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GLOBAL EDUCATION DIALOGUES RESEARCH

GOVERNMENT POLICY AND THE COMMERCIALISATION OF RESEARCH

SUMMARY PAPER

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This research was commissioned as part of the British Council's Global Education Dialogue, From Catapults to Commercialisation: How can universities use their knowledge and research more effectively?

9, 10 March 2015, The Crawford School of Public Policy, Australian National University.

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“It’s very difficult to transfer any system that works in one culture to another one and expect it to work. I know: I founded companies here and in the US. They are not alike. They are very different in terms of operation, in terms of everything. Korea needs to create a model that will work in Korea.”

(Professor and Entrepreneur, Korea)

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1 Background

In December 2014, the British Council engaged EduWorld to conduct a research project with the following objective:

- **To examine how national policies, as a sub-set of national pre-conditions, affect commercialisation outputs of research.**

This was to support the British Council's Global Education Dialogue (GED), a high-level discussion between higher education professionals and policymakers from Australia, the UK and the East Asia Region, held in Canberra, Australia in March 2015.

The Council identified four regions[1] on which to focus: the **United Kingdom** (primarily England and, to a lesser extent, Scotland), **Hong Kong**, **South Korea** and **Brazil**, each of which is actively looking at the commercialisation outputs of research, albeit at very different stages of development and, of course, within a different set of national conditions.

Following an initial consultation involving interviews with senior stakeholders in universities in the UK and Australia to direct and refine the focus of the research in line with the objectives of the GED, the research comprised two components conducted concurrently over the ten weeks of the project.

1. Primary research in the form of in-depth interviews with between five and eight stakeholders in each of the four countries.[2]
2. Secondary research, namely a review of a wide range of publications from many sources including government departments, parliamentary reviews, universities, funding agencies, non-government organisations, businesses, consultancies and media relating to the commercialisation of research.

This summary report tracks policy development, pulling out some emerging key themes in relation to national policies affecting the commercialisation of research and referring, as appropriate, to specific examples in each of the countries under review. Themes are summarised under the following headings.

- Characterisation of policy relating to the commercialisation of research
- Measuring innovation and regulatory frameworks: a comparative overview
- Key trends and emerging Issues:
    - Supply side
    - Demand side
- Building the ecosystem to support collaboration
- Other issues
- Broader considerations for governments

Detailed individual country reports are available from the British Council as an appendix to this summary report or, at www.britishcouncil.org.au/programmes/education/global-education-dialogues/papers after the GED.

[1] While Hong Kong is a Special Administrative Region of the People's Republic of China, it is referred to as a 'country' in this report for the purposes of comparison with the other relevant countries.
[2] A list of the organisations of participants is provided as an appendix to this report. Participants were assured that their names would not be used and that any comments would not be attributed to individuals.

1.1 What this Research does (and does not do)

To reiterate, this project's objective was to examine how the national policies of four countries, within the subset of their national conditions, affect the commercialisation outputs of research and to provide an analysis to stimulate debate amongst the GED conference attendees.

From the outset, it has been apparent that the dimensions of the project are far-reaching, encompassing policies relating to economic growth, education, science and technology, innovation, taxation, government spending and social policy, to name just a few, all of them formulated and implemented within their own, specific set of national historical, social, economic and political conditions.

Nevertheless, there is broad commonality in terms of what all countries are hoping to achieve through their commercialisation activities – increased productivity and economic growth – and an appreciation of the growing importance of research, innovation and knowledge exchange, as being key drivers.

This is an evolving and relatively new area for policy, and for research on the impact of that policy. All countries are, to varying degrees, still feeling their way. However, despite the fact that much of the formal and deliberate policy relating to commercialisation *per se* has only been developed over the past decade or two at most, there is already in existence a very large body of information on the topic, albeit with great variation in the date of publication and its consistency for comparative purposes across the four countries under scrutiny.

The volume of data serves as testament to the importance of the issues to policymakers, educators, researchers and businesses in all the countries examined.

Given the broad nature of the subject matter and the volume of data, within the confines of our research project, we have been forced to make some choices about how to best address the goal of providing a direction for the analysis that will best serve to stimulate debate. Our approach has been to seek to describe, through primary and secondary research, and against the backdrop of the national political and economic context, the policy choices which have impacted upon the commercialisation of research output. At times, but by no means in all instances, we have been able to provide some insights into why those policy choices were made.

Finding evidence of the success of these policy approaches has been challenging. A key issue is that measurement of the impact of policies is, as we will report in greater depth, a matter of some complexity, meaning that it is as yet – and may always be – difficult to attribute increases in commercialisation activity to any single or multiple policy or programme.

