EMBRACING THE KNOWLEDGE ECONOMY: EGYPT IN THE NEW MILLENNIUM

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CONTENTS

Foreword

In considering how best Egypt can integrate into the world economy, it is essential to remember that the world economy in 2000 is vastly different than the world economy even five years ago. The "knowledge economy" has become the economy. Its is no longer something to theorize about, it has become the global reality and the central challenge to the future of all nations—developed and developing. Egypt's integration and potential for growth depends in its willingness and ability to answer to this new paradigm of development and economics.

Although it is still early days in the transition to an information-driven global economy, there is much to learn from international experience. These experiences are not necessarily coming out of Europe or the United States—they are often those of small, struggling nations that had the vision and ability to make rapid policy changes when they saw an opportunity for growth. Ireland is a particularly interesting example for a country like Egypt.

Ireland has emerged as a small but significant leader in the new knowledge economy by emphasizing the role of the educational system in changing the link between academia and industry and the way we structure both new and extant knowledge. These are all relevant questions for Egypt, and the solutions tried and tested in Ireland's success story are proof that we need not be left out of this transformation into the knowledge economy.

Hisham Fahmy

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تقديم

إذا كا حاولنا دراسة مدى قدرة مصر على الإندماج فى الاقتصاد العالمى، فإنه من الضرورى أن نتذكر أن الاقتصاد العالمى فى عام ٢٠٠٠ مختلف بصورة كبيرة حتى إذا ما قورن بالاقتصاد العالمى فى خلال الخمس سنوات الماضية فقط. إن اقتصاد المعلومات والتكنولوجيا أصبح عاملاً رئيسياً للتنمية. لم يعد هذا مجرد نظريات متداولة، ولكنه أصبح حقيقة عالمية بل وتحدى رئيسى لمستقبل الأمم المتقدمة والنامية على السواء. إن إندماج مصر فى الاقتصاد العالمى وقدرتها على النمو يعتمد على مدى التجاوب مع هذا النموذج الجديد للتنمية والاقتصاد.

وعلى الرغم من أننا مازلنا فى مرحلة متقدمة من مراحل العملية الانتقالية نحو إقتصاد عالمى تلعب فيه المعلومات دوراً قيادياً، إلا أن هناك الكثير من الخبرات المفيدة على المستوى الدولى سواء تلك الآتية من أوروبا والولايات المتحدة أو حتى من دول صغيرة تواجه صعوبات ولكن لديها الرؤية والقدرة على القيام بتغييرات سريعة فى السياسات عندما تلوح لها فرصة للنمو. إن إيرلندا تعد مثالاً جيداً ومفيد بالنسبة لمصر. لقد أصبحت أيرلندا كدولة صغيرة تلعب دوراً هاماً فى إقتصاد المعلومات والتكنولوجيا، وذلك عن طريق تشجيع دور النظام التعليمى فى تغيير طبيعة العلاقة الموجودة بين القطاع الأكاديمى والصناعى. كل هذه الموضوعات هامة لمصر، والحلول التى تقدمها التجربة الايرلندية الناجحة دليل على أن مصر يمكن أن تكون جزء من هذا التحول نحو إقتصاد المعلومات والتكنولوجيا.

هشام عبد العظيم فهمى
المدير التنفيذى بالانابة
المركز المصرى للدراسات الاقتصادية
نفبر ١٩٩٩

ABOUT THE SPEAKER
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Dr. Vincent McBrierty is currently the Pro Vice Chancellor for Academic Affairs at Sultan Qaboos University in Oman. Originally from Ireland, he has had a long and distinguished academic career as both an administrator and as a physicist. Dr. McBrierty has recently published a book and numerous scholarly articles on the relationships between industry and academia, and what he calls 'the new techno-paradigm'. He is an expert on science policy and Ireland's experience joining the knowledge economy.

Part I

EMBRACING THE KNOWLEDGE ECONOMY: EGYPT IN THE NEW MILLENNIUM[1]

1. Introduction

Some four hundred years ago, the English essayist, Francis Bacon penned his famous remark "for even knowledge itself is power."[2] It could scarcely have been more prophetic. Today's most successful economies now depend on vital scientific and technological activity with new knowledge as their life-blood.[3] This direct link between knowledge and economic growth, fuelled by sustained developments in information and communications technology (ICT), is at the heart of the knowledge economy.

The pace of change is accelerating at an unprecedented level. We are now moving from the *information age* into the *transformation age* in which new information is transforming virtually every aspect of our day-to-day lives. The workplace has been reshaped by a core of new technologies that have replaced the more traditional ones. Knowledge, information and associated skills have displaced labor as the primary source of productivity and competitiveness. Growth in business and industry continues to be determined largely by new technology which is the 'output' of scientific endeavor.

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[1] The content of this lecture reflects three decades of personal, hands-on experience as Professor of Physics at Trinity College Dublin. Dialogue with countless colleagues during that period of Ireland's economic renaissance was of immeasurable benefit. I am particularly indebted to Professor Ray Kinsella, Professor of Banking and Finance at University College Dublin, and Dr. Eoin O'Neill, Director of Innovation Services at Trinity College Dublin. This remarkable period of creative endeavor in Ireland was further enriched by the perspective of time spent at AT&T Bell Laboratories. Sustained discussion over many years with Dr. William O. Baker and Dr. Dean Douglass in particular provided a rich source of inspiration and vision. My current posting at the Sultan Qaboos University in the Sultanate of Oman has afforded the opportunity to develop policies that are suited to a small and developing open economy in the Middle East.

[2] Francis Bacon, "*Nam et ipsa scientia potestas est* (For even knowledge itself is power)," in *Meditationes Sacrae: de Heresibus* (1597).

[3] V. J. McBrierty and R. P. Kinsella, *Ireland and the Knowledge Economy: The New Techno-Academic Paradigm* (Dublin: Oak Tree Press, 1998).

The economic future of both developed and developing nations—and, to a significant degree, that of society as a whole—depends on their ability to embrace the knowledge economy. Society has been globalized in a world that is appropriately termed 'a global village' networked with electronic information super-highways. A 'global consciousness' has been created with the result that the fabric of societies and the rules that govern them are gradually, and radically, being altered. The level of integration and interdependency is such that nations can no longer act oblivious of the rest of the world: they are no longer fully in control of their own futures.

The liberalization of global trade has been developing in parallel under the aegis of the World Trade Organization (WTO). WTO member nations agree to open liberal trade and economic freedom grounded in democratic principles. The WTO provides the institutional structure and acts as global guarantor.

The purpose of this lecture is to add further perspective to the economic debate in Egypt by focusing specifically upon the link between new knowledge and economic progress. Indeed, it is only in this context that one can begin to understand the more spectacular features of current global macroeconomics. For example:

- The remarkable strength of the American economy and the comparatively lackluster performance of Europe.
- The singular failure in Russia to exploit the opportunities generated by the knowledge economy. The failure to build an appropriate infrastructure has created an almost insurmountable barrier to economic progress despite a deep-rooted technology culture and massive underwriting with Western aid.
- The traumatic economic down turn of the Southeast Asian economies in 1997/98.

In the first case, the United States wholeheartedly embraced the knowledge economy and is reaping the benefits accordingly. Experience in Russia on the other hand, shows that economic benefits will not flow from technology without the appropriate 'institution building'; technology in itself is not enough. Japan paid a heavy price for temporarily

ignoring the fundamental laws of economics through poor financial management in a world of unprecedented volatility and capital mobility. Once again, access to some of the most sophisticated technology in the world could not compensate for this lapse. But the Asian miracle did not die. Like Ireland in the mid-1980s, Japan learned a great deal from its mistakes and has drawn upon its deep-rooted resilience to embark upon a path of sustained recovery.

What can Egypt deduce from these contrasting experiences? As a nation that has entered its seventh millennium, Egypt no doubt appreciates the value of history and the lessons that can be learned from it. While the future is by no means a simple extrapolation of the past, history and the contemporary experiences of nations that have addressed similar challenges offer much valuable insight and guidance. With this in mind, the nature of new knowledge is first reviewed here within the perspective of technological growth and its overall impact on the development of human society. The concept of the knowledge economy is then examined, citing, in particular, experience in the United States, the United Kingdom and Ireland as examples of large, medium and small economies. Ireland is particularly relevant as a small, open economy that has undergone a veritable renaissance, following a period of acute economic depression in the mid-1980s, to become one of today's most successful economic performers. Experience in Oman will serve to illustrate the way in which a small Islamic nation is embracing the knowledge economy. These reflections form the backdrop to a more focused analysis of Egypt's development in the new millennium.

The lecture will conclude with a critique of what I believe to be a strategic inflection or paradigm shift in which education is at the core. The universities as long-established centers of learning and research have a central role to play. This is the basis of a new techno-academic paradigm which implicitly promotes a culture that is both receptive to the new technology and has the ability to apply it wisely.[4] The importance of understanding and

[4] R. P. Kinsella and V. J. McBrierty, "Campus Companies and the Emerging Techno-Academic Paradigm: The Irish Experience," *Technovation* 17(5): 245-251 (1997).

applying the new dynamic for the benefit of global society as a whole is stressed because history cautions us that systemic advances in civilization, such as those we are witnessing today, will be subverted unless they are grounded in a set of principles that reflect fundamental human values and beliefs.

2. The Knowledge Economy

2.1. The Historical Perspective

> "Though history does not repeat itself exactly, recurring situations may have points of similarity as well as points of difference, and recognising them may help. In most important fields, parallels and precedents have been going on for twenty centuries or more and there is no sense in amputating them from our collective memory." *Russell, 1992* [5]

From the earliest times, the development of societies depended upon the exploitation of discovery and new knowledge. This is as real today as ever before and can be expected to remain so for the foreseeable future. The scale and global impact of change as the 20th Century draws to a close was recognized in the 1993 European Union White Paper, "Growth, Competitiveness, Employment: The Challenges and Ways Forward into the 21st Century." The White Paper assertes that, "this decade is witnessing a forging of a link of unprecedented magnitude and significance between the technological innovation process and economic and social organization."[6]

But is the current link between new knowledge, technological innovation and economic and social organization radically new? At first sight there are no glaring differences with previous experience. The closing decades of the 19th century, for example, witnessed dramatic developments in transportation, communications, industrial practice, and a quantum leap in scientific understanding with the birth of modern physics.

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[5] Lord Russell in, "The Dancer not the Dance," E. Sagarra and M. Sagarra (eds.), Trinity Jameson Quatercentenary Symposium, Trinity College Dublin, May 1992.

[6] E.U. Commission White Paper, "*Growth, Competitiveness, Employment: The Challenges and Ways* Forward *into the 21st Century*," Bulletin of the European Communities, Supplement 6/93 (1993).

In Jared Diamond's book, *Guns, Germs, and Steel: The Fates of Human Societies,* which traces the contribution of technology to global development over the last 13 millennia, there are two recurring themes in his book that are especially relevant to our analysis.[7]

First, the beneficiaries of new technology are not always those who made the initial breakthrough. Technology transfer from the creators of the new discovery to those who successfully exploit it has been going on from the earliest times. For example, Islam acquired Chinese paper-making techniques in the 8th Century, while Islamic craftsmen from Egypt introduced glass enameling and gilding techniques to Venice in the 15th Century. Recall too that the evolution of the modern alphabet can be traced back to Egyptian hieroglyphics, developed some 5,000 years ago when Egypt was a flourishing center of writing. Basic knowledge and learning are comparably mobile. Arab nations kept the concept of universities alive during Europe's dark ages, from the 8th Century to the 12th Century, having earlier acquired much ancient learning from the Greeks to complement their own extant body of knowledge. By the year 1000 A.D., there were thriving Arab academies and libraries that contained much of the accessible knowledge of humankind; an encyclopedia of medical knowledge, *the Qanun*, was written by Ibn Sina and Ibn Al-Haytham was soon to write his *Thesaurus on Optics*, both of which were used for centuries thereafter by European scholars.[8] In the middle ages, Islam was technologically advanced and open to innovation. Islamic societies in the Middle East had achieved far higher literacy rates than contemporary Europe and the flow of technology was overwhelmingly from the Islamic societies to Europe.[9]

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[7] Jared Diamond, *Guns, Germs, and Steel: The Fates of Human Societies*, (New York W.W. Norton and Company, 1997).

