

## The Hodge Foundation Research Project Summary of Initial Findings

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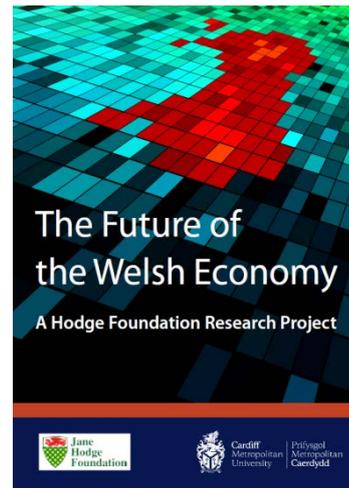
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### Introduction

The Hodge project is focused on a few challenging questions:

- Is it inevitable that Wales remains the poorest part of the UK?
- What, if anything, can be done over the next decade to start to catch up?

Our research so far has concentrated on two areas:

- (i) Governance structures and the role of political leadership
- (ii) Identifying specific strategies for economic development

We ask: Are our institutions and governance structures optimal to support timely decision making about competing economic objectives? Are the right delivery mechanisms in place?

We then ask: If we could solve these issues, what specific strategies for economic development are available to close the prosperity gap? How can we harness the existing strengths of the regional economy to more effectively deliver growth?

### Quality of Governance and Industrial Policy

To support these two themes we have initially undertaken a literature review on Quality of Governance (QoG). One interpretation of this is to identify measures of bureaucratic autonomy. Here we have focused on two variables:

- (i) the professionalization of the public sector, which includes the quality of training, as well as transparent measures for hiring and promoting staff; and

- (ii) the autonomy of the public sector from politicians, where the goal is to have a balance between too little autonomy (excessive centralisation which smothers creativity) and too much autonomy (creates an unaccountable public sector).

Regional QoG has been shown to have a positive impact on the level of returns on public infrastructure spending and on innovation performance. What then could be done in a place such as Wales, from both a governance perspective and the use of modern industrial and innovation policies, to enhance its growth prospects?

The current dominant approach, fostered by the EU, focuses on the concept of 'smart specialisation', which is based on the notion of an entrepreneurial discovery process. It builds on the notion of self-discovery developed by economists such as Ricardo Hausman and Dani Rodrik. Its main tenet is that there may be latent economic opportunities in any given place that are not being exploited. It suggests that the benefits to a region from finding a new specialisation that can generate a large number of firms and high levels of employment are quite significant. The problem is that the individuals that are the 'first movers' i.e. the first to invest in this nascent sector before it generates these larger benefits, would only reap a tiny amount of the total rewards.

This problem can be addressed through policy interventions. (Foray 2014). The objective is not to pick winners but instead to stimulate regional organisations (research institutes, executive agencies, business associations, etc.) to find areas of activity that are complementary to what already exists, but that could generate a whole new sector of activity. The government, through its agencies, could then support these new activities by investing in horizontal technologies that would be accessible to entrepreneurs and existing firms, and by helping to generate the human, physical and legal infrastructures necessary to support this process.

In order to achieve this, the state would need to become 'embedded' in civil society and communicate effectively with a variety of partners in order to identify any emergent opportunities. This notion of the 'embedded state' is contrasted with an excessively centralised state which would be too dependent on political cycles and hierarchical structures to engage effectively with the commercial world. Similarly, an excessively autonomous state is likely to be disembedded both from the political process and the socio-economic dynamics that surround it. The solution then is to find an appropriate balance between these extremes.

Looking at European regions, there are several regions that could be used as benchmarks for this sort of embedded autonomy. Preliminary research indicates that these regions benefit from a variety of factors: political stability; the presence of well-resourced and networked organisations - from business associations to research centres or Universities; and a combination of political leadership with the existence of executive agencies (such as innovation agencies, or regional development agencies) that are responsive to political change, yet autonomous enough to develop their own networks and engage regularly with the private sector.