In addition to a thorough literature search, we have sought expert opinion from a small number of senior stakeholders working within each of the national systems, asking them how their national systems address the fundamental issue of determining and implementing policy to impact on the commercialisation of research.

The diversity of the four countries selected for the project has meant that there are naturally significant differences in maturation, along with very specific country issues which might shape the respective national debate but are of only limited relevance elsewhere.

Even so, there are likely to be insights that are relevant when considering international collaborations with organisations (businesses and/or academic) from these countries.

The language used in relation to the topic – terms such as knowledge transfer, knowledge exchange, commercialisation, ecosystem – is mutable and used interchangeably, sometimes inconsistently, suggesting there is a lack of familiarity with the specific meaning of these terms and that this is still an emerging area of research. In saying this, we will not attempt to define the terms here, but rather, raise the issue for consideration and further discussion.

As noted, there is an enormous amount of literature about this subject and we recognise that it is likely that there are policies and initiatives we have excluded and, hence, our summary and country reports will inevitably have some gaps.

Our analysis has tended to focus on science and technology, but we recognise there are also many innovations in the fields of social sciences and the arts that might also be open to commercialisation.

One of the challenges of gathering information has been that policies change over time, adding a layer of complexity to any summary of the current state of play of particular policies. Literature that seems to provide a useful analysis of the situation within a national context may well already be out-dated. Compounding the situation is that there are credible sources that provide different, and in some instances, conflicting, information about a department, policy or initiative involved in this area.

Governments change too – meaning a shift in policy focus and/or the structure of the Ministerial/Departmental framework, again confuses attempts to characterise the system. Of course, the success of any policy or set of policies is as much dependent upon its application as it is on its intention.

Despite these numerous and varied caveats, we trust that this summary of findings and the individual country reports will provide some useful insights into the types of national policies that can affect the commercialisation outputs of research, with a view to raising issues, stimulating debate and offering options for other countries.

2 Characterisation of Approach to Policy regarding Commercialisation of Research

Of the four countries studied for this project, the United Kingdom (the UK) has the most developed and diversified policy environment in relation to the commercialisation of research. Government policy works at all levels of the ecosystem, with strategies to motivate researchers to push their work out, micro-level efforts to address barriers on the demand side, and the establishment of various intermediary structures to support the commercialisation ecosystem.

South Korea's push to commercialise its research is part of a broader economic plan, the 'Creative Economy' platform, which envisions a future that includes a large number of successful startup small and medium-sized enterprises (SMEs). This will be a significant shift from the current situation, in which the country is heavily reliant upon a small number of family-run conglomerates or 'chaebols'. It will require policy changes across many dimensions, some of which are already underway: the Korean Government is taking a directive and interventionist approach in selecting areas where commercialisation should be focused, while at the same time, taking steps to deregulate and stimulate an entrepreneurial, more risk-taking spirit amongst the Korean people.

In Hong Kong, there is minimal policy that works on the supply side to push research out of universities. With an historically hands-off approach, the government has tended to try not to intervene in the natural dynamics of the market, that is the demand/pull side. There has been little funding or policy to support the development of an ecosystem, though recent initiatives are starting to acknowledge and address this gap. Further changes are also planned, for example, the proposed establishment of an Innovation and Technology Bureau. It seems though, that Hong Kong's initiatives will be more likely be focused to position itself as a commercialisation hub and/or base for research activities, rather than to build local industries around the research.

At the heart of the Brazilian Government's economic platform is the plan to shift the country's reliance upon agricultural and mineral commodities and instead to build growth on innovation and increased productivity. While Brazil is often characterised as having an energetic and entrepreneurial culture, there is not, as yet, an established ecosystem in which business – other than the very largest companies and in relatively limited discipline areas – use the country's research output. Government policy on the supply side has been to compel universities to establish technology transfer offices (TTOs) but these have not, as yet, consistently delivered the desired results. On the demand side, policy measures have included attempts to stimulate SME involvement through various tax and other financial breaks. Policy efforts have also been directed towards raising the quality of research through international collaborations. More generally, in an already heavily regulated environment, there is a risk that new policies and programmes may just add further layers of bureaucracy, thereby deterring the very attitude that they seek to engender.

3 Measuring Innovation and Regulatory Frameworks: A Comparative Overview

There are various globally accepted and widely used innovation frameworks and ranking systems available.[3] The Global Innovation Index (GII) was selected for this study because it provides the most up-to-date and consistent data across the four countries reviewed.