[8] E. B. Childers was a noted broadcaster and writer with a keen interest in the Muslim/Arab world. This is an excerpt from one of his broadcasts on the closing millennium, entitled "Millennial Minds."

[9] J. Diamond (1997).

Second, the attitude of society is a major determinant as to whether the new technology will be exploited or not. As Diamond again notes, "it is not a matter of individual inventiveness but of the receptivity of whole societies to innovation … some societies seem hopelessly conservative, inward looking and hostile to change." This view is endorsed by many historians who would argue, for example, that, "14th Century China was an industrial revolution waiting to happen with the supply side of technology fully in place … tight control by the state prevented the emergence of a sophisticated demand base and dramatically stifled growth."[10] Typically, it was left to other nations to exploit China's truly formidable discoveries of magnetism and gunpowder in a way that conspicuously altered the pattern of evolution of global societies. It would be perilous indeed for contemporary thinking to ignore this particular lesson of history.

2.2 Is History Simply Repeating Itself?

We are indeed living in remarkable times that are profoundly different from the past in a number of respects. First, there is a burgeoning, self-catalytic growth of new knowledge. Its growth pattern is no longer discrete and localized as in the past. Knowledge now diffuses rapidly throughout the global community driven by its direct link to economic growth and enhanced communications networks. We are firmly in the electronic age with e-communication, e-government, e-society, e-commerce, and so on. The burgeoning communications phenomenon in itself is not new, merely its unprecedented pace and sophistication. As Childers so perceptively described it:

> "The [last] millennium's astounding rate of progress compared with all previous thousands of years did not happen because some significantly larger number of brilliant and perspicacious human beings were born during those centuries. It happened because it was, indeed, the first millennium of more and more highly organized and more and more extensive human communication."[11]

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[10] Cited in the critique of the U.K. White Paper, "*Our Competitive Future:* Building the Knowledge Driven Economy" Bulletin of the Centre for Economic Policy Reaserch (CEPR), No. 74, pp. 18-21, (London, 1999).

[11] E. B. Childers.

At the turn of the 20th Century, the noted physicist, George Francis Fitzgerald, also foresaw that telegraphy would create a network of 'nerves of civilization', the forerunner of the world-wide web.

Second, the nature of new knowledge and its relationship to technology is also changing. Consider, in particular, the distinction between the two components of science and technology (S&T). Whereas technology has been around since time immemorial, the *scientification* of technology has not. Technology is born and develops on scientific bases as a form of scientific knowledge itself: the two are twinned at birth.[12] For example, the *scientific* discovery of a new antibody can simultaneously represent a new *technological* step forward because of the immediate usefulness and commercial worth of the new discovery. The innovation cycle—that is, the process from the original discovery to the end product—has been severely truncated *(c. f. Section 3.2.2)*. Third, the lines of demarcation between different categories of knowledge, such as the traditional scientific disciplines of physics, chemistry and biology, are becoming increasingly diffuse. The prospect that the very nature of human life itself can be manipulated in the not too distant future presages a similar breakdown of the boundaries between the sciences and the humanities.[13] Overall, this heralds an inevitable return to a more eclectic approach to science as prevailed in earlier times when the term 'philosopher was' used to describe researchers in virtually every field of endeavor. The true significance of the Ph.D. degree—Doctor ate of Philosophy—with which we are so familiar has been reestablished.

And finally, at the macro-level, too, the well-defined boundaries between knowledge-driven industry and universities are also changing. Some of the larger industries are establishing their own universities, while universities, in turn, are increasingly

[12] V. J. McBrierty and R. P. Kinsella (1998).

[13] See, for example, "21 Ideas for the 21st Century," *Business Week*, August 30, 1999.

participating in business and enterprise with, for example, the formation of campus companies within their walls *(c.f. Section 3.2).*

2.3 Evolution of the Knowledge Economy

The development of an analytical framework to explain the dynamics of economic growth in the post-war period has been among the most challenging issues addressed by economists. The neoclassical model, with subsequent modifications, remains the most influential approach.[14] With the passage of time, the model has been reengineered by a process of iteration to account for the changing shape of economic growth and the role of technological change.

Human capital and technology are at the heart of the new growth theories. Technology is considered to be endogenous in the new models, thereby making the knowledge that generates such technologies a factor of production alongside the twin pillars of the original neoclassical model—capital and labor. This creates increasing rather than constant returns to scale at the level of the economy and reinforces the rationale for intervention implicit in the 'human capital' approach.

Two additional features are worthy of note. First, Stiblitz reminds us that knowledge differs fundamentally from other commodities, and this difference dictates the way in which the knowledge economy is managed. Knowledge is a public good but the innovations that flow from it have extensive externalities with benefits that extend well beyond the original generator of the idea. The second feature is the *cluster effect,* involving geographical concentrations of high-technology know-how and manpower and

[14] R. Solow, "A Contribution to the Theory of Economic Growth," *Quarterly Journal of Economics* 70 (1956) 65-94. R. G. Lipsey, *Globalization, Technological Change and Economic Growth*, Northern Ireland Economic Council, July, 1993. R. Lucas, "On the Mechanics of Economic Development," *Journal of Monetary Economics* 22 (1998): 3-42. J. Bradley, N. O'Donnell, N. Sheridan and K. Whelan, "Economic Growth and Convergence: Theory and Evidence," in *Regional Aid and Convergence* (United Kingdom: Auerbury, 1995).

geographical zones in which business can be carried out under more preferential conditions than would otherwise be the case.[15]

The fact that science and technology are developed by creative people operating in a supportive environment underpins the rationale *for technology clusters*. In discussing Silicon Valley, *The Economist* magazine noted that:

> "Research has increasingly concentrated on clusters—places or communities where there is 'something in the air' that encourages risk-taking. This suggests that culture, irritatingly vague though it may sound, is more important for Silicon Valley's success than economic or technological factors."[16]

Fortune magazine identified access to research institutions and 'knowledge workers' as the single most important determinant in locating new business operations in the United States.[17] Cantwell further noted that technology-based clusters, or technology-based alliances, facilitated the creation of a vibrant labor market and the dissemination of both *information* and *understanding*.[18]

All of the foregoing implies that sustained access to appropriately-trained manpower and research, within a creative and entrepreneurial environment, is both an attractor and subsequent anchor of knowledge-driven industry, as in Route 128 in Boston, Silicon Valley in California, Cambridge in England and Grenoble in France. The *electronic cluster* formed over the global information network is a variant of this concept. Centers of excellence in software development in India, for example, are routinely accessed by companies dispersed around the world.

Economic clusters or *zones*, on the other hand, operate under preferential trading conditions within the more constrained business culture of a nation. Sachs alluded to

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[15] J. Sachs, "*Achieving Rapid Growth:* The Road Ahead for Egypt," Distinguished Lecture Series 3, The Egyptian Center for Economic Studies, Cairo, 1996.

[16] "A Survey of Silicon Valley," *The Economist*, March 27, 1997, p.7.

[17] *Fortune Magazine,* December, 1993.

[18] J. Cantwell, Ref. 8, p. 19.

Export Processing Zones (EPZs) or Special Economic Zones (SEZs) which conduct profitable, usually export-oriented activities, in otherwise listless economies.[19] They underpin Singapore's position as the world's most competitive nation and have contributed significantly to economic progress in China and Ireland where this bimodal approach has created additional wealth and provided a welcome boost to economic growth without the need to transform the trading structure of the nation as a whole in a single operation.[20]

Overall, there has been significant movement in economic thinking from a situation in which exogenous technical progress was all that determined growth to one where the interaction between the generation of new knowledge, the concomitant flow of new technologies, human capital formation, and economic growth can all be discussed within a neoclassical framework. These developments collectively underpin the knowledge economy in its present form.

2.4 The Socio-Political Dimension

From the socio-political perspective, post-war economics were broadly shaped by two radically different ideologies: the open market system and a closed, state-led industrialization (SLI) system. As pointed out by Sachs, SLI-driven nations fared badly relative to the more open economies, inevitably facing macroeconomic crises of one form or another from about the 1960s onwards.[21] Corrective measures were often hampered by vested interests in maintaining state protection and the benefits enshrined in the original economic and political ideology. Entrenched cultural and historical factors added further to this bureaucratic intransigence *(c.f. Section 2.1).* The accelerated growth of the knowledge economy over the past few decades has been more in harmony with the open market philosophy, whereas its unrelenting dynamism has been clearly at odds with the erstwhile, effete thinking embodied in SLI that ignored the new realities.

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[19] J. Sachs (1996).

[20] M. Porter and J. Sachs, *Global Competitiveness Report* (Geneva: World Economic Forum, 1999).

[21] J. Sachs (1996).

3. Operational Framework

Who are the *dramatis personae* in the new global theatre of the knowledge economy? The operational framework for developing science and technology relies on inputs from four key players drawn from very different perspectives and backgrounds: government as the policymaker, facililator and source of funding the knowledge generators, such as the universities, who are an important source of skills and new knowledge; business and industry who are the end users; and private and semi-state finance and equity institutions who act as catalysts and partners in development.[22]

The successful exploitation of S&T depends critically on the establishment of close working relationships between these main participants. Only then can effective technology transfer take place between those with the knowledge and those who seek to exploit it. This is at the heart of the innovation process. Let us consider each in turn.

3.1 Government as the Policymaker

The task facing governments is a daunting one because the growth of new knowledge has outstripped the procedures required to manage it. Managers and policymakers often presume to argue in rational scientific terms with the authority of the scientific method and claim a precision for the method that science itself no longer claims. As a result, their conclusions are occasionally spurious and potentially damaging to civil society. Consider three issues in particular.[23]

First, societies in flux, as history shows, evolve new systems by which those who are charged with the responsibility to develop policy—policymakers, technocrats, civil servants, lawmakers—are the ones who must manage and oversee change. It is the effective management of change that is at the heart of good policy formulation and implementation. To succeed in managing *innovation*, policy itself must be comparably

[22] V. J. McBrierty and R. P. Kinsella (1998).

[23] V. J. McBrierty, "Science Policy in Higher Education: The Irish Experience," *Studies* 84(334), 187-196 (1995).

flexible and innovative. Blind adherence to the so-called 'rational approach' often stifles both the ability to challenge conventional wisdom and the flexibility to be unconventional in addressing the complex problems of modern society.

Second, policymakers are invariably concerned with measurement and quantification. As every economist knows this is exceedingly difficult and, occasionally, there is a tendency to measure the quantifiable and ignore what remains, thereby distorting reality. Eminent economists have warned against neat theories to describe the complexity of real problems.[24] Carter and Williams, for example, alluded to analytical over-simplification and the tendency of policymakers to seek a precision that progressively becomes unreal. This, they argue, "results from the common habit of removing complications for the sake of clarity in analysis…unfortunately the complications and uncertainties are an essential part of the problem."[25] Saul believes that the complex nature of society cannot be fully accounted for by many of the less enlightened models that are, "devoid of memory, anchored in the present, inescapably optimistic about the future [and] always have great difficulty in adjusting themselves to simple reality … technocrats [who create them] are, in a sense, slaves of dogma."[26] Because of the inherent difficulties in modeling societies, there is much to be learned from the complementary hands-on experience of others who have faced similar challenges. Learning-by-doing can enrich policy formulation in a practical and meaningful way.