## **Executive Agencies**

A key question then is: How can we achieve the right combination of political leadership at the centre with executive agencies at the delivery end? The two are closely linked – because the creation of robust institutions (outside of government) that are sustainable and durable, even after the political leadership has changed, has been described as the ‘most tangible act of leadership’. (Helms 2016)

In the context of collaborative leadership it is important to highlight the benefits and risks of setting up executive agencies. Typical criticisms focus on accountability. Others include the exposure to financial risks and increased opportunities for political patronage and corruption. But resolving the main issue of accountability would solve most of the other problems.

However, what is the evidence on this? Do executive agencies reduce public accountability? A review in the mid-2000s actually identified improved transparency and accountability as a key benefit of executive agencies. It emphasised that these agencies are compelled to publish separate accounts and disaggregated performance data, and this brings greater openness on costs, priorities and plans (Talbot 2004; Morgan 2004). Also, since 2010 the UK government has introduced strict controls on the actions of these agencies: covering spending on advertising, consultancy, IT, procurement and the hiring of new staff. So there has been a marked reduction in agency autonomy.

In this way the UK government has been focused on **reform** of quangos rather than their **abolition**. Its aim seems to be to create ‘a slimmed-down and more efficient centre that enables and empowers’. (Cabinet Office, 2011). In this new world ministerial departments are expected to become more focused on policy-making while commissioning delivery from a wide-range of executive agencies. (Flinders *et.al.* 2014)

Hence the current situation with regard to executive agencies in the UK remains very fluid. Whilst the abolition of the Regional Development Agencies in England and their replacement by Local Enterprise Partnerships (LEPs) has been presented as a rejection of the regionalist approach of the former Labour administration, it can also be seen as part of the UK government’s ‘localism’ agenda. Instead of abolishing quangos it has reformed and localised them.

However, in response to Brexit a rethink seems to be underway in relation to the spatial economic imbalances in the UK and highlighted by the recent call by the Prime Minister for a new ‘industrial strategy’. This is likely to support the devolution of more powers to UK cities and regions through the City Deal programmes, as well as greater economic development powers to the Devolved Administrations. A new role for a redesigned Executive Agency (or Agencies) in Wales could well emerge from this policy rethink. These agencies would need to be strictly controlled on all aspects of spend and procurement. They would publish separate accounts, bring greater openness on costs and be expected to set and meet challenging performance indicators.

## Key growth factors

To make headway with the second issue of identifying specific strategies for economic development we first asked: What makes for regional success?

We explored two sources of information:

- Statistical analysis of international regional data;
- Interviews and questionnaire with growing businesses in Wales

## A statistical analysis

One element in the initial phase of the research has been to look at the experience of other regions. The World Competitiveness Index Study data base provides statistics on 530 regions of the world for many of the variables thought to be associated with material prosperity<sup>1</sup>.

The most important elements distinguishing more successful from less successful regions were expenditure on education and R&D spending by private companies (government R&D was not so significant). There was also clear association between economic success and measures of internet connectivity such as number of servers and extensive access to broadband but much of the relevant data was estimated and of doubtful quality. Whether the association survives an effort at improving the data is the subject of further research. The structure of the economy mattered less than the factors listed above, though there appeared to be some advantage from having people employed in high tech services.

How do we derive these results? The data set for the 530 regions contained over 20 variables; some relating to R&D spending and patents, others relating to education expenditure and broadband connectivity. We analysed this data set for leads as to what features most distinguished successful from less successful regions. We first grouped the variables into measures of success – so called “output variables”- and measures of things that might have contributed to success – “input variables”. The most obvious success variable is GVA per head, but others include labour productivity, unemployment, the activity rate and mean monthly earnings. A composite success variable was constructed out of GVA per head, the activity rate and mean gross monthly earnings.

The approach was then to see which of the other variables was most associated with the success variable. The Pearson correlation coefficient between the success variable and GVA per head was calculated and it came out at 91 %. The 530 regions are enormously diverse ranging from extremely wealthy regions of the United States in Connecticut and California to very poor regions of India like Bihar. But substantial discrete clusters could not be identified and discriminant analysis implied that it made sense to analyse the whole data set together. Wales, incidentally, is number 266 in this data set, almost exactly half way. Its ranking in terms of GVA per head is very slightly higher at 247.