3.1 The Global Innovation Index (GII)[4]

The GII recognises the key role of innovation as a driver of economic growth and aims to capture multi-dimensional facets of innovation for both developed and emerging economies.

At the core of the GII Report is a ranking of world economies' innovation capabilities and results. It is calculated using indicators that go beyond the traditional measures of innovation, such as the level of research and development. We have included some of these indicators here for the purposes of providing further insights into the four countries' current positions in relation to the commercialisation of research.

Figure 1: Key Indicators[5]

	UK	South Korea	Hong Kong	Brazil
Population (millions)	63.2	50	7.2	198.7
GDP (US$ billions)	2,537.8	1,221.8	273.7	2,242.9
GDP per capita, PPP$	37,306.6	33,189.1	52,722.0	12,220.9

Of the four countries, the UK's and Brazil's economies are of a comparable size. However, with three times the population, Brazil's gross domestic product (GDP) per capita (adjusted for purchasing power parity) is just one third that of the UK.

Hong Kong has the smallest population and economy, but by far the highest GDP per capita of the four countries. South Korea's GDP per capita is slightly lower than that of the UK.

[3] For example, OECD Science and Technology indicators, World Bank Doing Business; Bloomberg Global Innovation Index
[4] https://www.globalinnovationindex.org/
[5] There may be more up to date information but we have retained the GII information to ensure accurate consistency and comparability

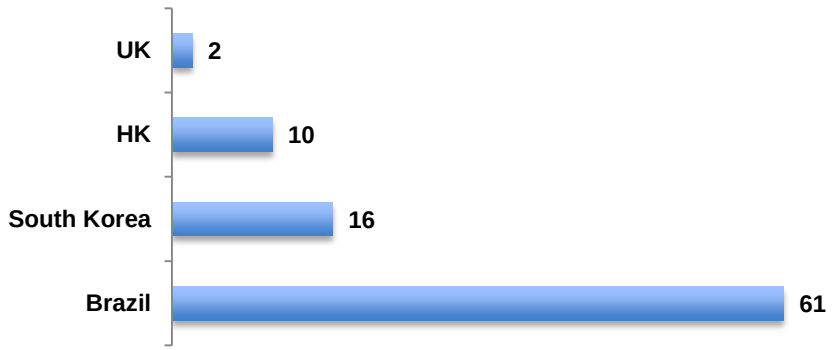
Figure 2: GII Indicators[6]

	UK		South Korea		Hong Kong		Brazil	
Global Innovation Index Indicator	**Value or score (0 - 100)**	**GII Rank**	**Value or score (0 - 100)**	**GII Rank**	**Value or score (0 - 100)**	**GII Rank**	**Value or score (0 - 100)**	**GII Rank**
Global Innovation Index (out of 143)	62.4	2	55.3	16	56.8	10	36.3	61
Researchers, headcounts/mn pop	6872.2	11	7698.7	8	3471.2	29	1,202.80	52
Gross expenditure on R&D, % GDP	1.7	21	4.4	1	0.7	45	1.2	31
GERD performed by business, % GDP	1.1	21	3.1	2	0.3	42	n/a	n/a
GERD financed by business, %	63.4	19	76.5	4	43.3	42	n/a	n/a
University/industry collaboration^	76.3	5	61.3	25	64.0	20	49.7	46
GERD financed by abroad, %	19.7	20	0.2	92	4.9	63	n/a	n/a

3.1.1 Overall Innovation Index Rank

Of the four countries in our analysis, the UK has the overall highest ranking: according to the GII, it ranks second in the world. Hong Kong (at 10th) and South Korea (16th) come in a little way behind. Brazil, in 61st place, is the lowest ranked of the four countries.

Figure 3: Global Innovation Ranking (out of 143)



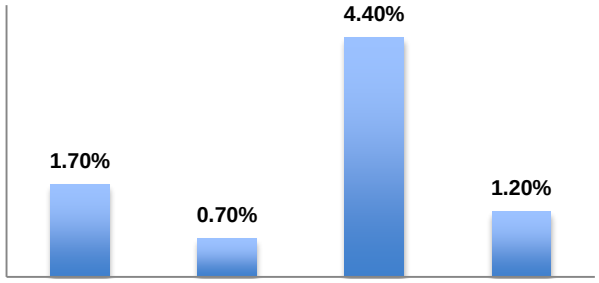
3.1.2 Gross Expenditure of Research and Development (GERD)

A country's gross expenditure on research and development (GERD), given as a proportion of its GDP, is considered an important proxy for the drive for innovation.