Third, policymakers occasionally fall into the trap of equating public accountability with direct state intervention, notably, in higher education. It is a sobering thought that in

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[24] C. F. Carter and B. R. Williams, *Investment in Innovation*, (Oxford: Oxford University Press, 1958). See also, R. G. Lipsey, *Globalization, Technological Change and Economic Growth*, Report No. 103, Northern Ireland Economic Council, July, 1993, and, D. North, reported in *Sometimes the West is Best*, by P. Tansey, Sunday Tribune Newspaper (Ireland), May 29, 1994.

[25] C. F. Carter and B. R. Williams (1958). See also, R. G. Lipsey (1993).

[26] J. R. Saul, *Voltaire's Bastards: The Dictatorship of Reason in the West*(Vintage Books: New York, 1992).

one of the most enlightened eras of civilization, society is increasingly being subjected to a mandatory 'culture of compliance'.[27]

How are these issues reflected in overall policy formulation? Sensible and balanced policy must convert the full range of interconnected, disparate and transient contributions into a cohesive strategy. But one must first understand the nature of these inputs. As noted earlier, the four key participants come from fundamentally different cultures, missions, philosophies and value systems that are, nonetheless, all part of the make up of society. They must be bridged, not reduced to a lowest common denominator, nor subjected to the dominance of one contribution over another.

Nor, in a complex society, can the new developments in science and technology be divorced from the contribution of the arts and humanities, which create the general cultural dimension of a nation's heritage. The arts and humanities also have a key role in the effective and humane diffusion of science and technology throughout society as a whole.[28]

Because of the overriding impact of finance on policy, governments understandably rely heavily on economists and business experts for advice, sometimes to the exclusion of other sectional interests. Reliance on an unduly narrow range of advice can also impoverish policy.

Therefore, enlightened policy must include the participation of: (i) scientists and technologists who are practitioners in the creation and use of new scientific knowledge; (ii) the social scientists and humanists who interpret the moral, social and ethical implications; and (iii) the economists and business experts who establish the financial operational structures and the practical narrative. It is then the job of the technocrat/policymaker to transform these inputs into coherent advice for politicians who then make decisions on behalf of society as a whole. In the end, society is the final arbiter.

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[27] F. Millar, "Master of the Universities," *London Times Higher Educational Supplement*, May 20, 1994, p. 23.

[28] R. P. Kinsella and V. J. McBrierty (1997).

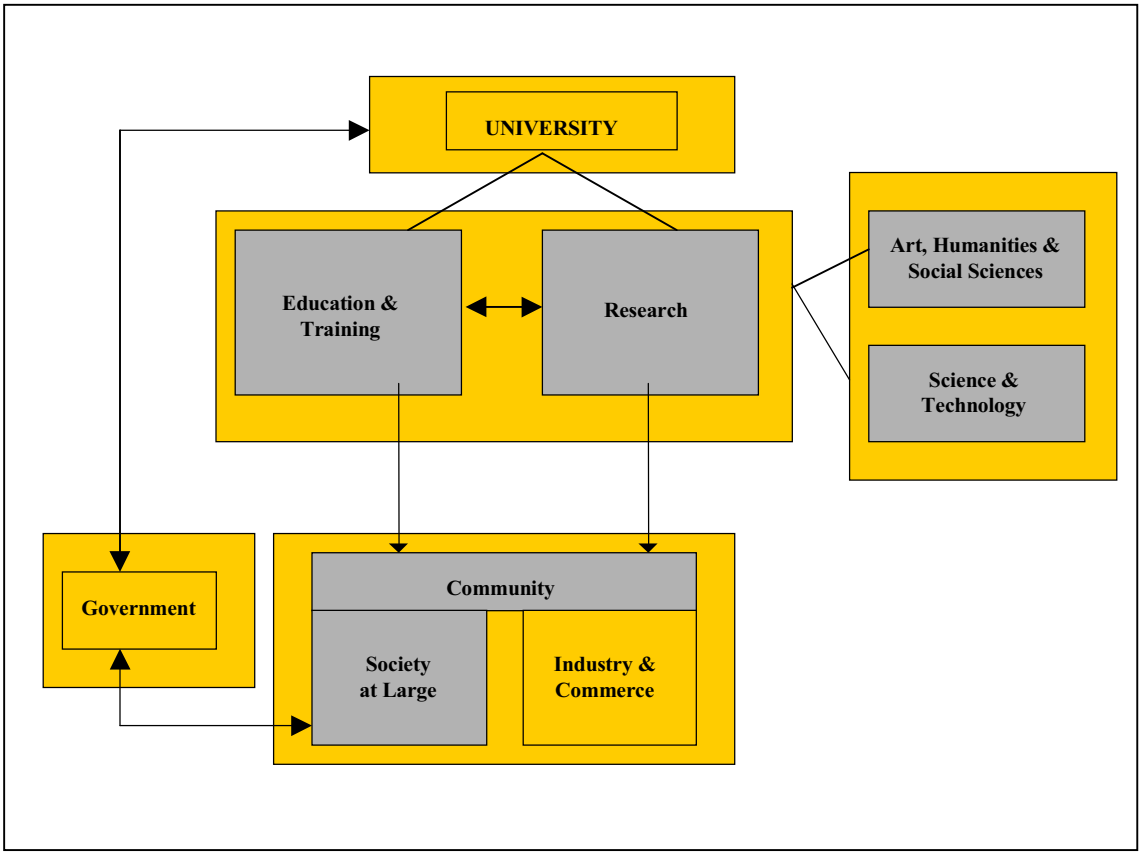
3.2 Universities as Knowledge Generators

For decades much of the new technology that shaped the global economy was developed in the major industrial research laboratories such as AT&T Bell Laboratories (now Lucent Technologies), IBM, General Electric, and Xerox Corporation to name but a few. The universities, following their age-old mandate, continue to be valuable repositories of creative thinking and new discovery; note, for example, that 80 percent of all Nobel Laureates in the fields of physics and chemistry are listed as professors.

Attention focuses specifically on universities for a number of reasons. First, they are an independent source of new knowledge that is readily accessible through the published research of literature. Second, they interpret research trends of interest to business and industry by routinely monitoring the published scientific research and patent literature. Third, they imbue much of the 'human capital' with the skills needed to sustain the creation and interpretation of new knowledge.

Universities are not merely a set of different disciplines working in splendid isolation, they are living intra-networked elements, connected in turn to the society which they serve (Figure 1). There has never been a period in history when this holistic, interconnected approach to learning and research has been more relevant.

Figure 1. Schematic of a Modern University



But once created, how can new knowledge be transformed into economic growth? This question raises five underlying issues: the concept of knowledge as a form of equity; the innovation process; protection of intellectual property; mechanisms of technology transfer; conversion of knowledge equity into jobs.

Knowledge as a form of equity. New knowledge is one of the most tradable commodities in the world because of its direct link to economic growth; hence the notion of knowledge as a form of equity just as finance is a form of equity.[29] The means by which *knowledge*

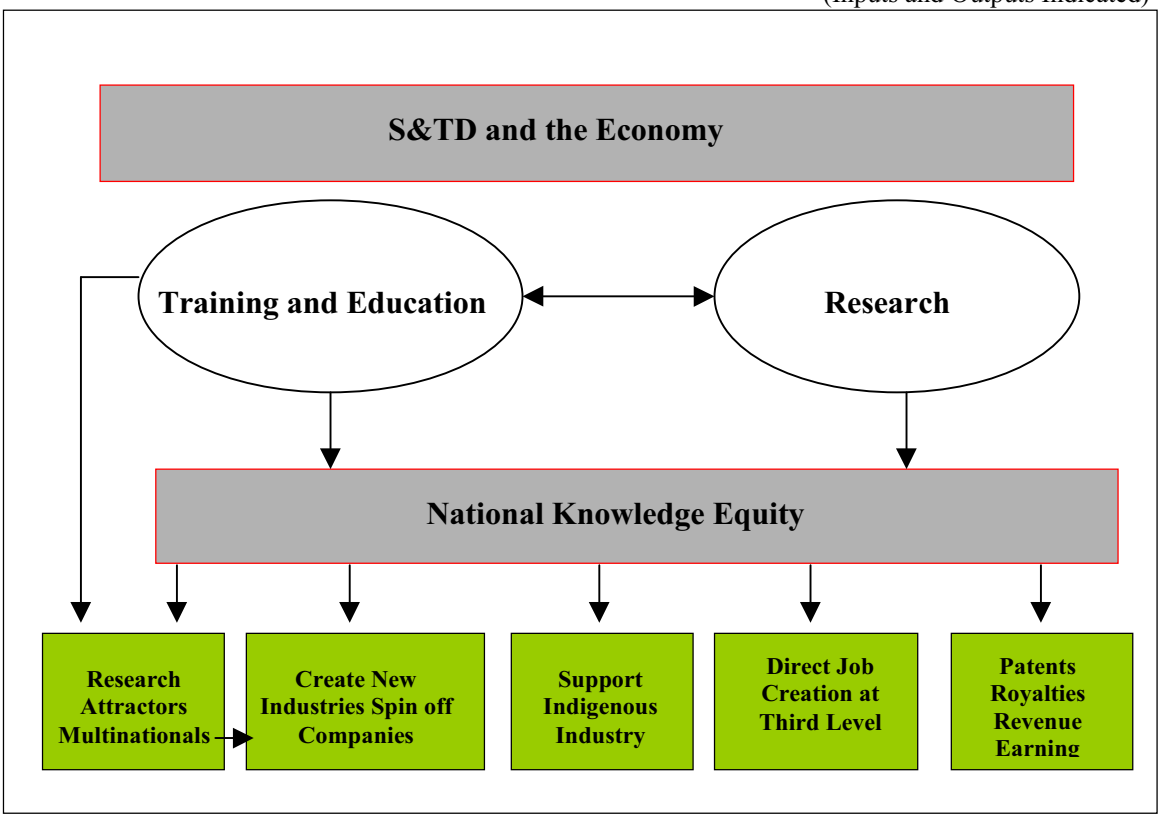
[29] V.J. Mcbrierty and R.P. Kinsella (1998).

equity is created in the university and subsequently exploited to the benefit of society at large are illustrated in Figure 2. Research from whatever source (basic, applied, imported), along with well-educated and trained graduates (human capital), constitute the academic contribution to the '*national knowledge equity base,*.[30] This term encapsulates the intrinsic value of the nation's protected knowledge (patents, copyrights) and the scientists and technologists who create and apply it (human capital). In this sense, *national knowledge equity* reflects the creative ability of the nation. The beneficial outputs for society include the following:

- Highly-trained graduates and readily-accessible research support for inward investors, usually subsidiaries of multinationals which, in turn, can spin-off further subsidiary service industries.
- A strong technology profile for the nation which is a further attractor of inward investment.
- Research and technological development (R&TD) support for indigenous business and industry.
- The creation of new home-grown, indigenous enterprise in the private sector and, in some cases, within the universities in the form of campus companies.
- Direct job creation within the universities in fulfilling its research contract commitments.
- Supplementary income including patent and royalty earnings from protected intellectual property (IP), which can be used, for example, to offset the inevitable shortfalls in state funding arising from an ever-increasing demand for higher education.

[30] Exclusive reference to universities is not intended to dismiss or diminish the valuable contribution of other sources of research—for example, other, research oriented institutions in the HE sector, state laboratories and industrial laboratories—to the national knowledge equity base. The intention is merely to illustrate the principles involved.

Figure 2. The University Contribution to the National Knowledge Equity
(Inputs and Outputs Indicated)



The innovation process. Innovation has been described in the EU Green Paper on Innovation (1995) in the following terms:[31]

> "Innovation is not just an economic mechanism or a technical process; it is above all a social phenomenon…the history, culture, education, political and institutional organization and economic structure…determine society's capacity to generate and accept novelty."

