

# **Innovation:** Transforming the way business creates

*includes a global ranking of countries*



An Economist Intelligence Unit white paper  
sponsored by Cisco Systems

## Preface

*Innovation: Transforming the way business creates* is a white paper by the Economist Intelligence Unit sponsored by Cisco Systems. The Economist Intelligence Unit bears sole responsibility for this report. The paper was written by Nick Valery and Laza Kekic, with sidebars contributed by Bob Johnstone and David Jacoby. It was edited by Nigel Holloway and the paper was designed by Richard Zoehrer. The findings and views expressed in this white paper do not necessarily reflect the views of the sponsor. Our thanks is due to each of the survey respondents for their time and insights.

May 2007



## Three themes for the interactions economy

**T**his white paper is one of three published in 2007 as part of a research programme that arose from the Economist Intelligence Unit's March 2006 report for Cisco, entitled "Foresight 2020." This report highlighted a number of important changes to the world economy over the next 15 years. The principal trends identified in the report—globalisation, demographics, atomisation, personalisation and knowledge management—will have a profound effect on the landscape of major industries and the working of the company.

In order to build on "Foresight 2020," we identified three themes that were then developed into separate research projects investigating personalisation, collaboration and innovation. Each is intended to stand on its own and to fit with the other two, describing from different vantage points the development of the interactions economy, in which customers, suppliers,

workers, owners and others go beyond mere transactions to exchange information for mutual benefit.

As companies adapt to the new forces moulding the interactions economy, they will find that personalisation, collaboration and innovation will present great challenges and opportunities. Personalisation goes beyond customisation, allowing the consumer to stamp a product or service with his or her own applications, preferences and configurations. Technology is particularly adept at enabling a high degree of personalisation, as in the case of the downloadable applications available on mobile phones or personal digital assistants. By offering a large variety of possible products, features and services, personalisation

has the power to increase sales and margins enough to transform business models.

Collaboration will have a similarly profound effect on business. Broadly speaking, collaboration means to work together, and our research focuses specifically on formal collaborative arrangements at work that bridge traditional geographic, institutional, and functional boundaries. The emphasis on core competencies, the need for corporate agility and the rise of emerging markets have caused firms to focus on collaboration both within and among

organisations. Collaboration among functional groups and organisations will help companies become more productive and innovative.

Innovation—defined here as the application of knowledge in a novel way, primarily for economic benefit—is becoming increasingly important for firms and governments. Business people regard it as a way to beat their corporate competitors. Government

policy makers see the need for an innovative environment if their economies are to prosper.

The three themes are linked in many different ways. Firms collaborate with customers in order to create innovative products that can be personalised. Process innovations can enhance collaboration in which carefully selected workers from around the world are brought together in teams to improve productivity. The development of the interactions economy is likely to strengthen the links among personalisation, collaboration and innovation and heighten their importance, with far-reaching implications for global business.



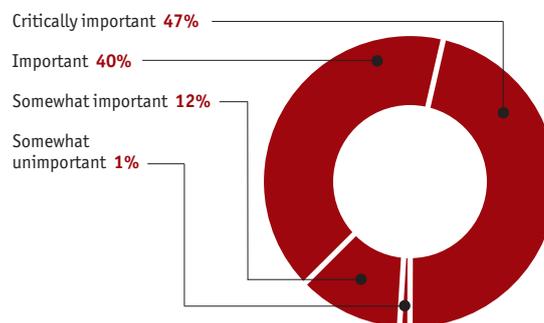


## Executive summary

**I**nnovation—defined here as the application of knowledge in a novel way, primarily for economic benefit—is becoming increasingly important for companies and governments. Business executives regard it as a vital weapon in fending off their corporate competitors. Government policymakers see the need for an innovative environment if their countries' economies are to grow.

But how important is innovation, which countries innovate better than others, and why? In order to find out, the Economist Intelligence Unit undertook two parallel research studies in 2006-07 in a programme sponsored by Cisco. The first was a worldwide survey of 485 executives to gauge a better understanding of the drivers of innovation and their relative importance. The second was a ranking of 82 of the world's

How important is innovation to your organisation's long-term success? (% of respondents)



economies by innovation performance during 2002-06, with a wider forecast to 2011.

