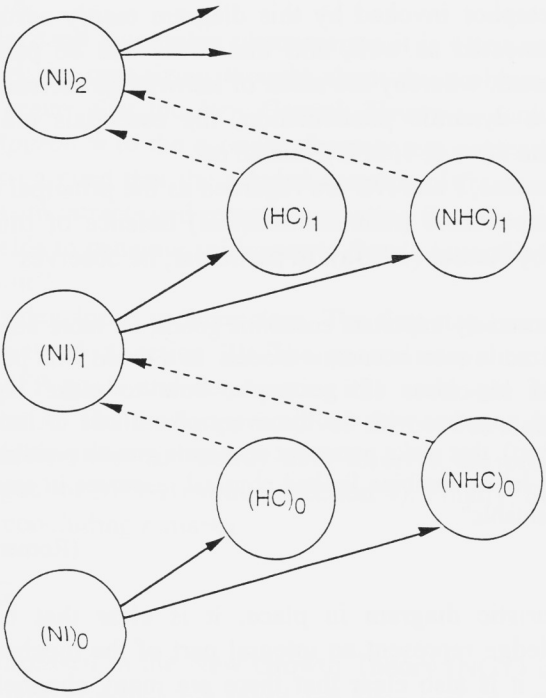

Figure 1. Megaprocess of Economic Growth

fully internalized by the firms carrying out research. Beneficial spillovers occur to other firms, thereby *reinforcing* increasing returns. Third, some sectors generate *more* endogenous growth than others. Then growth may be stimulated by public policy through the selection of the appropriate knowledge-producing sectors. Furthermore, a region that has acquired a comparative advantage in such technologically *progressive* sectors (for whatever reason) will tend to become a *growing lead*. The problem lies in the fact that it is far from obvious how high-powered growth-inducing sectors can be detected.

The line of argument under consideration also emphasizes the concept of 'newness', i.e. (somewhat roughly) new goods *matter* and policy interventions *may* affect the set of goods available in the economy (Romer, 1994). This in turn entails that a free-market economy is consistent with *multiple* outcomes, and makes direct contact with the contributions in the field of path-dependence and economic history.

In essence, the *Path-Dependence Approach* (PDA) argues that in those parts of the economy where increasing returns prevail there are usually *several* possible outcomes or time-paths the economy can follow, and the particular path selected by the free-market economy depends on *chance* historical events. The central mathematical tool figuring in this line of argument is a theorem that falls within the domain of nonlinear random-process theory.

The alluded mathematical proposition is both deep and subtle. To gain insight into the idea conveyed by the theorem (hereafter "Replication Theorem"), the following descriptive interpretation is very useful (see Arthur, 1990). Consider a table to which balls of different colours are added one at a time, suppose the probability that the next ball will have a specific colour depends on the current proportions of colours on the table, and define an *equilibrium situation* by the fact that the probability of adding a colour is given by its current proportions (i.e. the probability "*replicates*" the existing proportion on the table). In order to facilitate presentation, it is convenient to distinguish two versions of the replication theorem. The *weak version* asserts that as balls continue to be added the system converges to an equilibrium. To obtain the second (*strong*) version of the theorem it is only necessary to incorporate the assumption of positive feedback (increasing returns). This additional assumption preserves convergence, but provokes *multiple* equilibria.[7]

Arthur (1986) has analysed the dynamics of industry location under agglomeration economies with the help of the replication theorem. The problem of analysing economic sectors operating in a free-market economy under increasing returns to scale has also been attacked by Arthur (1989, 1990). He has shown that the replication theorem works remarkably well in this setting, and drawn an inevitable conclusion: the economic outcome selected by the market need *not* be the best one. Of course, to prove that free markets do not necessarily produce the best possible outcome, is not the same as proving that state intervention will do better than actual markets, but the possibility that something better could be arranged *without* meddling with the free market should not be overlooked.

As to outcome selection, it is not the thought that history - and only history - matters. Expectations are also important in the issue of multiplicity (Krugman, 1991). It is not inconceivable that if everyone believes that the market will end up in outcome 1, then it will; and that if they instead believe that it will end up in outcome 2, then it will. Consequently, the possibility of *self-fulfilling expectations* cannot be ruled out. The history *versus* expectations distinction makes direct appearance here: history alone may not be enough to dictate the market outcome. At the theoretical level, the relative importance of history and expectations in determining outcome is still an open question (see Krugman, 1991, esp. p. 666). It should be obvious that in the real world history and expectations (as well as tastes, technology, and factor endowments) matter.