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<sup>1</sup> Detailed description of the data set is in Annex 1

A cross-section regression was run on the data. There were 16 potential explanatory variables that could “explain” success but only 6 turned out to be statistically significant. In order of importance those were:

- Secure servers per one million inhabitants
- Per capita expenditures on R&D by business
- Broadband access per thousand inhabitants
- Per capita public expenditures on primary and secondary education
- Per capita public expenditure on higher education
- Employment in high-tech services per thousand employees.

Detailed regressions results are shown at the end.

When the same analysis was conducted on unstandardized data using GVA per head as the variable to be explained, the results were broadly similar. Business R&D spending remained significant though somewhat less so. The biggest difference was that spending on higher education ceased to be significant and all the significance of education spending resided in expenditure on primary and secondary schooling. While accepting that spending on primary and secondary education is more important (as reflected in the first regression) we place more credence in the first regression result reflecting the importance of all educational expenditures.

Things like unemployment rates, patents or the number of managers per 1000 inhabitants that might be thought important do not come through at all in distinguishing successful from less successful regions and nor do the proportion of the population employed in fashionable sectors like IT and biotech. That strongly implies that regions should follow their comparative advantage and so long as they have educated and connected populations there is more than one route to prosperity.

To further explore this a small number of regions were selected: the top four regions by success – all in the United States, Hamburg, Scotland, the North-West of England and Wales. A profile plot was produced showing the value of each variable for each of these regions. That allows a visual comparison of the different characteristics of these regions.

The results for the whole data set tend to be reflected in the differences between Wales and more prosperous areas. The more prosperous areas show no consistent pattern with regard to the sector of employment and have fewer managers per 1000 employees than Wales and less successful regions. R&D spending by private companies is clearly higher in the prosperous areas and secure servers and broadband access are conspicuously higher.

It is too soon to draw policy conclusions from this analysis (and some of the data needs to be verified) but there are some suggestive leads: Education, especially primary and secondary education is evidently an important element in the profile of more successful regions. Can Wales attract the R&D departments of successful companies or can it induce more R&D by companies already here? Would provision of faster and more universal broadband have any effect or is the association between connectivity and success a complicated and circular one? These are some of the questions to be addressed in interviews with Welsh companies.

## **What Welsh companies say: Preliminary survey results.**

Ian Jones' paper has set out the state of current thinking on appropriate policies for developing the economy of lagging or peripheral regions. Here we report on what a number of Welsh companies consider to be the main obstacles to their growth and draws some highly provisional conclusions for public policy support.

Of the 100 companies invited to complete the questionnaire we obtained a 21% response rate. We have begun a programme of more in-depth interviews with 20 companies and 14 of these have been completed at the time of writing. The companies chosen were those enjoying rapid growth or were in sectors that are widely thought to be growth sectors. They were selected with a bias to those which seemed to have good prospects for selling outside Wales and were located in South Wales in either the Cardiff or Swansea City Region. Below is a summary table of results. With a sample this small, findings are more anecdotal than clearly representative. Some of the anecdotes, however, are telling and one of the findings is so general in the sample that it may be regarded as statistically significant.

The good news from the survey was that 80% of the companies planned to expand in Wales during the next five years. On a subjective note, we were pleasantly surprised at how easy it was to find small or middle-sized Welsh companies with a distinctive IP and consequently good growth prospects. The sample showed that neither Rome nor Welsh prosperity was built in a day however; nearly 70% of the companies had been in business in Wales for more than 10 years while six were newer.

The sample reflected the openness of the Welsh economy. Some 72% said 50% or more of their sales were outside Wales while of those 43% said over 90% of their sales were outside Wales. Of those with important suppliers, three-quarters of companies said less than 50% of their inputs by value came from within Wales and for 40% of companies that figure dropped to 20% or less. However, one highly successful company in electrical engineering – exceptionally - had made a point of trying to ensure all its important suppliers were Wales-based and it had achieved that relatively easily.