Innovation involves the commercialization of knowledge and the translation of a new idea into a marketable product or process. It requires scientific, technological, design, engineering, and marketing inputs. Innovation flourishes best in an entrepreneurial and innovative culture within which a number of participants, including the universities, can

[31] Green Paper on Innovation, *Bulletin of the EU*, Supplement 5/95, 1995, p. 77.

cooperate to derive the full benefits of technology. This concept of *partnership* is all-important.

The commercialization process can be quite complex and costly, with three major hurdles to overcome. First, is the new idea commercially viable; second, will society accept the end product; and third, will the necessary finance be available to meet the development, production and marketing costs? These criteria, in effect, define the risks involved for those who wish to invest in the necessary research and technological development. It has been argued by one major multinational that for every dollar spent on research and development (R&D), a further $10 are spent on product design and a further $100 on product delivery and manufacturing.[32] This, again, reinforces the notion of shared risk through partnership and teamwork in exploiting the fruits of new technology.

Protection of intellectual property (IP). Since the innovation process depends acutely on *proprietary* access to new knowledge, it is essential that its ownership is firmly established and protected. This is all the more important in light of the high costs in transforming a new idea into a commercial product, as indicated above. The management of intellectual property is not only an issue for individual institutions, it is important at a national level, for example, in meeting the membership requirements of the WTO.

Mechanisms of technology transfer. Technology transfer between those with the knowledge and those who seek to exploit it is a key element in the innovation process. It is a central step in any strategy to achieve commercial benefit from new knowledge. Consider as an example, technology transfer out of the universities, which can be achieved through consultancy, research and training. Figure 3 illustrates the interface between academia and knowledge-based industry and indicates ways of strengthening the 'corridor of opportunity' between the two.[33] On the supply side, appropriate financial support, an entrepreneurial culture and improved systems of governance are essential in the niversities.

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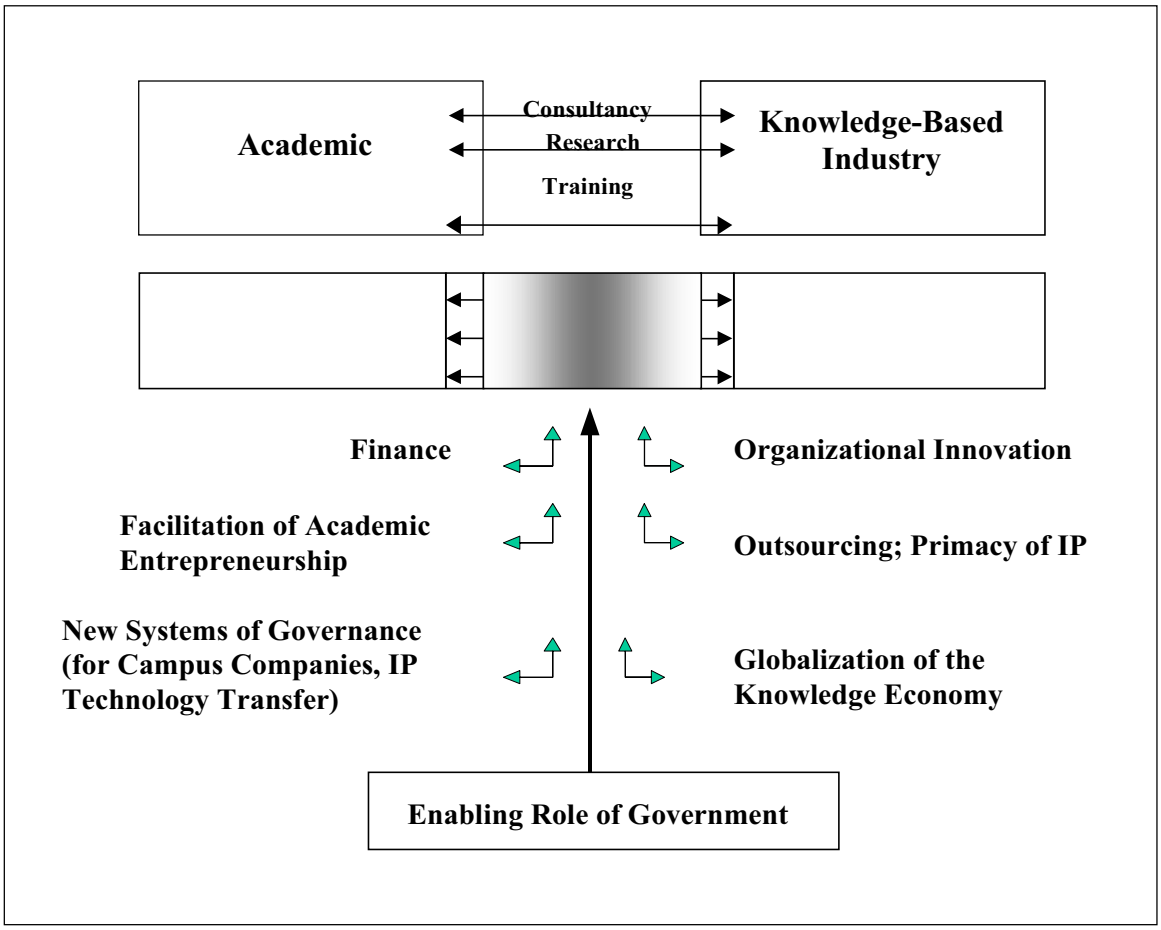
[32] C. Duke, "How to Get Value from Industrial R&D," *American Physical Society News*, December, 1998, p. 8.

Industry, on the other hand, requires organizational innovation, better management of intellectual property and a constant awareness of the continuing globalization of the knowledge economy, all within an enabling framework established by government.

Figure 3. Factors Leading to Widening the Techno-Academic Corridor of Opportunity

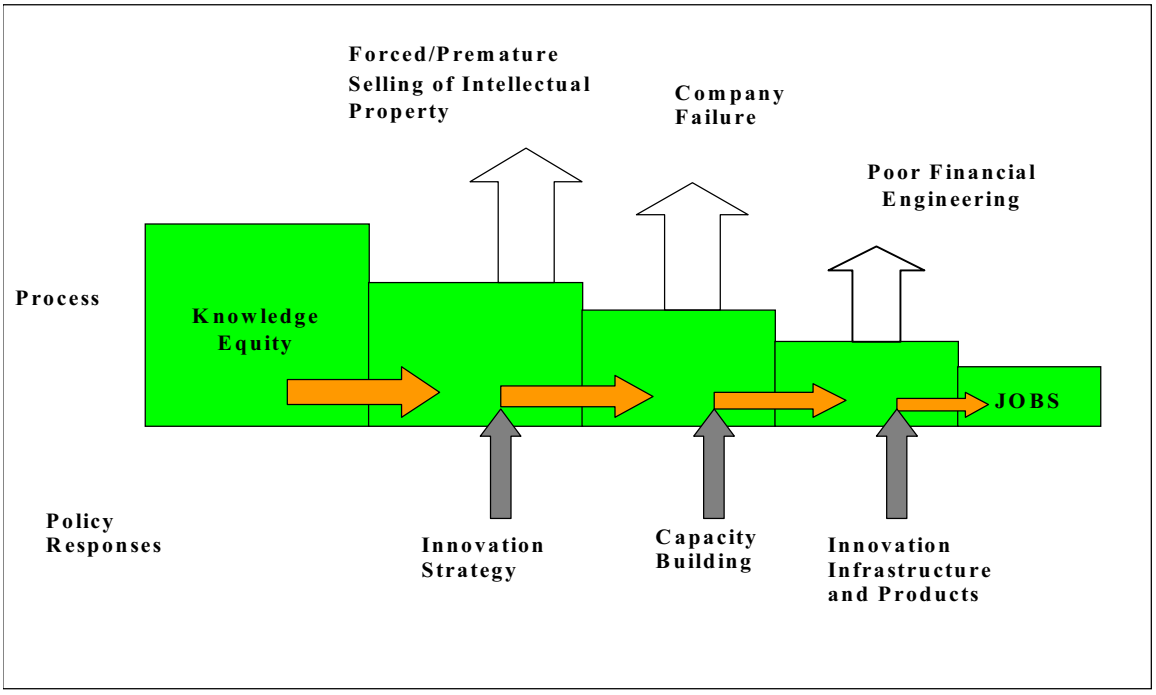


Conversion of knowledge equity into jobs. The process of converting knowledge equity into jobs is visualized schematically in Figure 4, which identifies the pitfalls. These include inadequate financing, difficulties in pricing technology risk and the low level of technological literacy in financial institutions. The overriding tendency to systematically

[33] V. J. McBrierty and R. P. Kinsella (1998).

under-invest in innovation ultimately presents the major challenge for governments and the private sector. The solution clearly lies in joint-public/private sector strategies to reach an appropriate level of investment to the mutual benefit of both the private sector and society at large (*c.f.* Section 4.5.3).

Figure 4. Commercialization of Innovation: The 'Dilution Effect' and Policy Responses



The techno-academic paradigm. It is clear that the universities and other research-oriented institutions in the higher education sector continue to have a vital role to play in the economic development of a nation. This will require sustained growth in entrepreneurial and innovative thinking if the fruits of their research are to bring maximum benefit to society. There are a number of elements which, taken together, form the basis of the techno-academic paradigm:

- A consolidated approach to the creation of a national knowledge equity base.
- The effective utilization of this equity base by means of an ever strengthening education/industry interface.

- A more enlightened approach to intellectual property.
- The need to address the human side of technological development by adopting a more holistic approach that incorporates the arts, social sciences and humanities into the strategy for exploiting science and technological development.

This approach emulates earlier initiatives by W O. Baker at AT&T Bell Labs in promoting the case for a more holistic understanding of a developing knowledge economy.[34] In the 1960s, a department of economics was set up to address issues at the techno-economic interface. Many programs were initiated to strengthen the interaction between Bell Labs and the universities, both local and foreign; and, latter, a division that included computer scientists, mathematicians and behavioral psychologists was set up to explore the social impact of the new information and communications technologies.

3.3 Business and Industry as End Users of Technology

As indicated in my opening remarks, the profile of global industry and its mode of operation have undergone a radical change in recent decades, driven by opportunities created by the new technologies. The sector is truly in the '*transformation age*'. Three trends in particular have emerged.

First, the corporate giants have progressively become more fragmented and globally dispersed in their mode of operation. A so-called '*world wide web of added value'* has been created in the sense that an increasing number of high-tech products now use components that are manufactured and assembled in many different countries.[35] This changes the rules for foreign direct investment (FDI) in countries and regions that seek to develop a multinational sector in their industrial base. Even a modest shift in such investment can have a large effect on local employment both in terms of the numbers

[34] W. O. Baker, former Chairman of Bell Laboratories (now, Lucent Technologies) and Presidential Adviser, private communication.

[35] In O. Donoghue (ed.), *Ireland in the 21st Century* (Dublin: Mercier Press, 1995).

employed and the quality of the jobs created. The large corporations now rely less on in-house research and technological development (R&TD) and more on external contract research. As a result, they have benefited from reduced overheads, improved access to leading-edge research in the universities and elsewhere and improved response time to the constant threat of technological obsolescence. This outsourcing of contract research provides an important opportunity for universities to earn additional income to compensate for ever-decreasing state support.

Corporate mergers are proceeding at an unrelenting pace. In 1999, mergers in world economies reached US$3 trillion. Contrary to expectation, however, this accelerated trend towards monopolies has not led to rising prices because of the built-in parameters that define the knowledge economy: globalization, increased investment in technology, deregulation and increasingly sophisticated computer and information technology, which have created a more flexible workforce and higher productivity. This, in turn, has triggered a downward trend in consumer prices worldwide through reduced costs and economies of scale. But, more importantly, small, innovative, knowledge-driven, IT-based companies are providing the necessary counterbalance.