Both NGT and PDA agree that the role of history is important as a determinant of dynamic comparative advantage. NGT contains models of knowledge spillovers predicting long-lasting effects of *temporary* industrial policies (Grossman and Helpman, 1991, Ch. 8). On the other hand, PDA pays special attention to the fact that *historical small events* are not forgotten by the

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[7] Although not done so here, the two versions of the replication theorem can be stated (and proved) with full mathematical rigour. See Arthur (1989, esp, p. 130). For a quasi-technical presentation, see Appendix.

dynamics, and thereby may decide the market outcome (Arthur, 1989). To summarize the key insights most succinctly: newness and history *matter*.

Having briefly outlined NGT and PDA the stage has been set for an analysis of the economic significance of MFP as well as a discussion of policy measures.

3. DEMARCATING THE ECONOMIC DIMENSION OF MFP

According to the *4 June 1992 Agreement on MFP Australia between the Commonwealth and South Australian Government*, the MFP project seeks to achieve eight objectives.[8] For clarity, these objectives are classified here into three main *categories* (general, environmental, and techno-economic) as follows. The objectives of the MFP Australia are to secure the creation or establishment of:

General Objectives

1. a model of equitable social and economic development in an urban context;
2. an international centre of innovation and excellence in urban development and in use of advanced science and technology to serve the community; and
3. leading centres of innovation in science, technology, education and the arts.

Environmental Objectives

4. a model of conservation of natural environment and resources; and
5. a model of environmentally sustainable development.

Techno-economic Objectives

6. a national focus for economic, scientific and technological developments of international significance;
7. a focus for international investment in new and emerging technologies; and
8. a model of productive interaction between industries and research and development, educational, community and other organizations and of the use of advanced information and communication systems for that purpose.

It is clear that the three categories shade into one another at the edges, and they each contain much variety. It is also clear that the MFP objectives are extraordinarily vast and complex, and exhibit a high degree of *vagueness*. To quote directly the evaluation carried out by the Bureau of Industry Economics:

> "The eight listed objectives of the MFP are extremely ambitious. To fulfil all objectives would be an extremely demanding task, especially given the resources available to the MFP. Questions thus arise as to whether the objectives should be prioritised and how. Similarly, should the objectives be refined and focussed to facilitate a planning process that is more likely to lead to fulfilment? As they are currently phrased, the objectives are more akin to aspirations. It is therefore

[8] The objectives in the 1992 Commonwealth/State Agreement are identical to the objects of the MFP Development Act (1991).

difficult to know if and when they are attained".

(BIE, 1994, p. 67).

Furthermore, one of the findings in this evaluation was that "in a literal sense the MFP has not achieved any of its objectives" (BIE, 1994, p. 67, boldface in original).

It should hardly be necessary to add that it is not just important but imperative to *reduce* the vagueness of the objectives and provide a clear statement of how the MFP's goals will be attained. Otherwise, it is extremely difficult to find a practical way of solving the MFP's *what* and *how* problems.

One basic question immediately suggests itself: what (if any) is the prime economic goal of MFP? It could be argued - following the Japanese and some members of the International Advisory Board - that the creation of a mosaic of villages (separated by lakes, forests and open fields, and linked with each other) exhibiting new holistic ways of living would constitute the prime economic objective of MFP. However, this view would reduce the economic dimension of MFP to a mere component of a multifunctional city of villages. Even though urban planning is an important element in this complex project, the MFP vision appears to go beyond a futuristic urban design. In fact, to the Development Corporation the MFP links an urban development and business development:

> "Australia's Multi Function Polis will be a unique community of advanced urban design. A smart city built on a specially selected site in the north-western sector of metropolitan Adelaide in South Australia. The MFP will balance innovative economic and social development, be technologically advanced and environmentally sustainable. To be developed progressively over the next 20-30 years, MFP is a unique strategic project for Australia and the world, based in Adelaide but linked to activities nationally and overseas. One of the main aims of the Multi Function Polis is to enhance opportunities for future growth through international collaboration of people and business. A vital priority is to underpin the economy of the MFP community by attracting private sector investment. MFP Australia's economic development is focused on three major knowledge intensive industries: Information Technology & Telecommunications, Environmental Management and Education. Fundamental to success is linkage between industry and research and development of emerging technologies, internationally. In creating it's unique smart city, MFP Australia will meet the challenge facing many international communities - the reclamation and restoration of land previously deemed unsuitable for development. The basic requirements for any community are economic sustainability, environmental sensitivity and social responsibility. This is the substance of the foundation stones on which Australia's Multi Function Polis is based: innovative urban and economic development and environmental clean up and management. It is the integration of all three activities to produce a globally significant model for better living that will make the MFP unique."
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> (MFP Australia, *Annual Review*, 1993-94, p.16)