### ***The biggest problem – qualified staff***

When firms were asked for the chief obstacles to growth, the greatest by far was getting qualified staff. 21 companies, 60% of the sample, cited that. Firms were offered five suggestions for the biggest constraint (including "other"). If they replied at random we would expect perhaps 7 firms to cite finding personnel. If 21 do so it is highly likely to be a general problem at least for growing companies.

Another 20% cited finance. Though that is not significantly above what you might expect from random responses, those complaining were vociferous and specific about the problems (see below). Just two cited infrastructure concerns, none cited problems with suppliers. Those results may well reflect the sectoral composition of the sample and its geographical location in urban centres in South Wales. Other factors cited included planning obstacles, the difficulty of getting adequate premises, lack of support from the

Welsh government and from head office outside Wales. Five cited difficulty in getting a big enough share of a competitive market to justify further investment.

The difficulty in getting qualified staff occurred across sectors – in engineering, software, finance and the creative sector. The main problem was at the graduate level. Getting shop floor operatives was less of a problem, though it had a sub-regional dimension. Firms south of the M4 or in the lower valleys near the M4 saw no problem finding less-skilled workers; firms near the heads of the valleys professed a problem getting even unskilled workers who were reliable in attendance and time-keeping (but the sample is very small).

There is a broader issue with the quality of general graduates for middle management and a still bigger problem in finding technical graduates at the right level. Over half the firms cited this as an inhibiting factor on their growth. However, one international software firm said a skill base on which to draw was a big attraction to them of being in Wales. A local university provides a course which feeds directly into their requirements. Even that firm said that as they grew the supply of qualified graduates was likely to get much tighter. Nonetheless this single instance shows that specialised course provision, anticipating a commercial demand, can be productive for the university and the economy.

Resolving the general problem of skill shortages unfortunately will take time since educational reform and expenditure takes decades to feed through into results. There was one immediate suggestion, however. Heads of incoming firms were impressed with the quality of life in South Wales. Cardiff offered excellent amenities and the outdoor environment and facilities were good too. Yet the impression outsiders had of Wales was that it was a poor post-industrial backwater, which inhibited recruitment from outside. Better marketing and branding of Wales was needed.

### ***Dealing with government – a mixed picture***

Only 8 companies had applied for export assistance but a surprising 91% of the sample had sought help from the Welsh government. Welsh business seems highly dependent or focused on public sector assistance. Opinions were equally divided on whether the experience of seeking government help had been satisfactory. Some firms were very complimentary about government support; others found it good but with reservations; yet others were scathing.

Some clear pointers emerged. Firstly, the Welsh government and Finance Wales score higher marks from companies they induced into Wales with support packages than they do from companies already here. A number of potentially important and dynamic companies said they were in Wales largely because of government grants. While there were stresses and strains in arranging the grants they generally reported a satisfactory experience. These firms were found in the finance, software, civil engineering and biotech areas. (How far such inducements will be possible after Brexit is an important issue).

For companies already here the story was less rosy. Indeed, one incoming company having received initial help no longer looked to the public sector, which it criticised for favouring footloose multi-nationals over indigenous or established companies. That risked

encouraging purely temporary investments while missing out on real opportunities for further growth.

Secondly, a frequent complaint was that the government purported to promote high value added sectors, like advanced manufacturing, yet these created only a small number of jobs. Meanwhile the government's grant procedures were actually strongly geared to direct employment creation; that was a contradiction. An emphasis on direct employment rather than value-added was generally seen as out-dated. One firm with strong IP and third-world markets had outsourced physical production to a third-world country. Nevertheless it wanted Wales to be the centre for research and product development and licensing. Getting financial support or investment from Welsh public institutions had been a tortuous business because the strategy meant much value-added would be in Wales but many "jobs" would not be.

Thirdly, several firms complained about slow, cumbersome, bureaucratic procedures that made it difficult to seize opportunities which required immediate finance. One respondent ascribed this to a lack of commercial skills in government organisations. Another found more flexibility but only at a very senior level while more junior personnel were not responsive. This meant that it was impossible to use public agencies for bridging finance or for working capital. One suggestion was that there should be a cadre of district loan officers who were empowered to extend finance without referring applications up to a committee. They would then be judged on results and audited to avoid corruption.