South Korea's GERD, at 4.4 per cent, is the world's highest, well ahead of the UK at 1.7 per cent (which puts it in 21st place for GERD). Brazil is a little further back, ranked 31st with 1.2 per cent. Hong Kong ranks the lowest of these four countries, at 45th place with 0.7 per cent of GDP spent on R&D.

[6] Definitions of how the individual GII Indicators are calculated are provided as an appendix to this report

Figure 4: GERD as Percentage of GDP



3.1.3 Commercialisation of Research

The GII includes various indicators that can be used as proxies for commercialisation of research.

University/industry score and rank is based upon responses to a World Economic Forum survey.[7] The responses put the UK in 5th place in terms of university/industry collaboration, Hong Kong in 20th, South Korea in 25th and Brazil in 46th.

3.2 Key out takes from the GII

Given the relatively modest expenditure on R&D, the UK ranks extremely high in the GII, supporting comments from many of our participants that the system actually functions very effectively.

South Korea has been inching up the GII in recent years, from 21st in 2012, to 18th in 2013 and now 16th in 2014. While the GERD is very high, there is concern that a disproportionate amount is being spent by and in the large, family-owned conglomerates, the 'chaebol'.

Hong Kong also performs well, despite its low GERD, though it has slipped down the index in the past three years (from 4th rank in 2012).

Brazil remains somewhat of an enigma, and this is reflected in its middle ranking on the GII: more detailed analysis of the data in the full GII report shows that it performs very well on some indicators (knowledge absorption) but very poorly on others (business environment).

[7] Source: World Economic Forum, Executive Opinion Survey 2013–2014. https://wefsurvey.org
Average answer to the survey question: In your country, to what extent do business and universities collaborate on research and development (R&D)? [1 = do not collaborate at all; 7 = collaborate extensively]

4 Key Trends and Emerging Issues

Over the course of the past few decades, there have been developments in the understanding of what commercialisation of research means and how it is referenced.

Thinking on the subject and the associated language has grown from narrow considerations of 'knowledge transfer' in which the debate was characterised by a focus on a linear model of demand/pull (contract research, R&D, where businesses seek solutions to specific problems) or supply/push (universities transfer knowledge via sale, transfer or licensing of IP) to an increasing recognition of the need for integration and collaboration; building relationships in which both sides learn how to work with one another. These days, analysis and debate is far more likely to use terms such as 'knowledge exchange' in recognition of the interplay of actors within a commercialisation 'ecosystem'.

However, whilst recognising that they operate within a larger context, the **supply/push** and **demand/pull** paradigms provide a useful framework around which to report some of the key issues that emerged during our research.

The supply side issues discussed below are by no means the only ones raised during our research. However, they are the ones that had the greatest commonality across the four countries. For the most part, we found that countries have identified and are working towards, or at least considering how, to overcome these supply side barriers.

4.1 Supply Side Issues

Issue	Description
Incentivising academics and institutions	With a general recognition that rewards structured exclusively around publications/citations may not be the best means to motivate academics to commercialise their research, in all four countries there is ongoing evaluation of the best way to structure the incentives for determining funding, promotion, size of research teams and so on. ▪ In 2014, the Research Excellence Framework (REF), the means of periodic assessment of research quality across UK HEIs, included for the first time an assessment of **impact**, (arising from excellent research, based on expert-review of case studies), enabling researchers to demonstrate their contribution to the economy, society and environment, public policy and services, and to culture, health and well-being. Impact accounted for 20 per cent of the assessment. ▪ In Brazil, there are indications that regulations governing academics efforts in this area are changing.