The main findings are highlighted below:

- Innovation has a beneficial impact on both national economic growth and on corporate performance. The evidence of such benefits is stronger at the microeconomic than at the macroeconomic level.
- At the corporate level, our survey found that among firms where innovation is identified as critically important, 46% perform better than their peers; only 32% of the firms that do not think innovation is critically important perform better than their peers.
- Among firms surveyed that are based in, or are closely connected to, a high-tech cluster such as Silicon Valley, 56% said they performed better than their peers; only 36% of firms outside of a high-tech cluster performed better than their peers.
- Our survey panel cited a broad range of factors in explaining what makes a country innovative, with the top determinants being technical skills of the workforce (92% of respondents) and quality of IT/telecommunications infrastructure (also 92%).
- Japan, Switzerland, the US and Sweden are the world's top four innovators among the 82 economies

### About our survey

In November 2006 the Economist Intelligence Unit conducted an online survey of 485 senior global executives on their opinions regarding innovation. The largest groups of respondents are in financial services, followed by IT and technology, professional services, manufacturing, and healthcare, pharmaceuticals and biotechnology. A total of 48% of the respondents work for companies with annual sales of up to US\$500m, and 26% are employed by enterprises with revenue in excess of US\$5bn. Thirty percent are board members or have C-suite job titles; another 35% are SVPs, VPs or directors, heads of business units or departmental heads; and the remainder are managers. Their functional roles are predominantly strategy and business development, general management, finance, and sales and marketing. A total of 56% of the responding firms are located in Europe and the Middle East, 25% in the Americas and 20% in the Asia-Pacific region (this adds to 101% due to rounding).



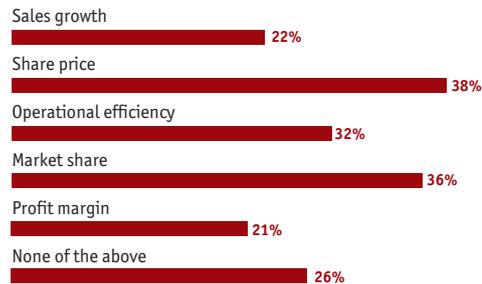
in our ranking, and we predict that they will maintain these positions during 2007-11. During this period, China's rank will move up by five places, and Mexico's will rise by six. Other noteworthy gainers will be Singapore, South Africa, Costa Rica and Lithuania.

- China has more favourable conditions for innovation than India. With annual expenditure of US\$136bn on R&D, China now outspends Japan. However, in the sphere of innovation, there is a "small country advantage": 12 of the top 25 countries in our league table in Appendix A on page 28 have a population of less than 10 million.

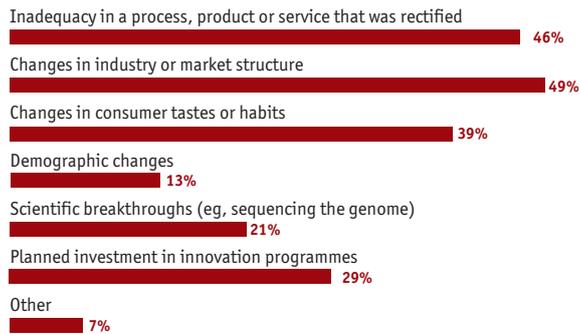
- The return on innovation is estimated to be higher in middle-income countries such as Mexico and China than in richer countries. Our empirical analysis suggests that middle-income countries tend to gain proportionately higher income per unit of additional innovation than richer countries. Although middle-income countries are dependent on imported technology, the speed with which they absorb this technology may depend on their own domestic innovation performance. This finding augurs well for the catch-up prospects of middle-income countries.

**For your organisation, is successful innovation more or less important than other metrics of success?**

**For my organisation, innovation is more important than...**  
Select all that apply (% of respondents)



**How would you describe the origins of your organisation's most successful innovations?** Select all that apply. (% of respondents)





## The innovation imperative

**W**hy innovate? Innovation has become the defining challenge for business everywhere. A decade ago, companies saw survival and growth in terms of restructuring, lowering costs and raising the quality of their goods and services. Since then, commoditisation, privatisation and deregulation

have swept the world—from the advanced economies of the United States, Japan and Europe to the rapidly emerging markets of the Asia-Pacific rim and Latin America. Thanks to the internet, air travel and improved patenting procedures, access to the latest technology has become universal. Today, few firms anywhere can feel secure behind their established brands, long-standing customer relationships, proprietary technology, or tariff barriers. The competitive pressure on them is global and immediate.

Companies everywhere, especially those in advanced nations with high labour costs, have become painfully aware that even in their new slimmed-down, outsourced, globalised guise, they cannot conduct business as before. No matter how good their quality, standard products made in the standard way cannot sustain a firm's competitive edge.

Business leaders in companies big and small, in every industry, have started to refocus on top- and bottom-line growth. And the general consensus is that one of the best ways to achieve this is through innovation. The reaction of consumers to such

products as the iPod and the BlackBerry suggests that companies can grow faster if they innovate. This gives them a head start, if not an unassailable lead.