A separate suggestion for government related to procurement. Several characterised the Welsh public sector as risk-averse in procurement, subject to the "IBM syndrome" and excessively afraid of being seen to favour domestic suppliers. This worked against Welsh companies, especially smaller ones. One firm in the construction sector could get on to the Welsh government's tender list only by going into partnership with a foreign multinational. That multinational always sub-contracted all parts of a project anyway so the indigenous firm did literally all the work on the project but had to remit half the profits abroad. The company was scathing about the suggestion that this was owing to EU regulations, saying that they encountered the opposite discrimination when tendering in France or Germany where domestic companies were openly preferred.

#### ***Other results from the survey:***

There were many fewer complaints about infrastructure than expected. Only two firms mentioned it as a constraint. Several incoming firms cited good communications as being in combination with government grants as the reason for their decision to come to Wales. It should be noted that the only other area of the UK where Tier 1 grants are now available is Cornwall, which clearly suffers from longer and worse communication links than Wales. Broadband connectivity was not mentioned at all, despite our statistical analysis indicating its importance. However, this result may reflect the bias of the sample to urban South Wales. Elsewhere that is more likely to be a constraint.

The majority of companies were satisfied with the specialist (private) business services available in Wales, with 68% declaring local legal and accounting services adequate or

better. Others had no specific complaint but used firms outside Wales, often for legacy reasons. The numbers for banking and insurance were slightly lower at 53% and a few respondents expressly said local banking services were adequate unless you wanted to borrow money when the banks proved exceptionally risk averse and demanded unreasonable securities. There were also some horror stories. One company wanted to factor invoices – mainly from large multinational clients who had never defaulted. The bank refused unless the owners provided personal guarantees for the money. At the time the business had an annual turnover of over £2 million.

Firms generally tended to regard themselves as unique in the Welsh context and only 3 companies said they collaborated with similar firms. That might suggest that Wales-based companies do not have the appetite or perhaps the opportunity for collaboration and co-operation to win contracts that require more competencies than they have in-house. Several of the more successful firms though cited collaboration with customers to develop the firm's competences and products. In a couple of cases large customers offered joint-ventures or other finance for development. More firms said they collaborated on R&D - 31% of the sample. There was slightly more collaboration with other commercial companies than with academic institutions. Less than half the commercial collaborations were with other Welsh companies while more than half the academic collaborations were with institutions in Wales. Reliance on trade associations to help with the business appeared to be sector-dependent. It was important for some 54% overall (19 companies).

### ***Limits to growth in Wales?***

From the in-depth interviews an issue related to IP emerged although none of the companies had identified it as a problem – because it is arguably a problem for the Welsh economy though not necessarily for individual business owners. It seemed to us that there is clearly an issue about keeping important IP in Wales. Several research-intensive companies saw that as they grew they would become takeover targets either through a trade sale or after they went public. Indeed, one or two saw no other way to acquire the branding that would open a bigger market up to their products as well as allowing founders to cash out.

That means Wales is rather like a second-division football club with a promising youth development system. As the players come through the best ones are the subject of transfer bids. In most cases they want or need to leave to further their career. If the club is ever to make the Premier League, however, it needs to find a way to keep more of its better players so they can grow and flourish with the club. Similarly Wales needs to keep more companies growing larger in Wales.

While the existing management of many companies had no desire to leave Wales they saw a trade sale or take-over as highly likely if they were successful. The Welsh government had only a little equity in these companies so the public's bet did not look a particularly good one. If the companies failed to be very successful the return on public money was meagre. On the other hand, they could be highly successful and get bought out. In that case the possibility that their IP and facilities would leave Wales was real and returns to public spending would be transient. In that sense Wales is in a worse situation than the analogous

football club: it is as if the club pays to bring the youngsters into the development system but receives none of the transfer fee when they leave. The list of good quoted or unquoted Welsh companies lost to the country in recent years is a melancholy one.

One indigenous private company we encountered employs over 800 people and has a turnover of over £300 million. Its founders still held all the equity in the company but were all over 65 years old. They did not want to sell but they will have no option if they wish to realise any substantial part of the value of the business. Some of its operations may remain in Wales after a sale but almost certainly a declining proportion after its head-quarters is moved elsewhere.