The size profile of industry has also changed with an ever-increasing emphasis on small companies as the major job creators—the small to medium enterprises (SMEs) or even microenterprises. In the United Kingdom, for example, there are 3.7 million businesses of which 7,000 are large companies of more than 250 employees, 25,000 are medium sized (50 to 249 employees) and the remaining 99 percent have between 1 and 24 employees. Since small companies are generally unable to carry out their own in-house R&TD, they too must rely on accessible sources of new knowledge for their sustained growth, as provided by the universities.

3.4. Finance and Equity Institutions

Technology-based firms (TBFs) require a broad spectrum of novel and diverse financial instruments to meet their non-traditional needs in exploiting innovation. The function of market-based finance, encompassing the credit and capital markets, is to provide finance in a way that reflects the risk/return profile of TBFs. In many instances, financial institutions have not kept pace with the emerging knowledge economy, leading to a market failure—or a technology financing gap—in the provision of financing for innovation.

A recent survey of five leading banks in each of the 15 member states of the European Union (EU) revealed that over 80 percent did not operate an informal capital system beyond the core bank products; nor did 40 percent provide venture capital.[36] Only 27 percent accepted intellectual property as collateral whereas some two-thirds of the responding banks indicated that they positively did not accept IP as collateral for loans to TBFs. There are many reasons for this:

- Difficulties in pricing risk.
- The perceived small size of the market.
- The lack of leverage that a more fully integrated public/market-based system would bring to the funding of technology.
- The fact that the balance sheets of TBFs which value IP as much as fixed assets is at odds with the banks' view that IP is not acceptable collateral/security.
- The availability of what are perceived to be more attractive, albeit more traditional, investment opportunities.
- A technology-averse mind-set or culture within major financial institutions for example, scientists and technologists, are significantly under-represented in key management or advisory roles within the banking system.

[36] R. P. Kinsella, *An Evaluation of EU Banks' Support for Technology*, Report for the EU Commission, Luxembourg, 1997.

Unlike the United States, Europe continues to be risk averse, which impacts negatively the growth of TBFs. But are TBFs, in fact, inherently more risky? On the basis of a pan-EU study of TBFs, one group of researchers concluded that:

"Small technology-based firms have higher growth rates and survival rates that are at least as high as those of small business in the non-technology sectors [and] on these grounds, investment in technology-based enterprises should be equally, if not more, attractive than investments elsewhere."[37]

4. Global Impact of the Knowledge Economy

The validity of the underlying principles of the knowledge economy, and their relevance to Egypt, is best illustrated by reviewing experience elsewhere in the world. For decades, the United States wholeheartedly embraced the knowledge economy and is now reaping the rewards of that foresight and vision. Europe on the other hand, lagged behind the United States in many important respects including technological development and its implementation; using the new technologies to refine work practices; creating an entrepreneurial and risk-taking culture; and promoting and protecting intellectual property. For many years, much of Europe was content to support long established and often ailing industries with periodic transfusions of state subsidies, generating, in effect, a form of economic sclerosis.

4.1. The United States and the Knowledge Economy: The Greenspan Critique

In May 1999, Alan Greenspan, chairman of the US Federal Reserve, analyzed the current remarkable strength of the American economy, underpinned by the lowest unemployment in decades, negligible inflation and an accelerated growth in labor productivity—up by a factor of three over the early 1990s.[38] Contrast this with the lukewarm economic performance of Europe and the financial downturn in Asia in 1997. The United States has

[37] D. J. Storey (ed.), "New Technology-Based Firms in the EU", Report for the EU Commission, University of Warwick, Center for SMEs, 1996.

[38] M. Porter and J. Sachs (1999). A. Greespan, remarks at the 35th Annual Conference on Bank Structure and Competition of the Federal Reserve of Chicago in May, 1999.

managed to provide a counterbalance to the comparative weakness of these co-members of the dominant global economic triad—but at a price. The US economy is currently experiencing a worrying negative personal savings profile, a widening trade deficit on goods and services and escalating domestic demand equivalent to one-third of the world's total.

What is interesting is that Greenspan's reasoning behind this performance fits the knowledge economy template in terms of:

> "A structural shift overriding conventional economic patterns over a number of years…[where] new innovations have begun to alter the manner in which we do business and create value, often in a way not readily foreseen even five years ago…the recent acceleration in labor productivity reflects, at least in part, a more deep-seated, still developing, shift in our economic landscape."

Importantly, business and industry in the United States are using new technology to improve and upgrade work practices and methodologies.[39] According to Greenspan, in financial management:

- The process of capital reallocation is benefiting from a significant unbundling of risks due to the development of new and innovative financial products.
- Lead times are foreshortened, making capital investment more profitable, thereby enabling industry to substitute capital for labor and other inputs more productively than heretofore.
- Inflation is dampened because of the effect of technology on international trade in reducing barriers to cross-border trade.
- Lower inflation supports wage restraint, and job security has become more important than wage increases in a period of accelerated job attrition through substitution of capital for labor.

In manufacturing:

- Real-time information is bridging many information gaps.

- Intermediate production processes are being bypassed or are dissolving altogether.
- Multinationals have become more decentralized and dispersed, leading to greatly-reduced overheads and employment levels *(c.f. Section 3.3).*
- The corporate giants are becoming less dependent on in-house R&TD and, increasingly, are reaping the benefits of access to 'global knowledge networks' (as indicated in Section 3.3, this also enhances a company's flexibility in dealing with technological obsolescence in an era of rapidly changing technology).

- Design times are shrinking because of advances in computer aided design (CAD) and computer modeling.

Greenspan, however, sounded a note of warning regarding the diminishing pool of skilled workers. Since 1986, for example, the number of engineering graduates has fallen, on average, by 20 percent due, in part, to the inadequate performance of American high school students in mathematics and science relative to many of their international counterparts. A pervasive disenchantment with science and engineering careers in many developed countries should also be noted. The message is clear: first, policy formulation must address the full spectrum of education provision, which includes the schools; second, the next generation of young people are, perhaps, signaling the importance of the non-scientific and technological disciplines in shaping the society of the future.

4.2. The United Kingdom and the Knowledge Economy

Nineteen-ninety eight was a landmark year for industrial policy in the United Kingdom with the publication of the White Paper, "*Our Competitive Future:* Building the Knowledge Driven Economy in December." [40] It presents a comprehensive program aimed at, "reversing a century of relative economic decline… [by] calling for a renewed focus on knowledge as a means of providing competitive advantage." The Department of Trade and Industry in the United Kingdom devised an implementation plan indicating mechanisms,

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[39] V. J. McBrierty and R. P. Kinsella (1998); A. Greenspan (1999).

time scales and targets, and is exploiting the Internet to ensure the most effective two-way communication between all participants throughout the public and private sectors.[41] Notably, the document vigorously promotes government/private sector partnerships.

The White Paper comprises five sections that illustrate the scope of the agenda for supporting innovators, assisting enterprise and encouraging entrepreneurship: building British capabilities; collaborate to compete; competitive modern markets; information communications technology; and innovation and entrepreneurship in government.

The more important initiatives include a new venture capital fund to support small and promising TBFs ($200 million); strengthening the interface between higher education institutions and business ($30 million); establishing a supplementary equipment fund ($120 million); developing high technology clusters; encouraging regional as well as central initiatives; and, more generally, fostering an entrepreneurial culture within which scientists and engineers can exploit fully the research carried out in the public and private sectors. The emphasis on universities as a key source of new and accessible knowledge attests to their importance in achieving industrial development and economic growth. Recall that the bulk of job creation in the United Kingdom is now achieved through small companies of 24 employees or less *(c.f. Section 3.3)*. These initiatives—designed to harness the nation's knowledge, skills and creativity and defined in an earlier section as the nation's *national knowledge equity*—represent a major cultural shift in the United Kingdom. It is a bold and timely step for a British Labor Government, representing as it does, "a turning point in ideology and policy for party and country," albeit in response to the potential threat of recession. It also obviates the erstwhile tendency in the United Kingdom to undergo abrupt reversals of economic policy with changes of government. In

[40] U.K. White Paper (1998).

[41] British Department of Trade and Industry web site, http://www.dti.gov.uk/competitive/wh-int1.htm.

the words of the British Secretary of State for Trade and Industry, "Labor has dumped its interventionist past."[42]

4.3. Ireland and the Knowledge Economy

At first glance, it is difficult to understand Ireland's truly remarkable economic performance over the last few decades because of the many apparently insurmountable difficulties facing small open economies. With a population of about 5 percent that of the United Kingdom, Ireland has few world-size indigenous companies and a GNP that is relatively small on the global scale. The GNP of the United States, Germany or Japan, the United Kingdom, and Ireland decreases in steps of about a factor of ten in progressing from one country to the next. But the rules of the game for economic growth have changed radically. A few people with the right intellect, flair and entrepreneurial ability operating within a supportive national infrastructure can exert disproportionate influence on economic growth. Crucially, that growth can be achieved on a national scale when the government and the private sector work in close harmony with each other.

Historically, Ireland did not benefit from the Industrial Revolution of the 19th Century. Persistent economic weakness led to chronic unemployment over two centuries and the disastrous famine of 1846—due to a failure of the potato crop—triggered emigration on a massive scale. Before 1846, Ireland's population was 8.3 million people; today the population of Ireland—North and South—is just over 5 million. In the intervening period, there was a dominant reliance on traditional agriculture and fisheries with little high-tech industry and an absence of an entrepreneurial culture. Having joined the European Economic Community (EEC) in 1973; Ireland was ranked among the poorest nations in the Community. Ireland labored under the additional burden of pervasive political and social unrest.

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[42] E. Masood, "Britain Embraces 'Knowledge Economy," *Nature* 396 (24/31) (December, 1998): pp. 714-5.

On the positive side, education, heritage and culture continued to be highly valued, even during the worst economic times. The natural beauty of Ireland and its strong cultural heritage were major assets with high potential for attracting tourism. Additionally, Ireland's membership of the EEC conferred direct access to European markets for inward investors.

There were three important inflection points in Ireland's recent economic development. First, the initial program in 1960 to develop a stronger industrial base through foreign direct investment (FDI); second, the decision to join the EEC in 1973; and third, the domestic measures taken to participate fully in the global economy as Ireland's only feasible option in 1987, which in retrospect gave birth to the so-called 'tiger economy'.

Figure 5 highlights Ireland's macroeconomic profile over the last four decades.[43] The data define an initial period of sustained development, from 1960 to 1980, followed by a period of acute recession in the first half of the 1980s triggered by excessive foreign borrowings to sustain growth in the 1970s. At that time, the debt/GNP ratio climbed to 130 percent, generating real fears of national insolvency.

Steps were then taken to restore an effective public finance policy which, in turn, initiated the current phase of growth. The current status of Ireland's economic development is shown in Figures 6a-c, which compare economic performance in a number of European countries.[44] Ireland's recent performance has, in fact, exceeded the 1997 predictions in noted Figure 5. The parameter that is most revealing is the ratio of GDP annual growth over 1998 and unemployment as a percentage of the workforce. This parameter monitors *growth through employment*, rather than growth at the expense of employment.

[43] Statistics prepared by the Economic and Social Research Institute, Dublin, Ireland, 1997.

[44] These data are based on the national statistics prepared by Dresdner Kleinwort Benson, 1999.