Issue	Description
Support for basic versus applied (and experimental research)	A key concern expressed in all countries is that basic research is not neglected, due to the increased focus on the impact of research. We observed that government policy is most likely to be moving towards taking an approach that involves multiple incentives, allowing for the fundamental work of universities (teaching and research) to continue while encouraging the 'third mission' – commercialisation. ▪ In Korea, where much of the country's massive R&D expenditure is currently spent on experimental research undertaken in businesses, government is directing funding towards basic research. In 2012, the Korean Government committed to increasing its basic research capabilities and outputs through establishing the Institute for Basic Science (IBS), a network of 50 research centres.
Encouraging an entrepreneurial mentality amongst academics (and students)	In all four countries, there is recognition that building an entrepreneurial mentality amongst academics and students and culture within institutions can help to increase the commercialisation of research. Various policy approaches have been adopted to encourage this. ▪ One of the distinctive aspects of government policy in the UK is the stream of public funding that works to induce collaboration – rewarding collaboration when it has taken place, rather than being targeted at specific activities. Evaluation of one of these streams, Higher Education Innovation Funding (HEIF) has been positive, on the whole. ▪ In September 2014, the Hong Kong Innovation and Technology Commission launched a new scheme – the Technology Start-up Support Scheme for Universities – to encourage university students and teaching staff to start their own technology business and commercialise their R&D deliverables.
Provide assurance of intellectual property/ protection of ideas	Ownership structures in relation to IP reflect differing historical, legal and structural characteristics of the systems within which they operate. There are various ways in which policy can be formulated: most clear is in terms of patent law. However, other considerations include labour and contracting law and ownership clauses in the regulation of national R&D systems. Generally, government policy in this area is converging on vesting the rights with the individual institutions. There exists a large body of literature on the subject of IP protection. However, in our primary research, with the exception of Brazil, where the discussion is still live, debate seems to have moved on to other broader matters relating to the commercialisation of research.
Limited expertise in TTOs/TLOs	Across all four countries, the university TTOs/TLOs (Technology Transfer/Licensing Offices) were seen as potentially hindering the effective transfer and commercialisation of research, due to a range of reasons including: TLO/TTO staff having limited skillsets; the lack of a commercial mindset and culture; the number of staff; and a lack of understanding of the 'bigger' picture and potential of relationships with external businesses.

4.2 Demand Side Issues

Issue	Description
Encouraging SMEs to become involved in the commercial-isation of research	Having been identified as a significant source of economic and employment growth in all four countries, a key thrust of government policy has been to encourage the involvement of SMEs in the commercialisation of research. ▪ In Brazil, FINEP, also known as the Brazilian Innovation Agency, launched the PRIME project in 2009 to support startups. Startups focused on innovation could apply for funds of up to around $65,000. ▪ In Korea, under its '2015 Policy Fund Management Plan for Loan Support for SMEs', the government committed funds totalling more than $2 billion for SMEs, including $757 million of new growth foundation funds for companies at the growth stage
Facilitate the flow of information/ communication	Research conducted in the UK has shown that one of the key barriers for businesses collaborating with universities is a lack of information about where to go to get the type of information or research expertise that they are seeking. ▪ Launched in 2013, the Gateway to Research (GtR) website has been developed to help businesses to search and analyse information about publicly-funded research. It provides a search interface for users to interrogate over 40,000 current and past research projects and their outcomes. Similar initiatives are underway in the other countries.
Tax breaks	A key policy, used in all four countries to varying degrees, is to provide tax relief on private investment in R&D, although with mixed results. ▪ In the UK, R&D tax credits are a company tax relief, which can either reduce a company's tax bill or, for some SMEs, provide a cash sum. R&D tax credits are the largest source of government support for business R&D. The SME scheme is now worth up to about 30p for every £1 spent and the large company scheme is worth about 7p for every £1 spent. ▪ The Brazilian Federal Government through its Ministry of Science, Technology and Innovation (MCTI)[8] created the *Lei do Bem* ('Good Act'), a law that creates tax incentives for legal entities that undertake R&D inside national (Brazilian) borders. However, a 2012 review showed that, of the companies who participated, only 3 per cent demonstrated results in technological innovation. More generally, the level of taxation reportedly remains a barrier to entrepreneurial activity in Brazil.

[8] Ministério da Ciência, Tecnologia e Inovação)

Issue	Description
Matched funding programmes	To encourage commercialisation of research, governments have various matched-funding schemes. ▪ In Hong Kong, the Matching Grant for Joint Research aims to foster private companies to collaborate with universities in proprietary R&D projects. ▪ The UK's Research Partnership Innovation Fund (RPIF) provides funding for large-scale projects. Every pound of public funding must be matched by double that amount from private/charitable sources. Initial evaluations point to its success, with more than £1.3 billion of new investment of benefit to universities and their partners.
Facilitating external investment	In some of the countries, governments have introduced policies to assist business, and particularly SMEs, in seeking the long-term, external funding required to develop innovation. • The KONEX (Korea New Exchange) market was launched in July 2013 as a specialised market facilitating the direct financing for SMEs.

5 Building the Ecosystem to Encourage Collaboration

In all four countries, governments have introduced policies that go beyond the supply/push and demand/pull paradigms, and that aim to encourage a functioning ecosystem within which collaboration between universities and business can flourish.

5.1 Intermediary/Bridging Organisations

In all four countries, the governments support various forms of intermediary or bridging organisations. Within universities, the most likely form these take are Technology Transfer Offices (TTOs), which aim to help academic staff to identify and commercialise the organisation's intellectual assets. While the success of TTOs tends to be judged in terms of their licensing revenue, one concern is that this might lead to a model where income is pursued at the expense of other considerations, for example, long-term relationships with industry partners.