A large number of studies have found a positive relationship between research and development (R&D) and growth in output. Studies of the effectiveness of firm-level R&D use productivity to measure performance rather than profits. It has been difficult to establish a direct link between innovation, or R&D, and profits, in part because the variety of influences that affect profits may be greater than for productivity.

Other results that emerge from most of these firm-focussed studies include: process R&D is more beneficial for companies than product R&D; basic R&D typically yields more than applied R&D; and R&D returns vary considerably between industries, with the highest returns occurring in research-intensive industries. R&D should not be confused with innovation, however. A company may invest heavily in research and not come up with a single, good idea. Indeed, our survey suggests that more innovations come from sales and marketing than from R&D (see page 19). But even so, without a good R&D effort, it would be hard to translate most of the ideas into innovative products and services. Given that R&D is rarely more than 5% of a company's total revenue, increasing R&D activity would seem to be a winning corporate strategy.

It is argued that countries generating innovation create new technologies and encourage the adoption of these new technologies. As a result, they grow faster than those that do not. The message that innovation is important is being heard by governments as well. The Organisation for Economic Co-operation and Development (OECD), a governmental grouping of 30 advanced economies, has been at the forefront

### KEY POINTS

- Innovation is increasingly important for companies and governments.
- The evidence of a link between innovation and performance is stronger among firms and industries than among countries. But even at the national level, innovation may help to improve economic performance.
- Innovation requires clear thinking, an ability to improvise and dogged determination.



of those emphasising that long-run economic growth depends on the creation and fostering of an environment that encourages innovation. Innovation is considered an important driver of long-term productivity and economic growth. It is argued that countries that generate innovation, create new technologies and encourage adoption of these new technologies grow faster than those that do not. However, the OECD's empirical tests of this proposition have been sparse, and those that have been undertaken for a limited number of OECD countries have yielded ambiguous results.

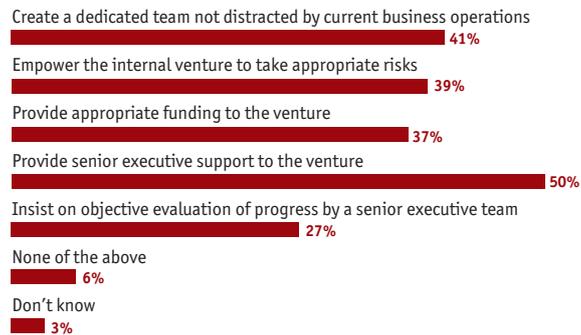
The conventional wisdom is that innovation is most likely to drive growth in the highly developed countries, while poor and middle-income countries can import technology from abroad and therefore need not bother to innovate domestically. However, our study indicates that for high-income countries, innovation yields a smaller impact on economic growth than for low- and middle-income countries. This is true for the top two countries in our innovation ranking, Japan and Switzerland, (as well for some innovative Euro-zone economies and Israel), whose economies have not grown rapidly for the past decade.

This finding also reflects the fact that for low- and middle-income countries, domestic innovation activity tends to facilitate the more efficient and rapid absorption of imported technology. Thus, they benefit from their internal innovativeness as well as from the spillover effect of foreign innovations. This would tend to increase the catch-up prospects of the more innovative middle-income countries, such as China and Mexico.

**Innovation defined** Innovations have two main characteristics. First, innovations break the mould by applying knowledge in some novel way. Second, innovations are the result of a chain of events that starts with an original idea, invention or discovery, and then proceeds (usually in a chaotic manner)

**Which of the following steps does your organisation generally take in support of planned innovation initiatives?**

Select all that apply. (% of respondents)



through prototype construction, financing, customer demonstration, field trials, engineering, production, marketing and finally sales. Only by successfully completing this obstacle course can an invention be considered an innovation. An invention that costs US\$1,000 to make can easily cost US\$10m to turn into an innovation.

Innovation, it has been said, is like climbing a mountain. There has to be a plan of attack, a team of talented mountaineers assembled, money for the venture secured, a full supply of provisions made available, and all the appropriate equipment hauled to base camp. There are usually well-trodden paths up through the foothills, and numerous potential routes to the top—some riskier but quicker, others safer but slower, still others that have yet to be reconnoitred. There will be many disappointments, with success rarely coming quickly or even at the first attempt. Apart from skill and resources, the most important requirements are a clear head, an ability to improvise and dogged determination.

Innovation is no less an ordeal. But, just as mountaineers who have scaled the peaks successfully have bequeathed charts for subsequent climbers to retrace or amend, the pioneers of innovation have likewise left route maps for the rest of us to use. What they demonstrate is that there is no one way to innovate.