There is awareness in policy circles of the need for cheaper early-stage finance<sup>2</sup>. Yet there may be an even bigger gap further up the finance ladder where substantial sums may be required either for MBOs or continuation financing if companies are to be retained in Wales. A requirement for keeping more growth companies in Wales is succession funding or consistent patient finance through the various stages of financing a growth business. There may also be a need for a collaborative effort in marketing Wales and Welsh businesses. The importance of a Welsh “brand”, we confess, seems a rather airy-fairy notion but it recurred as a theme among those business people who, while hard-headed and commercial, attached some value to staying and thriving in Wales. Evidently both finance and branding require greater commitment of resources than hitherto.

The Welsh government has announced a “succession fund” but it totals only £50 million, enough to keep a number of small businesses operating locally but of no use for the kind of larger company cited above. The scale of resources required makes it difficult for the long-term finance to come from a wholly state-owned institution. It could push the Welsh government “spending” beyond its Departmental Expenditure Limit<sup>3</sup>. There is a need for a substantial private equity investor able to raise and invest hundreds of millions in indigenous Welsh businesses but one seems unlikely to appear without substantial support from the public sector. What is required is a commercial organisation able to make money but one that gives weight to the location objective too. So far there are no proposals about how such an organisation could be constituted in Wales.

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<sup>2</sup> See, for example, Access to Finance Review, Stage 1 report and Stage 2 report, Dylan Jones Evans, published by Welsh Government 2014.

<sup>3</sup> HM Treasury, Statement of Funding Policy, November 2015, especially page 9.

## Provisional Summary of Survey Results

Firms who:						%
Sell more than 50 % outside Wales						72
Have more than 50 % of suppliers by value outside Wales						66
Use business services in Wales and find them generally satisfactory						60
Collaborate on R&D						31
		with other Welsh companies				11
		with Welsh universities				14
Intend to grow in Wales in next 5 years						80
Supply-side obstacles to growth*						
none						23
finance						20
getting qualified staff						60
finding suppliers						0
poor infrastructure						6
other						20
Have sought Welsh government assistance						91
		experience satisfactory				49
		partially or wholly unsatisfactory				43

*\*Firms could cite more than one obstacle*

*Current sample size: 35*

*N.b. a complete sectoral breakdown of the sample is available only for those companies interviewed. Some responses to the postal questionnaire were anonymous so not all of the respondents can be assigned to a sector.*

## Conclusions

There are, of course, reasons both historical and geographical why Wales is the poorest region of the UK on a number of measures. We started by asking whether it must inevitably remain so, and what if anything can be done to catch up.

The state of thinking in Regional Development was summarised in the Learned Society of Wales' Port Meirion Symposium last year<sup>4</sup>. It is consistent with the "smart specialisation" approach adopted within the EU. Many would argue it requires a smart and embedded state, able to learn about and understand more intimately what is going on in the economy than a state where industrial policy is organised on more hierarchical and/or centralised lines. As a generalisation that sounds plausible but raises the question how in practice

<sup>4</sup> See Welsh Economic Review, Spring 2016.

government structures need to be organised and what is required of political leadership to achieve the embedded state.

Political structures and institutions are already in flux in a number of areas such as city regions, LA reorganisation, proposals for an investment bank and an infrastructure commission, and these changes could continue toward building a more interactive State apparatus. More importantly, perhaps is to achieve a shift in attitudes toward economic governance that embraces the idea of an embedded State, where public agencies government would look to build up and maintain intimate knowledge of the industrial landscape of the country, and to nurture and facilitate, rather than to direct.

Our survey results to date provide some tentative conclusions about where reformed government structures can and should be focusing. Education and training is the area where Wales has the greatest need for development and where current outcomes are furthest below what is required. The responses of businesses to our survey make this ineluctably clear. Improvements are also needed in business support and finance. Apart from the well-canvassed problems with the cost of early finance for nascent businesses there is a gap further up the financing ladder which effectively limits the potential of firms to mature in Wales. This gap cannot be filled within current institutional structures and requires institutional innovation.