More recently, a former Chief Executive Officer of the Development

Corporation, Mr. Ross Kennan, has reiterated:

> "Business development activities are focused on knowledge intensive, environmentally sustainable growth industries. MFP Australia's three target sectors are environmental technology and management, information technology and telecommunications, and education and training."
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> (MFP Australia, *Annual Review,* 1994-95, p.14)

Consequently, the Development Corporation considers that three *target sectors* - located in knowledge-based growth industries - constitute an integral part of the MFP concept.

In the light of these observations, one can confidently say that the rigorous answer to the above mentioned basic question revolves around the interplay among *human capital, high-powered growth-inducing sectors, and clusters of innovation.* Necessarily, terminology will play an important role in what follows, so that it is pertinent to clear away several points of definition.

It is possible to characterize the notion of 'high-powered growth-inducing sector' along the lines suggested by NGT. To speak somewhat loosely, NGT seems to be saying no more and no less than attention should be focused on *source inputs*, that is, nonrival products which will be used as an input by other industries and which will reduce costs in those industries. It does not automatically follow, however, that source sectors should be subsidized, simply because the definition does not necessarily imply incomplete appropriability. A specialized form of the concept in question is that of a *first-best source input*, characterized by the three conditions of nonrivalry, cost-reducing, and partial excludability. The foregoing suggests that a (stylized) definition of 'high-powered growth-inducing sector' is given by the concept of *first-best sector*, i.e. an economic sector which produces at least one first-best input.[9]

The creation of *urban agglomeration economies*, e.g. 'urbanization externalities' (firms locate in places where demand is high) or 'localization externalities' (firms locate next to each other to share specialized labour), does not appear to be the main attraction offered by the MFP project.[10] What appears to constitute its attracting power is the development of human capital-intensive knowledge-based sectors.

Externalities associated with agglomeration of firms or individuals are also contemplated in some of the recent theories of endogenous growth. Certainly, the paper by Lucas (1988), has provoked a resurgence of interest in the economies of the cities. As suggested by Figure 1, knowledge spillovers represent an essential ingredient in the explanation of growth, and cities accelerate the process of learning from others, facilitate the flow of ideas, and help people to innovate.

Clusters of industry encourage the economic competence of firms due to a

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[9] A fuller discussion of these ideas is contained in Pol (1995).

[10] It is true that the quality of the human capital in the "*1994 Educating City*" (Adelaide) is world class, but it is also true that the strong quality of specialized labour can be confirmed in the other major Australian cities as well.

variety of positive feedback effects, e.g. through meetings of firms' representatives, member firms gain free information about developments in technology, personnel, etc. Physical proximity between firms also facilitates both the exchange of ideas and problems concerning R&D, production and marketing. In general, nonfirm-specific knowledge is dispersed among the members of the cluster, thereby enhancing the representative firm's ability to assimilate and exploit knowledge from the environment. Essentially, an industry cluster adds a dimension to the firm's learning process - what for lack of a better name can be called "learning by sharing" - i.e. new external knowledge that the firm captures due to geographical proximity.[11]

Even though instantaneous global telecommunications, television, and computer networks have relaxed the constraints of time and space, the social glue of personal relations remains of paramount importance. Human beings are, of course, more than thinking machines (they live surrounded by other human beings, and absorb information by sight, conversation, and emotion, as they do from esoteric symbolisms and abstract constructions). Generally speaking, geographical proximity allows more intensive intellectual contact, and it turns out to be important for people developing activities in knowledge-based sectors.

In the context of NGT, ideas and human capital are different economic goods. *Human capital* is defined as the cumulative of education and training possessed by a human being (Romer, 1993, p.72). Networking (in the *person to person* sense) generates a special type of agglomeration economies. By the term *human agglomeration economies*, it is meant the increase in the average level of human capital due to the interaction of specialized workers within a unit of research or education, e.g. R&D centre, university or city. The essence of this idea was originally introduced by Kuznets (1960), rediscovered by Jacobs (1969), and referred to as "external effects of human capital" by Lucas (1988).