For example, in Brazil, the Innovation Law mandates that all universities have a TTO. However, there have been significant variations in the implementation and hence effectiveness of the Law at a university level.

Some other examples of these bridging organisations include:

- Innovate UK opened the first Catapult Centre in October 2011. Catapults are technology and innovation centres where businesses, scientists and engineers work alongside each other on late stage R&D to turn high potential ideas into new products and services to generate economic growth. Each Catapult focuses on an area identified as being strategically important for the UK with a large global market potential. Four years on, there is mixed evidence as to the success of Catapults. While the initial formal evaluation (conducted by Dr Hermann Hauser, the original architect of the project) was positive, questions were raised in some of our interviews as to whether there could have been a quicker, less expensive solution than setting up an entirely new set of institutions.

- FINEP, the Brazilian Innovation Agency under the Ministry of Science, Technology and Innovation (MSTI) provides funding of R$640 million to support Brazil's 400 business incubators and approximately 30 science parks. Brazil's incubator program is perceived to be among the most successful in Latin America, with incubator models that are bottom up or suited to indigenous needs.

- The Hong Kong Science and Technology Park Corporation (HKSTP) is a statutory body which manages the Hong Kong Science and Technology Park and is charged with building a vibrant innovation and technology ecosystem to connect stakeholders, nurture technology talents, facilitate collaboration, and catalyse innovations to deliver social and economic benefits to Hong Kong and the region. Similarly, the overall success of the HKSTP in achieving this has been queried.

5.2 Taking a Cross-Departmental Approach

There are examples of countries restructuring departments and ministerial responsibilities in order to boost the importance of the issue of commercialisation in terms of government objectives and/or to remove some of the bureaucratic obstacles to doing so, for example:

- In Hong Kong, lawmakers have been debating the proposal to upgrade the status of the body responsible for innovation. The head of the proposed Innovation and Technology Bureau would coordinate policy in this area across various ministries.

- In Korea, the creation of a new position at the Office of the President, the Senior Secretary to the President for National Future and Strategy, signals the commitment of the government to implement change in this area. This has been supported by the formation of a new Ministry with the authority to coordinate nearly 80 per cent of governmental R&D budgets for all ministries, and to plan and implement R&D programmes.

5.3 Regulation and Deregulation

There is, of course, a need to ensure that the government funding to support the commercialisation of research is distributed in a fair and transparent manner. However, the associated regulatory requirements are such that, to varying degrees in all four countries, they are described as acting as a barrier to commercialisation. The complaints were greatest in Korea and Brazil.

- Korea's President Park has pledged to lighten the regulatory burden through various measures, including the introduction of a UK-type[9] one-in one-out system: 'cost-in cost-out' in 2015, cutting the number of registered business regulations by 10 per cent by 2015 and 20 per cent by 2016; expanding the use of 'sunset clauses' to speed up removal of redundant regulations; and asking ministries to report all unregistered regulations by June 2014. The issue is now reportedly at the top of the agenda of all government departments, though the shift to a culture of better regulation may be challenging. A system of performance evaluation would be needed to reward officials who put customers ahead of administrative convenience.

6 Other Issues

Some further key issues identified for consideration in the formulation of government policy related to the commercialisation of the outputs of research are presented here.

6.1 Different Sectors

Innovative research can occur within all faculties of a university. All sectors of the economy can benefit from new ideas. However, the requirements to take the maximum value from an idea that can be used in one sector may require a very different set of policies, resources and timeframes, to have a similar impact in another sector.

[9] In the UK, the government operates a 'one in two out' rule to reduce the number of new regulations for business, whereby for every new regulation which entails a cost to business, departments are impelled to remove or modify existing relation to the value of £2 of saving for every pound of cost imposed.

For example, the commercialisation of a biomedical breakthrough is likely to be subject to a longer lead time and stricter regulatory regime than a new idea in Information Communication Technology (ICT) or the arts/humanities.

- **It appears that there is no 'one size fits all' set of policies that is appropriate for the commercialisation of research across all sectors.**

6.2 Timeframes

One of the key issues underlying attempts to commercialise research is time: the time it takes for ideas to move from the lab to the market; the time it can take to set up a new business; the time that investors must wait to receive returns on their investment; and the time that governments have – and electorates give them – to assess the effectiveness of their policies to commercialise research.