## Measuring innovation

In order to look more closely at the drivers and performance of innovation, we considered it from two angles, from the top down and from the ground up. This white paper first takes in the view from the mountain top and then goes down to ground level to ask executives what helps them innovate. The

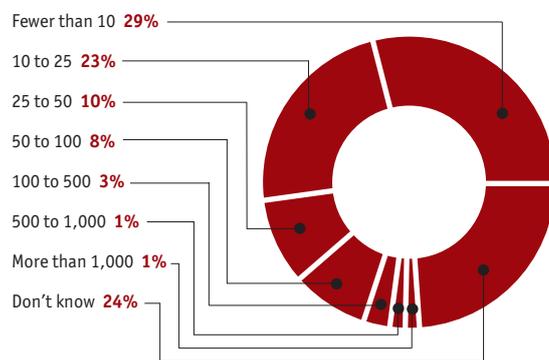
view from the top consists of an innovation ranking of the world's largest 82 economies. The view from the bottom is based on a survey of executives. The two aspects of the study were linked: we needed to know what weights to ascribe some of the innovation drivers for our global ranking, so we asked executives to rank the importance of a variety of environmental factors. We then applied those weights to the factors in the index.

Taking the top-down view first, in order to bring things into focus we needed to explain some of the methodology behind the way we analysed this topic. The first step was to decide how to measure innovation at the national level.

**The patent as a measure of innovation** The most common measure of innovation for a company is how many patents it generates annually. The number one corporate innovator in the world is IBM, which has a worldwide portfolio of more than 40,000 patents.

The most appropriate measure of innovation for a country is how many patents it generates per million population. Based on our research on 82 economies, the top-ranking national innovator is Japan,

Approximately how many documented suggestions/proposals for innovations does your organisation consider for each successful new product/service/process it rolls out? (% of respondents)



with a perfect score in our index of 10 out of 10. We construct our measure as the sum of patents granted to applicants from the 82 economies by three major government patent offices—the European Patent Office, the Japanese Patent Agency, and the US Patent and Trademark Office. The data are averaged over 2002-05 and expressed in terms of patents per million population for each country. These numbers are then converted into an index on a 1-10 scale.

While the number of patents generated is not a perfect measure of innovation, we found that it is a very useful one. Clearly, some inventions are more valuable than others. A patent for a new melon-baller is not equivalent to a patent for shotgun sequencing of the genome. Moreover, a patent can represent a family of inventions or can be merely a single member of one such family.

One approach to patenting, for example, a bicycle would be to describe it as a two-wheeled, human-powered machine for transport. Another would be

### KEY POINTS

- Patents are a proxy for innovation.
- Some innovation inputs, such as the educational attainments of the workforce, have a direct impact on innovation; others, such as macroeconomic stability, have an indirect impact.
- Some countries are better at converting these inputs into innovation output than others.



to patent separately the frame, wheels, handlebars, saddle, crank and chain as components for a two-wheeled, human-powered transport machine. Some patenting jurisdictions tend to favour the latter interpretation, skewing the numbers of patents generated in the country concerned. This was a perennial problem when comparing Japanese patent figures with those of other countries.

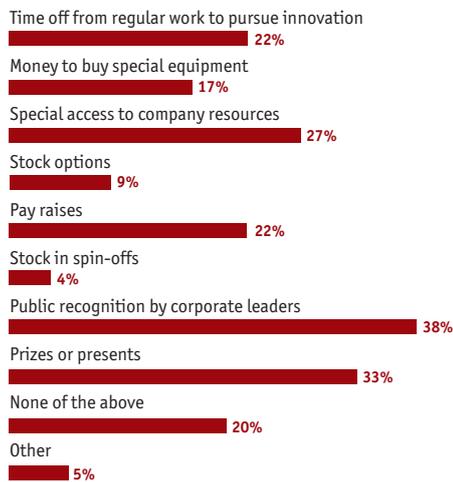
We have corrected for the “Japan effect” by assuming that the maximum value that the index can take, with a top score of 10, is 800 patents per million population. This is below the actual value for Japan of 1,213 to allow for the fact that until recently a different patent application had to be submitted in Japan for each claim. An explanation of how the separate data sets were combined and the regression analysis used can be found in Appendix B on page 32.