Armed with the preceding conceptual weapons and those introduced in Section 2, it is possible to formulate the economic core of MFP as follows. The *ultimate* economic goal of MFP is to originate human agglomeration economies through clusters of innovation in high-powered growth-inducing sectors. Thus, from the economic viewpoint MFP is conceived here as a geographical specialized bundle of first best source sectors where economic agents (firms and individuals) will be able to pick up knowledge without paying for it. This characterization provides an indirect answer to the fundamental question: what would be achieved which could not be done without MFP?

The chief economic objective of MFP can only be reached by inducing a *critical mass* of firms to operate in Adelaide. Because the value of the membership to MFP to one firm is expected to be positively affected when another firm joins and enlarge the cluster, MFP will be said to display *positive*

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[11] Note that the familiar idea of "learning by doing" refers to repetitive *in-house* process by which the firm becomes more efficient at doing a particular activity, while *learning by sharing* represents the absorption of valuable knowledge generated in the interaction within the geographical environment.

cluster effects. This conjecture is intuitively plausible, but empirically undocumented. Notwithstanding, the generation of positive cluster effects is a *sine qua non* of the success of MFP (otherwise, it would be reduced to a futuristic urban development). For the sake of definiteness, the 'optimal outcome' will be identified with the essential objective of MFP, that is, *optimal outcome* means 'MFP endowed with a critical mass of firms operating in first-best sectors'.

Any realistic approach must take as a point of departure that there is no reason to believe that the optimal outcome will be automatically attained by the market forces. Industry location patterns may not be the unique solution to a problem of spatial economic equilibrium, but rather the outcome of a process influenced by historical accident (Arthur, 1986). In addition, the target industries are located in sectors where increasing returns prevail and thereby, according to the replication theorem, there is no guarantee that the dynamic process will converge to the optimal outcome. Consequently, it is really hard to imagine how the prime economic purpose of MFP could be achieved without a *facilitating* government.

In order to generate critical masses in knowledge-based growth sectors a selective support to private R&D may be required, with the government acting as a *catalyst* rather than as a substitute for private decision-making. The reason is not far to seek. Until the MFP agglomeration economies are in place, there is no point in locating there. Private investor support cannot be generated without government support. Policies which serve to attain the ultimate goal of MFP are the most likely way of achieving '*win-win*' outcomes, regionally and for the Australian economy as a whole.

4. HOW TO IMPROVE THE ECONOMIC DIMENSION OF MFP

According to the policy implications of NGT, there are at least two situations where governments can implement "strategic behaviour". The first and most general is to use government as a vehicle of promoting *voluntary* R&D associations. More precisely, these are *Romer's (1993b) institutions* specializing in basic and generic industrial R&D. In principle, it is not indispensable to identify the "critical technologies". The crucial point in Romer's proposal is that the government has to impose a consumption tax. A second situation is where government selectively promotes R&D by targeting *first-best input fields*.[12] This section explores how governments can enhance the attractiveness of particular locations in order to accelerate regional endogenous growth with a view to improving national economic performance.

Before advancing to the main question - how to attract global firms to MFP - it is important to assemble five motherhood principles constraining the notion of regional industrial policy. The general constraints are introduced by specifying the criteria of "workability". A *Workable Regional Industrial Policy (WRIP)* includes at least the following five conditions:

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[12] This is what I call the "input-specific approach to R&D" (see Pol, 1995, esp. pp. 14-18).

1. *Market-friendly condition*: The policy should be consistent with the free market mechanism, in the sense that resources should flow to their most efficient uses impelled by market forces.
2. *Win-win condition*: The policy should encourage regional growth and improve national performance, i.e. both the region and the country as a whole should benefit.
3. *Investment field condition*: The policy should enhance the attractiveness of the region to general fields of investment, rather than providing selective inducements to specific firms.
4. *Symbiotic condition*: The policy should act as a catalyst, rather than as a substitute for industry decision-making.
5. *Credibility*: The policy should create a vision that is credible through enabling legislation.

This immediately prompts the question: does there exist at least a nontrivial industry policy consistent with the workability criteria? The paper advances an R&D subsidy (hereafter *MFP subsidy to R&D*) that harmonizes with the notion of WRIP and conforms to the mainstream of NGT.

Two points inevitably arise in considering the design of a subsidy to R&D from a practical, as opposed to a theoretical angle. One concerns the specific objective of the subsidy, and the other the statement of the eligibility conditions. The *overall objective* of the proposed subsidy to R&D is to provide positive support for encouraging clusters of innovation in the realm of MFP. This objective is compatible with a broader set of objectives which seeks to encourage, through Federal Government policies, the development in Australia of internationally competitive, export oriented, innovative industries.