- **One of the ways that government policy can work is to facilitate an ecosystem in which the supply side (universities) and the demand side (business) understand each other's likely timeframes. Businesses need solutions immediately, but academics may need longer to provide the solutions they are seeking. Greater interaction between the two, i.e. a more developed ecosystem, will likely assist in overcoming this barrier.**

6.3 Metrics

Governments inevitably want to be able to assess the impact of their policies and funding and the extent to which knowledge transfers are permeating the system (i.e. the strength of the ecosystem). In order to do so, they need to benchmark and track commercialisation of research.

Historically, patents have served as the most commonly used indicator of commercialisation activity. However, it is increasingly acknowledged that patents are an imperfect measure: they only measure numbers, not quality. There will be variation between legal regimes/countries, meaning there are some places where it is far easier to lodge patents; and different sectors/types of products may have vastly differing numbers of patents, which do not reflect the work involved or the potential of that patent. Moreover, patents/licensing have been shown to make up only a small proportion of the knowledge exchange that happens between universities and businesses.

Looking beyond patents, best practice measurement might implement a variety of measures, which may include quantitative data, expert opinion and case studies.

Even then, the ability to attribute causality to a specific policy is limited.

Moreover, the measures are only as good as their ability to capture the change that is observable – there may be elements that are not yet recognised. Or there may be changes in the future that have not yet eventuated.

- **Measurement is, like much of the debate around commercialisation of research, an evolving topic and certainly one that bears further investigation and robust discussion.**

7 Broader Considerations for Governments

In the following section, we lay out some broader, concluding topics for consideration by governments wishing to develop policy to commercialise the outputs of research.

7.1 Socio-economic Context

Despite differences in the systems, all the countries we researched are engaged in the subject and striving for improvements in this area of the commercialisation of research.

However, the differing historical, cultural, social and political environments mean that policies that work in one environment might not necessarily be easily, if at all, replicated in another.

Examining the four countries has provided insights into some of the broader socio-economic, cultural and historical elements that may also have an impact and, therefore, need to be taken into consideration when considering the environment – the national pre-conditions – within which policies affecting the commercialisation of research are enacted.

Some of the pre-conditions for consideration include, but are no means limited to:

- Strength of the local economy;
- Key sectors within the economy;
- Existence of local manufacturing;
- Degree of globalisation/interaction with neighbours and other countries;
- Make up of the economy in terms of SMEs and large businesses;
- How and where research occurs (in universities? Government research institutes? Business?);
- University funding models;
- Aspirations of young people;
- Entrepreneurial spirit within that country;
- The attitude towards, or the organisation of, science and technology;
- Financial system including taxation;
- Availability of private investment funds; and
- Access to capital and the appetite of investors to invest in these types of initiatives

- **Given their differing pre-conditions, is it possible, or for that matter desirable, for all countries to develop a commercialisation ecosystem? If so, to what extent does policy need to be adapted to suit each particular country?**

7.2 Increased spending on R&D

While some research on the impact of specific policies indicates that government funding can serve to attract in private funding, rather than crowding it out, there is still concern that public money can distort in a market.

As indicated in Figure 4 above, there are major variations among the four countries in the proportion of GDP devoted to R&D and in the amount that is made up by government spending.

- **Can a big spending approach buy an ecosystem? Can it lead to a self-sustaining ecosystem? Or does public funding distort the market, leading to a system that is dependent upon future government support?**

7.3 Regional Approaches

Inevitably, policies designed to stimulate and support the commercialisation of research are just part of a wider set of policies. Given that they are generally linked to strategies for growth in a country, commercialisation policies are often closely intertwined with those relating to regional concerns, particularly in countries where there is significant disparity.

We see examples of this in the UK (with the location of the Catapult Centres sometimes linked to the need to stimulate regional economies), in South Korea, with a policy to stimulate regional science and technology programmes (outside of Seoul), and in Brazil, where despite efforts to decentralise research efforts, the focus is still on Rio de Janeiro and Sao Paulo.

- **Can governments achieve the dual goals of striving for balanced regional growth and still produce the best possible research output for commercialisation?**

7.4 Shifting the Culture

In all four countries, governments are trying to engender an entrepreneurial culture, but it was something that we heard about the most in Brazil. An emerging economy with a growing middle class, many people are already making the most of the opportunities to start businesses that are not reliant upon innovation (for example, in the retail sector). However, these businesses only offer limited opportunities for long-term growth.

In Korea, the situation is somewhat different: the chaebols offer a safe and well-respected employment path, whereas the notion of entrepreneurship is less highly regarded.