Although the number of patents may be an imperfect measure of innovation, it correlates well with three other proxies for innovation performance:

- Citations from scientific and technical journals per million population. The data are for 2003 from Science and Engineering Indicators 2006 published by the US National Science Foundation, and Thomson ISI’s Science Citation Index.
- The average of two ratios: the share of medium- and high-technology products in a country’s manufacturing output and the share of medium- and high-technology exports in its total manufacturing exports, taken from the United Nations Industrial Development Organisation (UNIDO) Industrial Development Report 2005.
- The results of a survey question from the World Economic Forum’s Global Competitiveness Report 2006 that asked respondents to rate the extent to which companies in 125 countries were adept at, or able to absorb, new technology.

We have constructed a composite measure of innovation performance that consists of these indicators as well as our patents measure of performance (see

**How does your organisation incentivise employees to suggest and develop innovations?** Select all that apply. (% of respondents)



p. 32). The composite index gives very similar results to the “patents only” measure. For example, the top three remain Japan, Switzerland and the United States. Thus we can examine the “patents only” index with considerable confidence that it truly reflects a country’s innovation performance.

What factors lead to innovation on a national level? There are two types of factor: direct and indirect drivers of innovation.

**The direct drivers of innovation** The direct drivers—factors closely linked to innovation—are selected from a broader index called the Business Environment Rankings (BER), an Economist Intelligence Unit database. These direct drivers are:

- R&D as a % of GDP
- Quality of the local research infrastructure
- Education of the workforce
- Technical skills of the workforce
- Quality of IT and communications infrastructure
- Broadband penetration

Each country is ranked according to its score for



## *Japan and Taiwan are very efficient innovators; they produce a lot of innovations for a low level of inputs*

these direct inputs, a number that is based on the unweighted average of the six indicators.

**The indirect drivers of innovation** A separate index was constructed for the indirect inputs, the broad economic, social and political factors that facilitate (or hinder) innovation activity. The innovation environment index is based on the following 12 factors:

- Political stability
- Macroeconomic stability
- The institutional framework
- The regulatory environment
- Tax regime
- Flexibility of the labour market
- Openness of national economy to foreign investment
- Ease of hiring foreign nationals
- Openness of national culture to foreign influence
- Access to investment finance
- Protection of intellectual property
- Popular attitudes towards scientific advancements

Again, the source for all the indicators is the BER, with the exception of popular attitudes towards science, which is taken from the World Values Survey, published by a global network of social scientists.

Since these enabling factors are subjective and not easy to quantify, we asked our survey respondents to rank them according to their importance as innovation drivers. The results allowed us to assign weightings to each of the indirect factors that we then used to assign an innovation environment index for each country. (See Appendix B on page 32 for details on the various factors and their weightings.)

For the purpose of this study, indices of both the

direct drivers of innovation and the indirect environmental factors were created for all 82 economies in our database. These were then combined with a 70% direct and 30% indirect weighting into a single innovation enabler score.

For each of the 82 economies, our chart lists values for direct inputs, the innovation environment and the combination of the two: the innovation enabler score. A statistical analysis of our rankings shows that the inputs we use for the ranking account for more than 90% of the differences we see in innovation performance among the 82 countries. In addition, we are able to calculate the innovation efficiency for each country.

**Innovation efficiency** A comparison of a country's rank on its innovation output (performance) with its ranking on direct innovation inputs can provide an insight into the efficiency of innovation. A large discrepancy in the two rankings suggests either a high level of efficiency (high innovation output relative to inputs) or a high degree of inefficiency if the direct inputs rank exceeds significantly a country's ranking on innovation performance.

By this yardstick, Japan appears to be a very efficient innovator, coming first in the output ranking despite being in 11th place in the direct inputs ranking. Taiwan is also in this category. It is in 8th place in terms of patents per million population, but in 14th place in terms of direct inputs.

A glance at the innovation environment index can in this context also be informative. A good innovation environment can help to explain why a country's direct inputs may be efficiently translated into innovation performance (outputs). China is an inefficient innovator, ranking 42nd in direct innovation inputs but is ranked a full 17 places below that in innovation performance (ranking 59th). The discrepancy in the two rankings partly reflects the fact that China's innovation environment (the framework through which



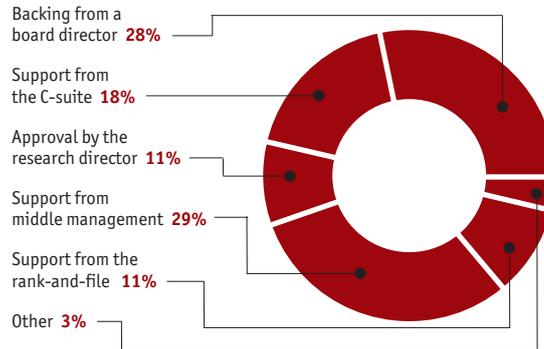
inputs are translated into outputs) is significantly lower (in 57th place).