Figure 5. Annual Average Growth in Ireland (% GDP)

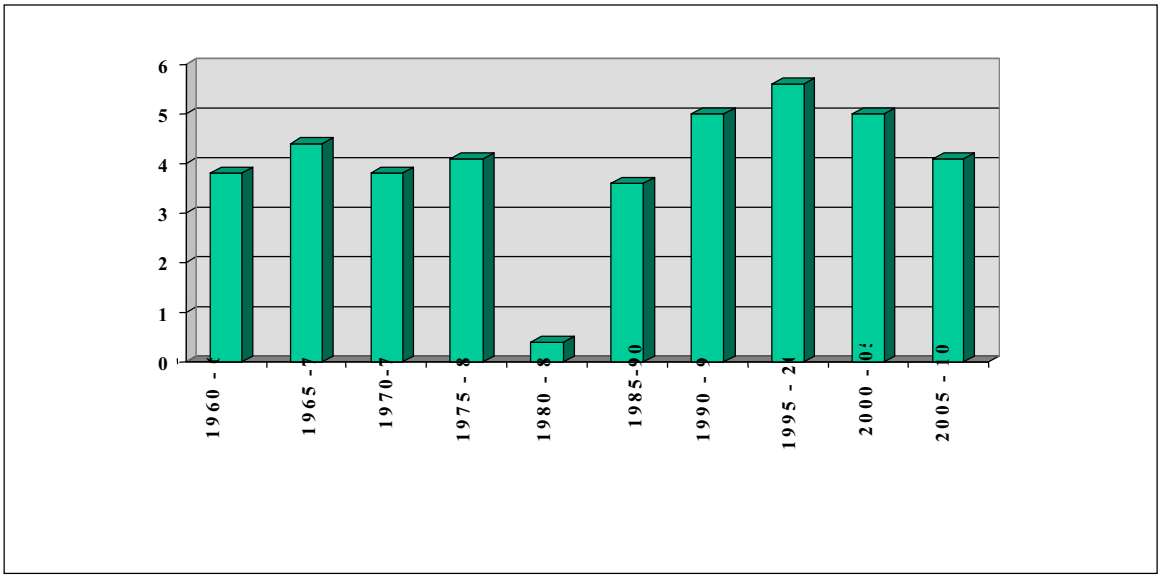


Figure 6a. Percent of GDP Growth over 1998 for Nine European Countries

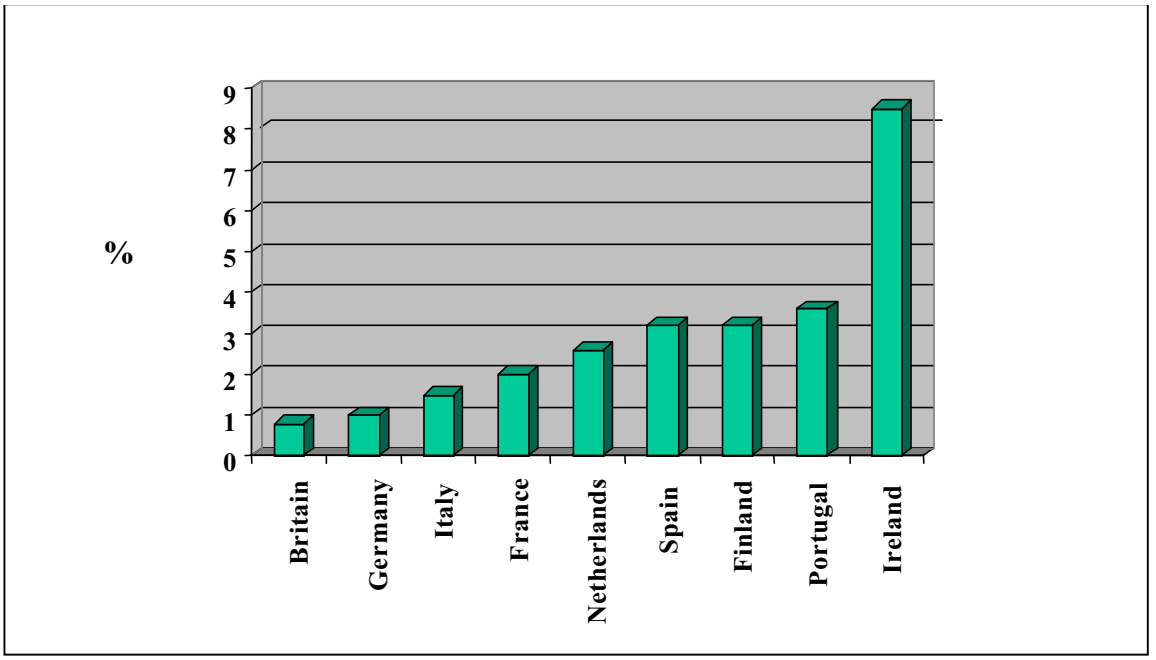


Figure 6b. Unemployment as a Percent of the Workforce in 1999

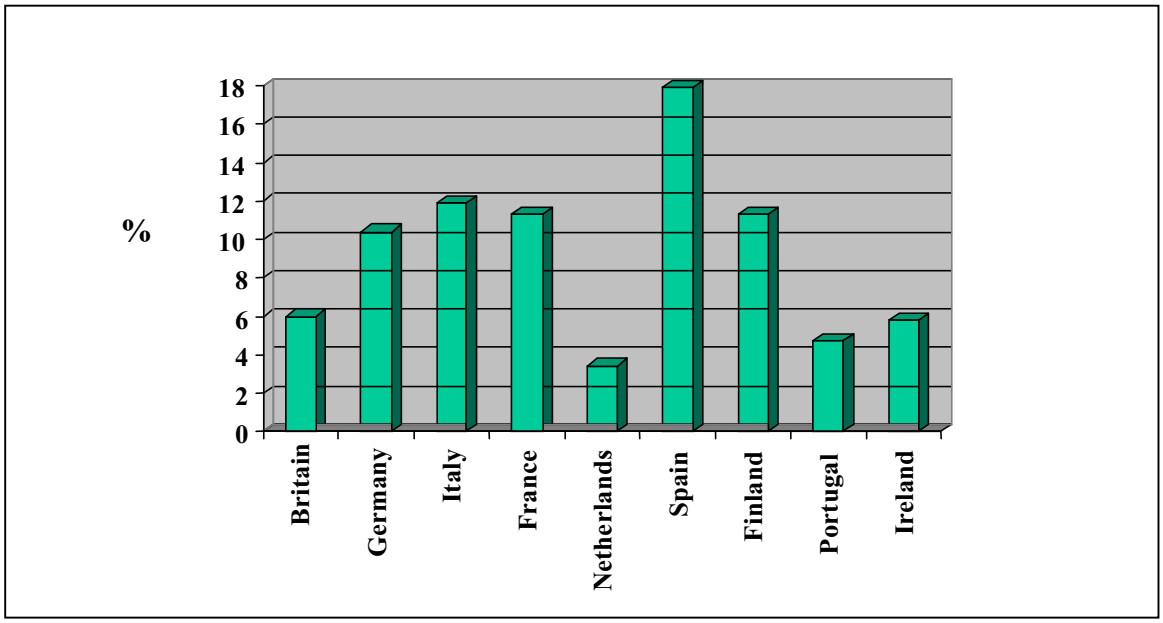
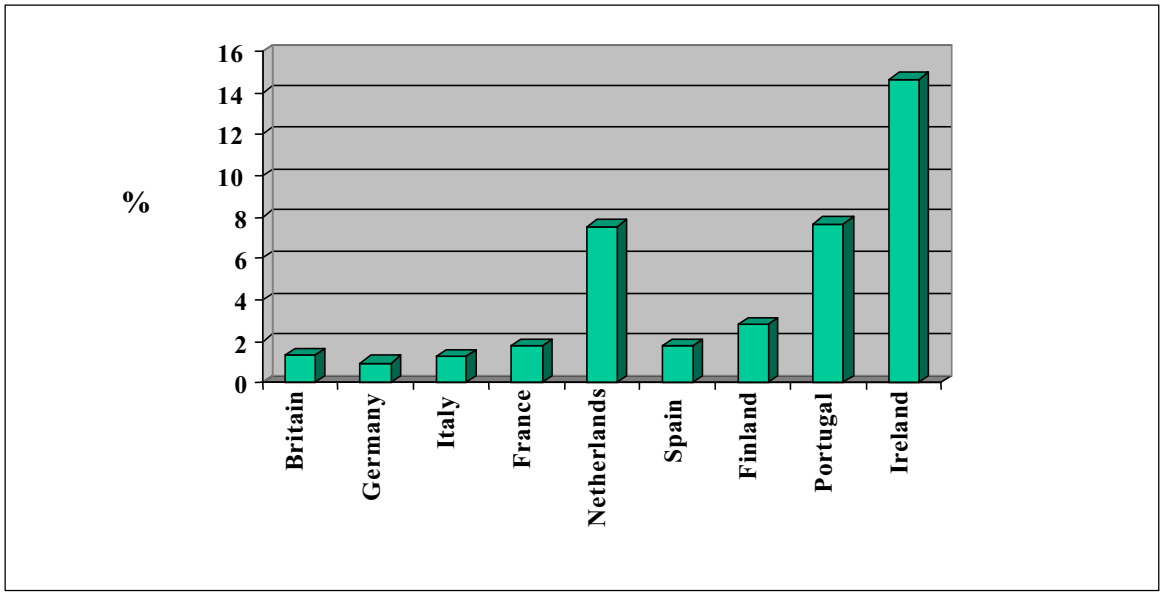


Figure 6c. Ratio of GDP percentage Growth over 1998 and Unemployment as a Percentage of the Workforce



How did this renaissance come about? During the depression of the 1980s, it became clear that Ireland was faced with a stark choice: ignore the global knowledge economy or embrace it. A conscious decision was taken to become part of this broader group of global markets, with Europe as a subset. This followed a rather painful critique of the institutional changes required and the budgetary discipline needed for progress. The key steps in the new approach were:

- First, acknowledge the earlier policy failure and learn from it.
- Second, reaffirm the importance of a research-intensive process of study and investigation that ensured, as far as possible, that decisions on new policy were informed. What did not work or what was rendered obsolete by the rapidly-changing global economic environment was changed or adapted according to a series of ongoing studies among which the Culliton Report (1992) and the Report of the Science, Technology and Innovation Advisory Council (1995) were notable examples.[45, 46]
- Third, recognize that economic and social progress must proceed concurrently. The only effective basis for full social inclusion and stability is not only a willingness to accommodate the fiscal and monetary requirements of economic growth, but also to build inclusive institutions and partnership arrangements that are made to work. This implicitly recognizes that a dynamic economy is the only basis on which the resources necessary for social progress can be acquired, albeit creating a dual economy in the initial phase of development.
- Fourth, acknowledge that universities were a key enabling factor; along with a willingness to make changes in the mechanisms of government and industrial economic policies. This entailed significant institution building to sustain FDI, support R&TD, ecourage SMEs and microenterprises (10 people or less), and

[45] Report of the Industrial Policy Review Group (Culliton Committee), "A Time for Change: Industrial Policy for the 1990s," Government Stationery Office, Dublin 2, Ireland (1992).

[46] Report of the Science, Technology and Advisory Council (STIAC), "Making Knowledge Work for Us," Government Stationery Office, Dublin 2, Ireland (1995).

overall, to create and sustain an entrepreneurial and innovative culture. An environment was created wherein university knowledge equity—that is, intellectual capital—could flourish and act as an attractor of FDI and a generator of a robust and innovative domestic sector.

- Draw upon Ireland's vast reservoir of skilled personnel who emigrated to other countries during Ireland's more difficult economic times. With the growth of the knowledge economy the necessary incentives could be provided to attract some of these people back to Ireland.

Social partnership. Social partnership was a key contributor to Ireland's recent change of fortunes. Employers, trade unions, farmers and senior civil servants came together to negotiate three successive strategies: the Program for National Recovery (1987 to 1990), the Program for Economic and Social Progress (1990 to 1993), and the Program for Competitiveness and Work (1993 to 1996). The basis of these programs was a trade-off between wage restraint and higher productivity, on the one hand, and social equality and tax reform on the other.

Foreign direct investment (FDI). Increased productivity is linked, in large measure, to FDI which has been the main driver of Ireland's industrial strategy since 1960. Subsidiaries of foreign multinationals were attracted to Ireland with tax incentives, the availability of trained manpower and access to European markets. The direct benefits accruing from FDI include: employment creation; building local infrastructure; generating spin-off companies; acquisitions and joint ventures; investment in new start-ups; partners in industrial government policy; and support for R&TD.