- **Will the policies introduced in these countries, many of them working at the micro-level to remove barriers to starting up innovation-driven businesses, be sufficient to result in the desired shifts at a deeper, cultural level?**

7.5 Need for Clear, Consistent Policy Initiatives

Constant to all countries is the need for clear, consistent policy initiatives in relation to the commercialisation of research. Businesses need to know that the environment into which they are about to invest will continue, for at least the next five or ten years, to have at least the same level of support as it does today. Equally, researchers need to know that the work they are doing will be considered to be valued.

- **Given an inescapable political cycle and, in some countries, increasingly short-term focus of policy-making, how can the long-term needs of commercialisation of research be assured?**

7.6 Directing Commercialisation of Research

Much of the policy debate about how to best support the commercialisation of research revolves around the extent to which government should be involved in making decisions about which projects to fund.

There are concerns that the Korean Government's approach, its attempts to 'pick winners', might lead to the wrong type of projects being funded, dooming efforts to failure.

The Hong Kong Government has historically, taken a more hands-off, *laissez-faire* approach, and until recently has been reticent to become overly involved in the commercialisation of research.

In the UK, the Catapult Centres have been a recent government initiative, Otherwise, policy in this area in the UK tends to be less directive, focusing on ways to facilitate collaboration between industry and academia and then leaving the two to work things out amongst themselves.

While the Brazilian Government is being fairly directive in its attempts to force a more entrepreneurial culture on both the supply and demand sides, it appears to be taking a hands-off approach to determining where activity should take place.

- **Is there a correct approach in terms of directing activity? Is a certain approach better suited to a particular set of pre-conditions? Or is it better for government to leave decision-making to the researchers and the market?**

8 In Conclusion

Given that many of the barriers identified relate to attitudes and behaviours, it seems that building a functioning commercialisation ecosystem is likely to be a long-term project, and one that requires policy measures that address both supply and demand side barriers.

Governments in all four countries have taken policy steps to facilitate the commercialisation outputs of research. While it is possible to learn from the efforts of these other nations, there is no 'silver bullet' that will guarantee success in all situations.

Appendix 1: Stakeholder Organisations

We are grateful for the input into the research from stakeholders working in following organisations. A complete set of references is available in each country reports.

Brazil
Agency of Innovation at Unesp (AUIN/ São Paulo State University)
ANPROTEC (Association of Business Incubators and Science Parks)
Education Sector (Science Technology Innovation and Culture) Brazilian Embassy, Canberra
Embrapa (Brazilian Agricultural Research Organisation)
Science and Innovation Network, FCO, Brazil
Technology Centre of Regional Development of Viçosa (CenTev),
University of Sao Paolo
Vale (global mining company)

Hong Kong
Anakata (Wind power resource company)
Hong Kong Polytechnic University, Institute for Entrepreneurship
Hong Kong Science and Technology Park
Hong Kong University of Science and Technology
ICF International (Global research and consultancy firm)
Innovation and Technology Commission

South Korea
Korea Association of Technology Holdings (KATH)
Korea Venture Business Association
Korean Advanced Institute of Science and Technology (KAIST)
Korean Science and Technology Holdings
OECD
Science and Innovation Network, FCO, South Korea

United Kingdom
Centre for Science, Technology and Innovation Policy, University of Cambridge
Edinburgh Napier University
Government Office for Science
HEFCE
National Centre for Universities and Business
UCLB (the TTO of UCL)
Universities UK, International Unit

Appendix 2: GII definitions

Indicator	Description
Researchers, headcounts/mn pop	Researchers per million population, head counts. Researchers in R&D are professionals engaged in the conception or creation of new knowledge, products, processes, methods, or systems and in the management of the projects concerned. Postgraduate PhD students (ISCED97 level 6) engaged in R&D are included.
Gross expenditure on R&D (GERD), % GDP	Total domestic intramural expenditure on R&D during a given period as a percentage of GDP. Intramural R&D expenditure is all expenditure for R&D performed within a statistical unit or sector of the economy during a specific period, whatever the source of funds.
GERD performed by business, % GDP	Gross expenditure on R&D performed by business enterprise as a percentage of GDP.[10]
GERD financed by business, %	Percentage of gross expenditure on R&D financed by business enterprise.[11]
University/industry collaboration^	Average answer to the survey question: In your country, to what extent do business and universities collaborate on research and development (R&D)? [1 = do not collaborate at all; 7 = collaborate extensively] [12]
GERD financed by abroad, %	Percentage of gross expenditure on R&D financed by abroad—i.e., with foreign financing.[13]

[10] Source: UNESCO Institute for Statistics, UIS online database (2004–12). http://stats.uis.unesco.org
[11] *Ibid.*
[12] World Economic Forum, *Op. Cit.*
[13] UNESCO, *Op. Cit.*