We suggest, therefore, that institutional innovation will be required in several areas to improve capacities in delivery and achieve an embedded State for practical support and advice. While our enquiries have pointed at key factors, we have not identified “sectors” on which to concentrate. Further research may yield suggestions - though responsiveness to entrepreneurs with competitive advantage at firm level may be more important than preconceived priorities.

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## **Annex 1 Background on the WCIR dataset**

The dataset for the analysis consists of that provided by the World Competitiveness Index of Regions (WCIR), which aims to provide a tool for analysing the development of a wide variety of regional economies based within differing national economies (Huggins et al., 2014). The WCIR represents an integrated and overall benchmark of the knowledge capacity, capability, and sustainability of each region, and the extent to which this knowledge is translated into economic value and transferred into the wealth of the citizens of each region. Therefore, the WCIR is explicitly tied to the theoretical discourse stemming from endogenous growth theory, with knowledge and human capital at the centre of its analysis.

The WCIR framework employs a set of 19 indicators. In the input domain of new knowledge production, we choose the number of employees in five high-tech sectors as proxies for the human capital devoted to innovation. A number of studies attempt to classify sectors based on criteria related to research and technology intensity (Lee and Has, 1996). The WCIR uses the Eurostat (the European Commission's statistical office) scheme of industry classification, which was developed in collaboration with the OECD (Hatzichronoglou, 1997; Laafia, 1999). It classifies into five groups those sectors considered by Eurostat as 'higher-tech manufacturing sectors', 'medium-high-tech manufacturing sectors' and 'high-tech service sectors'. The five groups are: IT and computer manufacturing; high-tech services; biotechnology and chemicals; instrumentation and electrical machinery; and automotive and mechanical engineering.

Other technology-input measures include R&D expenditures performed by the business and government sectors. Compared with corporate R&D, the impact of public sector R&D is less direct in its route in terms of both diffusion and timing. Nonetheless, there is evidence that spillovers from public sector R&D raise an economy's productivity (Jaffe, 1989; Adams, 1990).

Another technology measure used is the number of patents granted. The propensity to patent is known to vary widely across industries, with many patents turning out to be worthless, while a few are extremely valuable (Pavitt, 1982; Griliches, 1990). However, there is some evidence that suggests a close association between patents and other productivity-based measures at the national and regional level (Fagerberg, 1996; Acs et al., 2002).

Private equity investment capital is used as a proxy of the availability of funds for knowledge-based, start-up firms. Private equity funding is often concentrated in small or medium-sized firms, including venture capital and start-up investments, which tend to be in knowledge-based activities.

For indicators of the long-term competitiveness sustainability, public expenditures on primary and secondary education and higher education are included. There is a sequential interaction between a region's education and training system and its stock of high-skilled workers. The rate of enrolment in education is influenced by a region's employment and career prospects, as well as the socioeconomic background of pupils and the quality of schooling. Enrolment, in turn, determines the region's workforce skills, productivity and economic performance (Bradley and Taylor, 1996). Public investment in education plays an important role in this sequential cycle, particularly improving the quality of local schooling over time. In addition, three indicators of internet-based infrastructure are employed: numbers of internet hosts, secure servers, and broadband access - as measures of knowledge competitiveness sustainability.

Other measures included are the regional unemployment rate and economic activity rate (defined by the ratio of the labour force to the working-age population). Also included is the proportion of workers employed in a managerial capacity, which is used as a proxy of human capital. Although this is hardly a perfect indicator of human capital, a similar indicator is used in international studies of

the labour market (OECD, 1994). The wages of managers are generally higher than those of other occupations, reflecting the greater amount of investment made in education and training. Lastly, we adopt labour productivity and mean gross monthly earnings as indicators of competitiveness outputs and outcomes, respectively.

To remove effects of the size of each region analysed, per capita figures are taken for the following variables: R&D expenditures performed by the business sector and government sector; patents granted; private equity investment capital; internet hosts; secure servers; broadband access; and public expenditures on primary and secondary education, and higher education. Employment in the five high- or medium-high-tech industries and the number of managers are based on a per total regional employment basis.