Initially, foreign subsidiaries assumed a purely manufacturing role based upon imported product and process protocols. With the continuing evolution of the knowledge economy and a desire to anchor these FDI companies more firmly in Ireland, they were encouraged to undertake a comprehensive range of activities including R&TD, product and process development, as well as manufacturing and marketing. In some cases, new intellectual

property was created, often through joint ventures with the universities. This approach was also in harmony with the growing tendency of large corporations to downsize the parent plant and disperse their activities across the globe *(c.f. Section 3.3)*.

Ireland's industrial base expanded progressively and selectively to include, in particular, computer software and hardware, food processing, pharmaceuticals, telemarketing, and financial services. By 1994, the OECD estimated foreign direct investment per capita from Americain to Ireland at $3,000 compared with $2,000 into the United Kingdom, $500 into France and Germany, and $200 into Spain. The return on investment for these companies was productivity and profit levels that far exceeded their domestically-owned counterparts. In the words of one commentator:

> "The newcomers have transformed their host. But they have done this not mainly by forcing indigenous Irish companies to change their ways so much as by constituting a new economy in their own right."[47]

Thus, a dual economy was created with a relatively low productivity, low-tech indigenous sector coexisting alongside a highly-advanced set of foreign-based, knowledge-driven subsidiaries. Regrettably, there has been little evidence to date of mutual synergy, dialogue, technical, managerial, or organizational innovation between the two sectors.

Tourism. While there have been remarkable developments in global society over many millennia, history again teaches us that human nature and human instincts remain relatively unchanged. Today's technology-driven age enhances the need for cultural pursuits; thereby generating a growing and sustained interest in both national and global culture and heritage. It therefore comes as no surprise that tourism—and cultural tourism in particular—is a growth industry. The World Travel and Tourism Industry estimates that

[47] *The Economist,* May 17th, 1997.

in 1999 travel and tourism is generating, both directly and indirectly, 11 percent of global GDP and about 200 million jobs, which represents 8 percent of total employment.[48]

This has borne out in Ireland where international earnings in 1991 were $1.6 billion, that is, 9 percent of total foreign earnings. In 1997, this figure increased to $8 billion or 15 percent of foreign earnings, which was achieved with government investment in tourism of only 0.3 percent of gross government expenditure in 1997.

Human Resources. Economic growth depends crucially on access to a sustained supply of well-educated personnel in both the professional and vocational streams. This requires an educational system at the primary, secondary and tertiary level that is flexible and responsive to the changing needs of the knowledge economy without sacrificing the core requirements of a broad-based education. Skills must match demand and since that demand is fluid, education must instill the essential attributes of flexibility, teamwork and problem solving. The more traditional view of a career-for-life is now being replaced by the notion of education as a life-long learning process with numerous job and career changes. After generations of emigration, Ireland is now a net importer of people, at least half of whom are talented emigrants who traveled abroad during Ireland's recessionary period.

A Note of Caution. Despite this unprecedented success, there is little room for complacency. Ireland's new-found prosperity is generating rapidly-escalating property prices and growing demands for unrealistic wage increases. Will Ireland become a victim of its own success at a time when membership of the European Monetary Union (EMU) precludes the use of conventional economic instruments for controlling unwelcome economic trends at the local level? These instruments are now in the hands of others.

Furthermore, while the economic model described in the section on FDI generated clear short-term benefits, it will not be deemed wholly successful if the dual economy in Ireland

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[48] K. Spragg, "Cultural Heritage Tourism Promised Growth for Oman," *Oman Daily Observer*, 13 October 1999, p. 6.

becomes a permanent feature of the national economy. It will certainly be viewed as a failure by the marginalized of Irish society if the quality of life does not improve as a result of the additional wealth created. Despite the fact that unemployment has fallen to 5.8 percent (down from 15.9 percent in 1993), with the long-term unemployed accounting for 2.6 percent of the labor force, there are real concerns that a significant number of long-term unemployed or 'marginally attached' people with low skill levels will be left behind.

4.4. Oman and the Knowledge Economy

Oman is an interesting example of an Islamic nation in the process of developing a knowledge-based economy. In 1970, at the beginning of his reign, His Majesty Sultan Qaboos bin Said made the following promise to his people:

> "I promise you that a new dawn will rise in Oman, a new dawn which will give its people a new life and a new hope for the future."

Since that time, progress has exceeded all expectations. Oman has established the essential physical infrastructure for future growth, namely: efficient transportation facilities by road, sea and air, instruments of commerce and trade, and comprehensive health, education and training services. Successive five-year plans, consolidated in the strategy document *Oman 2020,* define the challenges for the country as it enters the next millennium. A central plank of future policy is, "the achievement of economic stability and diversity based on modern scientific basis and advanced technology, so that it could interact remarkably and intensively with the global economy." To achieve these policy goals, Oman is committed to the following specific actions:

- Developing a vibrant, diverse and stable private sector to reduce the current level of dependence on oil;
- Encouraging FDI;
- Generating a well-trained and educated Omani workforce that is both flexible and relevant to the future needs of Oman;

- Developing and exploiting science and information technology to the benefit of Oman as an integral part of the global economy; and
- Creating joint government/private sector development strategies.

These goals are also in keeping with Oman's intention to become a member of the World Trade Organization.

Sultan Qaboos University (SQU) has a key role to play in fulfilling this mission. Mechanisms are now in place to promote research and development, to protect new knowledge, to strengthen the interface between SQU and the wider community, and to establish technology transfer mechanisms between the university and the industrial sector. A strong dynamic partnership between the university, government and the private sector will create an appropriate framework to promote Oman's growth into the next millennium.

5. Egypt and the Knowledge Economy

Since 1952, and more particularly since 1991, Egypt has become a model emerging market.[49] In the words of H.E. Youssef Boutros Ghali, Egypt's Minister of Economy, "The reform program has moved from the hormonal exuberance of adolescence to the cruising speed of adulthood."[50] Inflation remains below 4 percent, the budget deficit is about 2 percent and GDP and foreign reserves are approximately of $19.8 billion. The 5.2 percent growth achieved in 1998, though satisfactory in comparative world terms, is less than the stated objective of 7 to 8 percent of GDP and less than economist Jeffrey Sachs' estimate of what could be achieved.[51] According to International Monetary Fund (IMF) estimates, meeting this growth target would require $22 billion of investment each year and a 25

[49] "A Survey of Egypt," *The Economist,* March 20, 1999 pp. 1-18.

[50] Y. Boutros-Ghali, *ibid.* p. 4.

[51] J. Sachs, (1996).

percent increase in productivity. The necessary investment would require an increase in FDI from a current level of $1 billion to about $8 billion.[52]

Note, however, that the proposed new Northwestern Gulf of Suez Industrial Zone has a stated potential to attract $44 billion in long-term investment *(c.f.Section 2.3.)*. Foreign investors will benefit from tariff-free exports to nearby European, African and Arab markets, while Egyptian products will have easier access to foreign markets. Access to the Common Market for Eastern and Southern Africa (COMESA) and the European Union through this joint Egyptian/Chinese venture is appealing to potential investors provided their concerns about some of the more pedantic regulations and business practices can be satisfactorily met.[53]

Towards this end, current growth has been achieved with a policy geared towards economic stabilization, sustained deregulation, transparency, and restructuring under three successive 5-year plans from 1982 to 1997. As a result, exchange controls have been abolished, the rules governing financial transactions have been relaxed and more open access to information has been achieved. The resilience of the reform process was severely tested by the fall in oil prices, the meltdown of Asian economies in 1997 and the downturn in tourism following events in Luxor in 1997.

The new government in Egypt has pledged not only to continue privatizing state-run firms but to accelerate the process in keeping with the advice of the World Bank. State-owned banks, however, have evaded privatization. This will undoubtedly change as a result of the expected increase in competition from E.U. countries, anticipated agreements with the European Union and Egypt's compliance with WTO rules by 2002.

There have been important improvements, too, in Egypt's physical infrastructure. It is no longer the case that 95 percent of the people are confined to the 5 percent of land in the Nile Valley. Major irrigation schemes and a systematic development of the coastlines have

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[52] M. Huband, "Dearth on the Nile," *The Banker*, July 1999, pp. 60-68.

[53] S. El-Gamal, "Egypt Builds Mega Industrial Zone," *Oman Daily Observer*, 20 September 1999, p. 10.

rendered other regions of Egypt habitable, thereby leading to a greater population spread throughout the country.

That said, there is much that remains to be done. *The Economist's* survey of March 1999 singled out the following problems:[54]

- A high level of protectionism with legal and regulatory systems that remain inefficient. For example "it still takes 77 bureaucratic procedures in 31 different offices to register property."
- There is still a shortage of skilled professionals in the senior ranks of the civil service where as in many other countries, seniority takes precedence over merit.
- Government power is centralized with little or no local empowerment.
- The educational system leaves much to be desired with a mismatch between the skills required and the education provided.

More generally, Egypt displays the worrying symptoms of many other developing economies, namely: economic growth that is outpacing social growth, inadequate diversification of revenue sources, excessive reliance on foreign borrowing to forestall recession and accelerate economic growth (as was the case in Ireland prior to 1985), and the creation of a dual economy where, in the words of one commentator, "The great bulk of Egyptians still continue to scrape along somehow on a blend of wit, ingenuity, humor and tolerance, regardless of the economic earthquake stirring the ground all around them."

In summary, while continuing to make strident progress, Egypt has not yet fully embraced the knowledge economy. Nor has Egypt begun to exploit its strengths in the areas of education and research. While the education sector is relatively quiescent at home, countless Egyptian academics are making major contributions elsewhere in the Middle East and beyond. What greater stimulus could there be to mobilize this sector than the award of the highest accolade for research—the 1999 Nobel Prize for chemistry—to Professor Ahmed Zewail for his pioneering work in the field of femptochemistry. Because

[54] *The Economist*, March 20, 1999.

of his research, it is now possible to observe the rapid motion of molecules during chemical reactions on a time scale of one-thousand million-millionth of a second.

Recall too the experience in Ireland where education played such an important part in economic development and where, for centuries, the 'brain drain' of its most capable researchers and scholars had been a fact of life. Many are now returning to fuel and sustain Ireland's growth.

Three examples of successful practical initiatives to promote and develop research in the Irish universities are singled out for consideration and possible implementation in Egypt: Programs for Advanced Technology (PATs), campus companies (*c.f.* Section 3.2.1) and the Education Technology Investment Fund initiative[55].

5.1. Programs for Advanced Technology (PATs)

Within the general framework of Ireland's overall R&TD policy, the Irish government funded a series of research programs that were at the cutting edge of research. They were designed to bridge the gap between emerging technologies and extant research capabilities in the universities, thereby strengthening Ireland's indigenous capability in science and technology and increasing international competitiveness in Irish industry. Niche areas were selected where international competitiveness was feasible and where the technology developed could be readily transferred into the industrial sector. Particular attention was paid to electronics, biotechnology, advanced manufacturing technology, opto-electronics, advanced materials, power electronics, computer hardware and software, telecommunications, sensor technology, and analog devices.

The PATs are driven by excellence and relevance. They are mission oriented with well-defined technical goals and an overall requirement to achieve a measure of self-sufficiency within a specified period of time. In this sense the initial funding by government ($22.5

[55] V. J. McBrierty and R. P. Kinsella, (1998).

million) was pump-priming. They constitute an important policy initiative that is working well.

Campus Companies

One operational definition of a campus company is the following:

> "A private limited company with permission from the host institution to trade in a range of goods and services for a limited period of time (normally three years, extended to five as mutually agreed)."[56]

Formation of a campus company is normally proposed by an academic staff member or members in the university or other institution. Permission to form such companies is granted only after a rigorous evaluation process as laid down by the host institution. The need for a robust and legally enforceable framework of governance based on existing best practice within the institutions themselves was recognized at an early stage. Furthermore, it was clear that systems for screening, monitoring and managing relations with campus companies needed to be standardized which, in turn, required prospective campus companies to provide detailed documentation, including a development plan, on a common basis across every participating institution.