Turning to the question of the *eligibility criteria*, it is necessary to make clear not only under what conditions a product is eligible, but also what kind of expenditure is eligible. A novel product is *eligible* to claim the MFP subsidy to R&D, if it satisfies three simple, but essential, conditions: a) it is nonrival; b) it is intended to be sold or rented to non-associated firms, and has both the potential to be used as an input by other industries in their own production processes (perhaps also going directly to final demand) and the ability to reduce costs of potential users; and c) it is partially excludable. As to *expenditure eligibility*, the following restriction applies: eligible expenditure for the MFP subsidy to R&D is the amount of sunk costs incurred in the actual process of R&D conducive to the novel product.

It is hardly necessary to stress that the R&D activities conducive to the novel product must be carried out in South Australia. Moreover, in order to qualify for the MFP subsidy to R&D any person involved in R&D activities should be continuously residing in Australia during the financial year immediately before the creation of the eligible product.

Two further restrictions and one qualification are in order. The MFP subsidy to R&D and the 125% Tax Concession must be *mutually exclusive*. The subsidy should allow the eligible firm to reduce its after-tax R&D costs by *exactly* the amount of sunk costs incurred over the time period involved in the creation of the

product. Finally, the subsidy should be administered and oversighted by the Industry Research and Development Board (the creation of an *Australian Centre for Industrial Innovation and Economic Growth* may be desirable to assist the Board).

It could be argued that the regional industrial policy in question is superabundant because it might only be attaining what the market mechanism would achieve anyway. This charge would be true under the assumption that the market's choice always gives the desired result. Nevertheless, the application of the replication theorem to the parts of the economy that are knowledge-intensive conveys the following message: there is *no* guarantee that the market solution (without incentives) will coincide with the desired outcome.

The intuition behind the preceding scheme is not far to seek. Suppose that there are several geographically *indifferent* regions, in the sense that the intrinsic benefits a potential entrant can gain (e.g. positive cluster effects, quality of human capital, etc.) are the same in each region. Also suppose, however, that only one region (say MFP) offers a first-best product field subsidy to R&D. Quite obviously, firms would pick MFP purely on the existence of the (*ex-post*) subsidy. Furthermore, an increasing proportion of firms operating in MFP would increase the probability of adding another firm, and thereby first-best industrial clustering would become *self-reinforcing*.

More formally, the process of choice of location can be thought of as a random sequence of arrivals. Firms decide where to locate on the basis of the choices of previous arrivals. The inception of a specific subsidy to R&D constitutes a historical event that may determine the desired outcome.

MFP is an obvious case in which *both* history and self-fulfilling expectations are of absolutely fundamental importance. The MFP subsidy to R&D reinforces the possibility of a self-fulfilling prophecy. In fact, if everyone thinks that due to the market-friendly incentive MFP will be a "well of innovation" in knowledge-based sectors, then it will. But if global firms believe instead that it would end up in a wishful thinking due to the lack of appropriate incentives that would happen instead.

Finally, it can be confirmed straightaway that the proposed MFP subsidy to R&D is in accordance with the first four requirements of WRIP, and fits nicely into the spirit of both NGT and PDA.

The issue of designing a subsidization mechanism is not one to be dealt exhaustively in a few paragraphs, and it would not be difficult to amplify or qualify the foregoing strategy. But I hope to have carried the description far enough to permit the following broad conclusion: there are (nontrivial) market friendly forms of government actions, ones that *without* tampering with the free market induce better economic outcomes.

5. SUMMARY AND CONCLUDING REMARKS

Modern theoretical contributions to economic growth and industrial organization have emphasized the importance of newness and history, thereby

significantly altering our thinking about policy issues. In particular, the formal developments of the New Growth Theory (NGT) and the Path Dependence Approach (PDA) call into question the claim that the market's choice is always the best.

It has been the general contention of this paper that the results of the alluded body of work shed light on the nature and scope of the Multifunction Polis (MFP) Australia. Taking as a point of departure the motherhood statements represented by the agreed eight objectives of MFP, the paper has characterized the economic dimension of the project from a new perspective. The message conveyed by this characterization is that MFP has enormous potential to confer significant benefits on the Australian economy.