These indicators of innovation efficiency can help to guide government policy. They can, for example, highlight possible inadequacies in certain environmental factors, such as the number of work permits for foreign scientists and engineers, or whether the protection of intellectual property (IP) rights is inadequate. Moreover, we have been able to forecast innovation indices for the years 2007-11, because our BER model contains forward-looking assessments for the next five years.

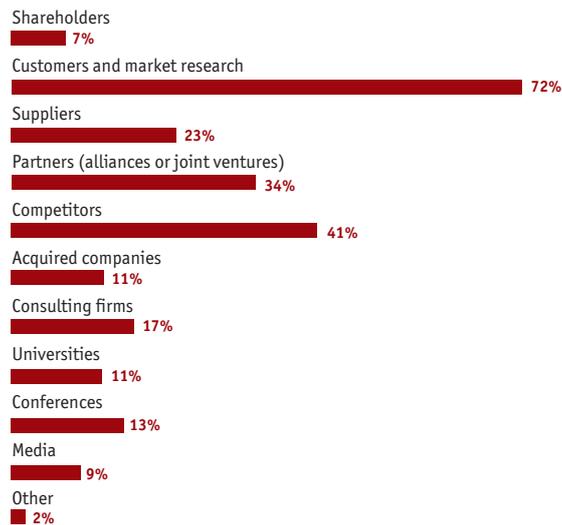
For corporate strategists, the present and future indices and associated ratios are helpful in deciding where new products should be developed overseas and what to expect from the national government, local services and labour force. For investors, the international innovation rankings are useful because to some extent the more innovative a country, the greater its growth potential.

Now that things are in better focus, we can look more closely at which countries come higher than others and why.

**Generally speaking, how do ideas for innovations start to gain momentum within your organisation?**  
(% of respondents)



**From what outside sources does your organisation most often get ideas for new products/services/processes?** Select up to three.  
(% of respondents)





## The world's most innovative economies

**J**apan is in 1st place, generating 51% more patents than the US. Because Japan's population is only 42% of that of the US, its ratio of patents per million population is 3.5 times higher than the US—and indeed the highest such ratio of all. Thus, it tops out as the most innovative country in the world, despite having lower rankings in the direct

factors that drive innovation (such as the stock of human capital and IT/telecommunications infrastructure) and still-lower rankings in the index that measures the environmental factors that are conducive to innovation. Japanese education, for instance, fosters conformity, not creativity.

However, several factors propel Japan to the position of top innovator. For one thing, this resource-poor economy has long taken an “innovate or die” approach. For another, the

economy has a large proportion of high-technology activities that are, by their nature, more innovation-intensive. In Japan there used to be a symbiotic relationship between large companies and associated smaller firms that were closely integrated into so-called keiretsu and were under strong pressure to innovate. These ties have broken down, but they continue to drive innovation to some degree.

In addition, Japan invests proportionately more in R&D than the US (3.35% compared with 2.79% of GDP) and most other major countries. And more of that R&D is carried out by industry (rather than universities and national laboratories) than is the case

in the United States. Furthermore, Japan has more scientific researchers per million population than the United States (5,900 compared with 4,200).

Switzerland is in 2nd place, demonstrating the importance of the so-called small-country advantage. It is no coincidence that 15 out of the top 25 performers on the innovation index are countries with fewer than 10 million inhabitants. Generally speaking, small developed countries appear to enjoy more comprehensive education and welfare services than large countries, and the knowledge and skills set of the labour force are important drivers of innovation.

Small countries with clusters of world-class companies in research-intensive sectors—such as Switzerland, Sweden and Finland—outperform on the innovation index. Their universally high standards of education, especially in science and mathematics, guarantee their continued success at creating wealth through their innovation prowess. Israel's access to well-educated immigrants allows it, too, to punch over its weight.

Small countries also benefit from easier networking and comparative advantages derived from clusters of historical specialisms (for example, watch-making in Switzerland). With its high-tech clusters in the horological, electrical and pharmaceutical industries, Switzerland is a leading innovator. Pharmaceutical companies in particular have to be innovative because there is a longer period than for other sectors between the filing of a patent and the marketing of a product. This gap is necessitated by the lengthy and expensive testing protocols to ensure that drugs are beneficial and safe.