In terms of territorial coverage, the WCIR dataset covers 546 regions globally. In the European Union (EU) member states, a total of 137 regions are benchmarked. This not only gives a wide perspective across EU regions, but provides insights into the regional disparities that are so important to the EU's economic convergence goals (Keating and Loughlin, 1997). The regions of the EU states are based on the NUTS (Nomenclature of Territorial Units for Statistics) classification, with a majority of them belonging to NUTS-1 group (Austria, Belgium, Bulgaria, Estonia, France, Germany, Greece, Hungary, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Spain, and the UK), and the remaining ones to NUTS-2. The inclusion of the three European Economic Area (EEA) states – Iceland, Norway, and Switzerland - means that there is coverage of 140 regions within the wider European free trade area.

Due to the rapid development in the performance of the BRIC nations (Brazil, Russia, India, China), the WCIR gives the regions of these nations prominent coverage. Under the European continental bloc, 56 Russian regions are included, bringing the total of European regions to 196. Russia, being a transcontinental country, posed a separate challenge, with a number of the more eastern regions classified within the Asian continental bloc. The splitting of the Russian regions was considerably eased by the Russian administrative regional divisions, allowing the use of the conventional continental border of the Ural Mountains and the Ural River to distinguish between the European and Asian Russian regions. Only one region was divided between the two continents – Orenburg Oblast. It is classified here as European, due to the majority of its territory clearly being on the European side.

In North America, 90 US regions are benchmarked along with 12 Canadian regions (based on their defined provincial units). The US regions are based on the Metropolitan Statistical Areas (MSAs) as defined by the US Census Bureau. MSAs consist of an area with a substantial population centre and adjacent counties having a high degree of economic homogeneity, which is – compared with counties, cities and states – more robust for economic analysis, as they reflect the boundaries of clusters of firms in related industries. In the case of Asia and Pacific regions, 164 regions are included from Australia, Japan, South Korea, China, India, Kazakhstan, Taiwan, Singapore, New Zealand, and 'Asian Russia'. The Asian and Pacific regions are defined by city or provincial/prefecture boundaries for most nations (for example, provinces for China).

In the Middle East, 35 regions covering Israel, Qatar, and Kuwait (each as region-states), as well as 13 Saudi Arabian, 7 United Arab Emirates, and 12 Turkish regions are benchmarked. Finally, the WCIR covers regions from two South America nations: Brazil (27 regions) and Colombia (22 regions).

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## Annex 2 Regression results

Model Summary				
	R	R Square	Adjusted R Square	Std. Error of the Estimate
	0.928	0.861	0.856	0.3572

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	1.707	.016		110.024	.000
Employment in IT and Computer Manufacturing per 1,000 employees	-.037	.021	-.039	-1.726	.085
Employment in Biotechnology and Chemicals per 1,000 employees	.009	.019	.010	.468	.640
Employment in Automotive and Mechanical Engineering per 1,000 employees	-.013	.023	-.014	-.587	.557
Employment in Instrumentation and Electrical Machinery per 1,000 employees	-.033	.024	-.035	-1.389	.165
Employment in High-Tech Services per 1,000 employees	.096	.019	.102	4.989	.000
Number of Managers per 1,000 employees	-.020	.020	-.021	-.998	.319
Per Capita Expenditures on R&D performed by Government	.034	.018	.036	1.903	.058
Per Capita Expenditures on R&D performed by Business	.207	.024	.220	8.686	.000
Number of Patents Registered per one million inhabitants	.003	.020	.003	.162	.871
Unemployment Rates	.008	.018	.009	.474	.636
Per Capita Private Equity Investment	-.037	.021	-.039	-1.793	.074
Per Capita Public Expenditures on Primary and Secondary Education	.184	.029	.195	6.283	.000
Per Capita Public Expenditures on Higher Education	.172	.030	.182	5.812	.000
Secure Servers per one million inhabitants	.231	.037	.245	6.217	.000
Internet Hosts per 1,000 inhabitants	.019	.021	.020	.934	.351
Broadband Access per 1,000 inhabitants	.206	.030	.218	6.810	.000