The main section of this paper has been concerned with the outline of an unconventional subsidization strategy, namely: MFP subsidy to R&D. More precisely, Section 4 has introduced the notion of workable regional industrial policy (WRIP), developed a specific policy consistent with both NGT and PDA, and pointed out that the proposed scheme harmonizes with WRIP.

Four final points must be stressed most strongly. First, I do not profess to have fully captured the whole richness of MFP. But I believe that economic policy-makers interested in accelerating the MFP project will find useful insights in my approach to its economic dimension. Second, everything concerning MFP relies not only on the magnitude of the expected agglomeration economies, but also on the assumption that the productive externalities will be *lasting*, in the sense that there will be continuing knowledge spillovers to be captured by locating near other firms operating in the MFP. Third, the paramount task of economic policy-makers is to create *convergent* expectations about MFP-Australia. Finally, the need for specific incentives to MFP calls for modifications in the legislative and regulatory framework. In particular, the legal impossibility of financing the MFP's goals through the allotment of location - specific subsidies resembles the familiar dominant strategy equilibrium in game theory where individual (State) rationality leads to an outcome which is non-optimal from the players' collective viewpoint. The cooperative solution is likely to lead the concentration of industrial innovation in a number of successful regions and *not* a single region — South Australia becomes more prominent in first best input fields of R & D, and other regions in some other product fields of R & D. These successful clusters of innovation may hold each other in balance through increasing specialization between them.

Summing up, recent developments in NGT together with parallels insights afforded by PDA constitute a powerful organizing framework for both thinking about the scope of MFP and designing policy tools able to act as MFP's catalyst.

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APPENDIX. Replication Theorem

What I call here "replication theorem" is part of the *Arthur-Ermoliev-Kaniosky theorem* (hereafter AEK theorem). A precise statement of this proposition can be found in Arthur (1989, p. 130). To be sure, the replication theorem is a complex mathematical tool. In this appendix the emphasis will be on the essence of the proposition, rather than on the immanent technicalities. To keep the presentation transparent, first proceed by stating the basic hypotheses, then introduce the equilibrium concept, and finally paraphrase the key result.

To fix ideas, suppose that the colors in question are blue *b*, green *g*, and red *r*, and the corresponding current proportions are x_b, x_g, and x_r, respectively. Denote by p_b, p_g, and p_r, the probability that the next ball will be blue, green and red, respectively. The collection:

$$x = (x_b, x_b, x_r) \tag{1}$$

represents the vector of proportions on the table, and the vector of probabilities is denoted by:

$$p = (p_b, p_g, p_r) \tag{2}$$

The (major) hypotheses of the AEK theorem are the following three:

(H_1) The color of the ball to be added next is *unknown.*

(H_2) The probability that the next ball will have a specific color depends on the *current* proportions on the table. This can be expressed by writing:

$$p_b = p_b(x),\ p_g = p_g(x),\ \text{and}\ p_r(x) \tag{3}$$

or more briefly, by putting them all together to obtain a *map* from the unit simplex of *proportions* S^3 into the unit simplex of *probabilities* S^3

$$p : S^3 \rightarrow S^3 \tag{4}$$

defined by the formula:

$$p = p(x),\ \text{if}\ x \in S^3 \tag{5}$$

(H_3) The process is iterated to yield the vectors of proportions:

$$X_t\ (t = 0, 1, 2, \ldots) \tag{6}$$

The probabilities of addition *vary* with time, *t*, and the sequence:

$$p_t = p_t(X_t)\ (t = 0, 1, 2, \ldots) \tag{7}$$

"rapidly" converges to a *limiting map* p^*.

Going a step further, it is necessary to characterize the notion of an equilibrium in the

context of nonlinear probability theory. The system is in *equilibrium* if the probability of adding a color is always to its current proportion. Formally an equilibrium is a *fixed point* of the limiting map, i.e. x is an equilibrium if and only if:

$$p*(x) = x \tag{8}$$

A simplified version of part of the AEK theorem is as follows. *Replication Theorem: Given hypotheses* H_1, H_2 and H_3 *after many balls have been added, the process converges with probability one to one of the stable fixed points of the limiting map* $p*$.

Quite obviously, the theorem says that sometimes one equilibrium will emerge, and at other times another. But it also means that, even though it would be out of the question to know in advance which solution would emerge, it would be possible (within the same setting), to influence the probability of a particular outcome by changing the initial conditions. The importance of this theorem in the mathematical modelling of sectors displaying increasing returns is pointed out very strongly by Arthur (1994).