The US ranks third in innovation. There are only six economies in the top 25 that can be classed as medium to large, with populations in excess of 50

### KEY POINTS

- Japan, Switzerland, the United States and Sweden are the top four innovators and are likely to remain so in the next five years.
- During this period, China's ranking will move up five places; Mexico's will rise by six.
- Other noteworthy gainers will be Singapore, South Africa, Costa Rica and Lithuania.



million, and the US, with its 300 million population, is at the top of this list. Its high ranking says much about the creativity of its companies as well as the efficiency of its patenting process. Both Switzerland and the US rank near the top, far above Japan, in terms of innovation enablers. This indicates that Japan has a high innovation efficiency.

So much for the past five years. What about the next five? Does our mountaintop view allow us to peer into the future?

**Innovation forecast** Our research provides a ranking of countries by how innovative they are today. Through an analysis of innovation enablers, nation by nation, we can also predict which economies will be the most innovative in 2011. Our forecast enables policymakers to plan their investment and R&D

strategies for the future.

In the next five years, nearly 60% of the 82 countries studied are likely to improve their innovation performance. Overall, between 2007 and 2011, we expect a 6% increase in innovation performance on average for the 82 economies in the ranking, similar to the rate of increase between 2001 and 2004. This increase will be achieved because of rising R&D spending and ongoing improvements in the quality of IT and communications infrastructure. We also predict continuing improvements in most of the indirect or environmental drivers of innovation. Despite some moves towards protectionism and anti-competitive practices in a few areas, most economies are benefiting from greater economic openness, improved IP rights and better conditions for financing innovative investments.

### Current and Forecast Innovation Index

The full ranking is on page 28

	2002–2006		2007–2011		Change in rank		2002–2006		2007–2011		Change in rank
	Index	Rank	Index	Rank			Index	Rank	Index	Rank	
Japan	10.00	1	9.91	1	0	<b>Belgium</b>	8.80	14	9.00	15	-1
<b>Switzerland</b>	9.71	2	9.80	2	0	<b>South Korea</b>	8.78	15	8.97	17	-2
<b>United States</b>	9.48	3	9.56	3	0	<b>Norway</b>	8.73	16	8.94	18	-2
<b>Sweden</b>	9.45	4	9.55	4	0	Singapore	8.72	17	9.03	14	3
Finland	9.43	5	9.38	7	-2	<b>United Kingdom</b>	8.72	18	9.00	16	2
<b>Germany</b>	9.38	6	9.51	5	1	Ireland	8.46	19	8.60	20	-1
Denmark	9.29	7	9.32	9	-2	<b>Italy</b>	8.41	20	8.74	19	1
<b>Taiwan</b>	9.28	8	9.42	6	2	Australia	8.37	21	8.50	21	0
Netherlands	9.12	9	9.11	13	-4	<b>New Zealand</b>	8.17	22	8.42	22	0
<b>Israel</b>	9.10	10	9.33	8	2	Hong Kong	8.16	23	8.24	23	0
Austria	8.91	11	9.16	10	1	<b>Slovenia</b>	7.68	24	7.91	24	0
<b>France</b>	8.90	12	9.15	12	0	Spain	7.47	25	7.57	27	-2
Canada	8.84	13	9.15	11	2						



## Innovation: Transforming the way business creates

A rising tide raises all boats, and the top four innovators in 2007, Japan, Switzerland, the United States and Sweden, retain their positions in 2011. The ranking of the next six economies in the 2007 top ten (mostly small economies) is not quite as stable. Finland, in 5th place, drops to 7th; Germany, at 6th, rises to 5th place; Denmark, 7th, drops back to 9th place; Taiwan, 8th in the ranking, rises to 6th; the Netherlands, 9th, drops four places to 13th; and Israel, in 10th place, moves up to 8th in the ranking, despite the instability in the Middle East.

### *China and India are breaking out of their position as members of the underdeveloped world*

In the next ten places (11th to 20th), Singapore makes the biggest improvement, going from 17th, today, to 14th position in 2011. In this group, South Korea and Norway, at 15th and 16th, respectively drop two places to 17th and 18th in 2011. Canada, which ranks 13th today, rises two places, as does the UK, from 18th to 16th in 2011.

Russia, ranked 37th, is not performing especially well on the innovation scale, and it is predicted to rise by only one place, to 36th, in 2011. By contrast, the biggest gains in performance will take place in the emerging markets, albeit from a low base.

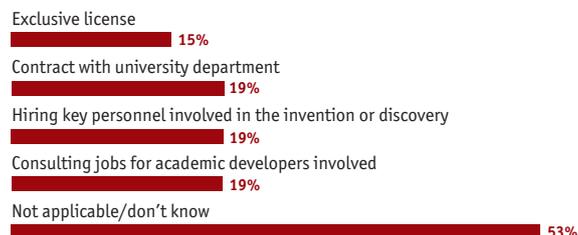
China is breaking out of its position as a member, along with India, of the underdeveloped world. While it is still not as efficient at innovation as India, the huge sums of money it is pouring into R&D and education will ensure that it climbs steadily up the rankings, leaving India some way behind.