Best practice regarding the governance of campus companies is an important issue. On the one hand, a campus company carries the imprimatur of the host institution and, therefore, there is an added onus on the company to ensure good governance. On the other hand, the campus company operates under company law which confers legal autonomy and concomitant responsibility on them.

A number of practical developments have been identified to promote the success of campus companies in their formative years including: 'incubator units' to nurture campus companies in their early stages of growth; high-level training for academic entrepreneurs as an integral part of the designation of a campus company; seed and venture capital; clarification of the role of the host institution in the company's affairs at board level.

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[56] Ibid.

The growth of such knowledge-intensive companies within the higher education sector constitutes a new and developing component of Irish indigenous industry. It is interesting to note that areas of activity are by no means confined to the technology s ector. The 30 campus companies in Trinity College Dublin, for example, are drawn from all the major academic disciplines in the arts, sciences, humanities, economics, and medicine. There have been a number of notable commercial successes.

Education Technology Investment Fund Initiative

In 1997, Ireland successfully launched a $375 million Education Technology Investment Fund (ETIF) to finance the development of scientific and technological education. The Fund is managed by a National Agency which reports to the Treasury and operates with the objectives of: modernizing the infrastructure in the technological sectors; identifying emerging skills demands, forecasting new areas and prepare graduates accordingly; encouraging innovation and technology transfer to promote job creation and economic growth; and undertaking R&D and developing the national research equipment base.[57]

It is a measure of the success of this initiative that the Fund has recently been allocated a further $270 million. Notably, the humanities and social sciences have been included in the overall remit. In the words of the Minister, "While the sciences may fuel our economy, we are cognizant of the need for development in other areas society is better served by a broadly-based educational excellence, than by the myopic concentration of resources in one area."

It is the government's intention that this investment should act as a catalyst for inducing market-based financial institutions, particularly the banks, realistically to appraise technology risk and to respond to the latent demand for funding by growing technology-based firms.

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[57] Ibid

These developments in Ireland prompted USAID/Egypt to propose the establishment of a U.S. Egypt foundation that would oversee a similar fund in Egypt.[58] It is envisaged that the fund would be initially capitalized with bilateral resources. The foundation could also administer USAID-financed endowments. Furthermore, according to USAID:

> "If the fund were targeted towards areas recently identified by the President's Council and well-managed to avoid decapitalization, it could serve as a mechanism for encouraging a modern education curriculum and innovative R&D. It could also be used to strengthen management training which is deemed critical for competitiveness. By devoting resources now, it could be maintained as a fundamental element of a US/Egypt Foundation and, along with endowments, would comprise an eventual USAID legacy."

VI. Summary and Conclusions

In charting Egypt's future development as a knowledge economy, we can now draw together the various strands of experience and advice from diverse sources.

World Economic Forum. Guidelines for economic progress are implicit in the criteria used by the World Economic Forum to create their annual Global Competitiveness Reports: openness to trade and investment, the role of the state, finance, infrastructure, technology, management, labor, and institutions. The Forum also recognizes the growing importance of innovation.

[58] T. Christiansen-Wagner, private communication.

The Sachs Critique. Sachs identified three main factors for achieving economic growth in Egypt, namely: the accumulation of the factors of production including physical and human capital, the efficient allocation of resources within the economy and the improvement of technology over time.[59]

The Irish Experience. Five main parameters underpinned economic development in Ireland: a vibrant research base supported by government/private sector funding, a well-educated workforce, a technology culture, the necessary infrastructure to support industrial development (for example, venture capital, government support program and incubator facilities), and focused development in specific industrial sectors.

From the perspective of policy formulation and implementation, a number of recurring themes and challenges can be identified:

- The critical role of education as a life-long experience.
- The management of change—perhaps, the greatest challenge. Governments, in particular must be innovative and flexible in their approach to policy making.
- The need to ensure that decision-making is informed.
- The importance of an innovative and entrepreneurial culture supported by appropriate 'institution building'.
- The need to ensure that economic and social development proceed hand-in-hand.
- The essential diversification of the private sector.
- The benefits of partnership.
- Exploitation of technology transfer within and between nations.
- The need for a holistic approach, encompassing the arts, social sciences and the humanities to moderate the rampant march of technology in today's knowledge-driven economy.

These observations apply equally to nations that differ in size, culture and level of development: Egypt is no exception when an economy commits to trade integration and

[59] J. Sachs (1996).

the disciplines that this enforces, where it develops the inclusive social partnership arrangements that ensure social cohesion, where it invests in the generation of knowledge and R&D and where it provides innovative policy instruments that facilitate the commercialization of, and trade in, new knowledge, then that economy will become an integral part of the knowledge economy.

We are indeed experiencing a strategic inflection or paradigm shift in global economics as we now move from the information age to the transformation age wherein new information is transforming virtually every aspect of human experience. Will the 21st Century start out as a new age of reason? Despite the shortcomings in the ways in which some new knowledge is used, Frühwald, former president of the German Research Council, nevertheless, reminds us that, "Science and scholarship are the instruments that humanity has shaped for its survival."[60] Remedies are not in short supply but do those who chart the future of societies have the informed wisdom to use the continuously replenished reservoir of new knowledge more wisely than heretofore?

I will end with a very wise remark made at a conference in Japan in 1986 which, I believe, sums up the central challenge facing humanity in the next millennium, namely the need for collective wisdom.[61]

> "Mankind now has God's skills but not God's wisdom; herein lies the problem.
>
> *K. Fushimi, 1986.*

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[60] W. Frühwald, "Science and Technology: On Research and the Universities in Europe," in *The Dancer Not the Dance*, E. Sagarra and M. Sagarra (eds.), Trinity Jameson Quatercentary Lectures, Trinity College Dublin, 1992, pp.19-29.

[61] K. Fushimi, in V. J. McBrierty (ed.), *Futures in Science, Technology and Democracy*(London: Butterworths, 1996).

PART II

EMBRACING IN THE KNOWLEDGE ECONOMY:

DISCUSSION

Chairman: Thank you very much, Professor McBrierty for this inspiring talk indeed. It gives us a lot of food for thought. We have very little time so I will take only a few questions before we close this session.

Participant: Thank you Mr. Chairman. I'd like to express my deep thanks to our distinguished speaker Professor McBrierty for an excellent lecture about what he called 'the knowledge economy'. As we do not have enough time, I will mention just three points. The first point is about the knowledge economy. I think that the ultimate goal is to help achieve economic development. According to my 40 years of experience as a professor of economics specialized in economic development, we have not yet discovered the secret of economic development. Two months ago, during the meeting of the International Economic Association, we discussed the different factors affecting economic development, and I think that the majority of economists agreed that it is very difficult to say which factor is the most important. The second point is the lessons learned and our speaker mentioned some lessons learned during the last years as we approach the 21st Century. I think there are three main lessons. The first is macroeconomic stability, which is, in my view, the most important factor to achieving economic development. In particular, stability of prices, and second, stability of the exchange rate. If we look to Egypt's economic reform program, we can see that the stress was on these two points and this is the reason why we succeed in our economic reform program. Also, development must address human needs directly—first of all, food, shelter and clothing, and the other needs after that. There must be a comprehensive policy to achieve development. In other words, without a comprehensive policy we cannot achieve economic development, a policy that emphasizes all the sectors of the national economy and that uses all the tools of

fiscal policy as well as monetary policy. The third and last point is the challenges we are facing at the end of the 20th Century. I hope that knowledge economy can help in finding solutions to these challenges. How can we reduce poverty? According to the last report of the World Bank, 20 percent of the population of the world hold at least 80 percent of the world's income. And number two, how can we insure food security? Third, how shall we address water scarcity? As has been said many times, the next war in the Middle East will not be because of oil but rather water.

Chairman: Thank you very much. I'd like to take one more question.

Participant: One cannot help but see the interrelation between the knowledge economy and education. Education as we know it, at the basic or university level, is fundamental to the knowledge economy. What is your perception as far as universities playing a role for research and development versus just being a center to train and educate skilled technicians. With the explosion in knowledge, it seems that these two functions should be separated and should not continue under one umbrella.

Speaker: You cannot separate them. You cannot teach purely on the basis of learned knowledge. A university differs in part from a technical institution or other kinds of institutions that deal with extant knowledge. The uniqueness of a university is the fact that there has to be intellectual curiosity. There has to be a group of people who challenge the collected of wisdom. There has to be a group of students who not only are part of the fundamental tools of trade, business, chemistry, engineering, but are taught to think, to reason, to develop creative talents and become creators. The best way of doing this is to continually refer to new developments, new research, new possibilities: in other words, the knowledge that's around the corner. The final point is that with universities indulging in contract research for example, or as in my own college in Ireland, there is close involvement with real, practical, day-to-day problems, generalist problems, as opposed to specific ones that we find in a textbook. It is essential for students to be exposed to that, to see what it is to get a request from an industry that says: this product doesn't work. You analyze it and you find that you may have to draw upon three, four, five, or six different

areas of science. That sort of approach to understanding and developing reasoning and problem-solving skills help to create a sound graduate and far exceeds what the normal course would be like if they were only doing the teaching and the research inside. The research and development contract is an enriching influence on the full education process. The big problem today is the stress on curricula—'You *must* give 14 lectures in these areas—It is supressing that creativity in the classroom, in the lecture theatre. That is a very serious price to pay. I would argue that universities as we have known them for thousands of years—universities in the Arab nations in the 11th and 12th centuries when Europe was going through its Dark Age—if you look at all the efforts to keep them alive, I actually think they are under a greater threat now than ever before and that has to be resisted at all costs.

Chairman: Thank you very much. I certainly endorse much of what you have said. There is no doubt that industry has taken over research and development. Certainly the cooperation between the academic world and the university and business in industry is essential, and I think the experience of Trinity College in creating campus companies is very important. There is no doubt that the ability to create a society with innovative skills must start at the university and with the training of students at the university level to be able to translate that further when they move into industry. I can certainly see that it is certainly very important and we have many examples of that, including Ahmed Zuewil. Certainly Egyptian universities could do more in the way of creating these research opportunities.

Participant: Again to mention briefly the issue of research and training: how can you ask a professor to teach his students to be creative if he is not himself creative and is not involved in research? This is one point, another is that of course research and involvement with industry and so on reflects in a vast way on how the university professor gives his lecture. You find a fantastic difference between those who are confined to their text books

and their closed academic lives and those who have operational experience, research experience with industry and so on. There is a huge difference between the two types. I support what Dr. McBrierty is advocating, because we find that this attitude sometimes prevails: 'let's have research institutes that are full-time devoted to research and leave universities to just teach'. It is very detrimental to the teaching process.

Speaker: At Trintity College Dublin, we are involved with many foreign industrialists coming from Japan and elsewhere, who set up facilities in our own university. Hitachi, for example, set up one of its two European research labs at Trinity. How did that happen? Well, we spent about 15 percent of the time talking about all the technology—semiconductors, URL networks and fifth generation computers—and we spent about 85 percent of the time talking about the culture: the area music, history, and so forth. These were the all-embracing elements. Once the company was sure of the technological question, the decision rested on the cultural and intellectual ambiance, and that cannot be stressed enough. Thank you.

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Adel Youssef Gohar
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Ahmed El-Khadem
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Vincent J. Mcbrierty's analysis adds further perspective to economic debate in Egypt by focusing on the link between new knowledge and economic progress. He highlights the contemporary experience of other nations that have already embraced the knowledge economy. He used Ireland—as well as other countries' experiences—as a particularly relevant example to Egypt. A small open economy, Ireland has undergone a veritable renaissance despite the acute economic depression that it went through in the mid-1980s. Today, Ireland has become one of the most successful economic performers.

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