China is expected to overtake India in the index by moving into 54th place from 59th and is likely to make steady improvements both in its direct inputs and its innovation environment. China has already overtaken Japan to become the world's second-larg-

est investor (after the US) in R&D in absolute terms. According to the OECD, China spent US\$136bn on R&D in 2006, a 20% increase on the previous year. This was more than Japan's spend of US\$130bn, but still well below that of the United States at US\$330bn.

China can expect to benefit more than India from foreign direct investment because of its more favourable regulatory and economic climate. Much of China's inbound investment will continue to target innovation-rich sectors such as mobile and fixed communications, aviation, vehicle manufacturing, pharmaceuticals and foodstuffs. The number of university students in China has more than quadrupled in a mere ten years. At present, there are 16 million students in China. While the US produces 137,000 engineers a year, China produces 352,000. In terms of sheer numbers, 1.76 million new engineers in the next five years will almost certainly boost China's ability to innovate.

**If you sometimes obtain innovations from universities, what form of technology transfer does your organisation favour?**  
(% of respondents)



In addition, the commercial infrastructure in China is modernising rapidly. Multinational companies are opening research centres in China, lured by the fact that local scientists are paid only about 20% as much as Western scientists. To exploit this situation, more than 300 foreign companies, including major life science firms, have established R&D centres in China.

Nevertheless, China is not an innovation utopia. Problems include the rampant theft of intellectual



property, academic fraud, weak financial markets, and political meddling in science and research. At the corporate level, Chinese innovation remains weak. Top-down government plans for fostering innovation do not automatically lead to a strong innovation performance.

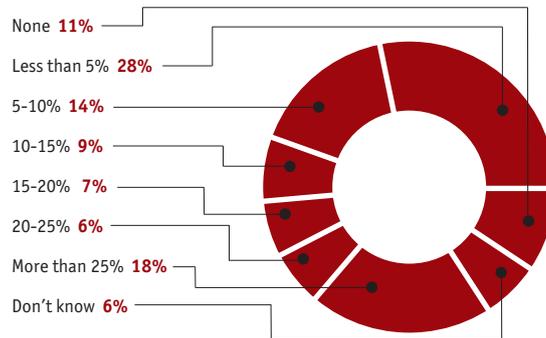
India will also rise in the ranking, although not as much as China. Now in 58th position on our innovation index, India will rise to 56th in 2011.

Mexico is expected to rise a full six places in the next five years, from 45th to 39th place. Since the North American Free Trade Agreement, Mexico has benefited from considerable foreign investment. The pay-off in terms of training, infrastructure improvements and better IT facilities is beginning to have a knock-on effect, as deregulation, privatisation and modernisation measures spread throughout the economy. Mexico's proximity to the US and the free flow of goods across the border ensure that it will not only maintain its competitive edge over the rest of Latin America, but that it will start to leave behind economies to the south.

In terms of innovation rankings, Lithuania's 11-point movement from 51st place, at present, to 40th place in 2011 makes the highest leap on our chart. This big rise largely reflects the fact that it has recently made some overdue reforms, including the improved protection of IP rights, and its R&D spending and educational levels are increasing. In order to stem the outflow of skilled workers, a "knowledge" park has been established at Kaunas Technology University, and there are plans to build a similar establishment in Vilnius.

The innovation performance of two other economies should be noted. Australia, in 21st position, has some excellent enablers but is not predicted to rise in the ranks in the next five years. It would seem to have a poor innovation efficiency ratio. Italy, by contrast, has few innovation enablers but demonstrates its flair for innovation by coming in at the

Approximately what percentage of your organisation's employees are scientists or engineers? (% of respondents)



rank of 20th today, rising to 19th in 2011.

As for the entire EU, despite its efforts to boost innovation performance, it is unlikely to close the innovation gap with Japan and the United States over the next five years.

Before descending from the summit, there is more to be said about national innovation performance. The rankings are all very well, but do they foretell which countries will succeed in overall economic performance? Certainly, a growing number of governments are placing a high priority on creating the right conditions for innovation to occur. But does this guarantee faster economic growth? As the next section suggests, the answer is more complicated than it might at first appear.



## Innovation and economic growth

Companies are the ultimate engines of innovation, yet there is much that governments can do to kick-start the process. In the end, it is public policy that determines much of the environment within which firms can be innovative. Over the past decade, a growing body of empirical data has

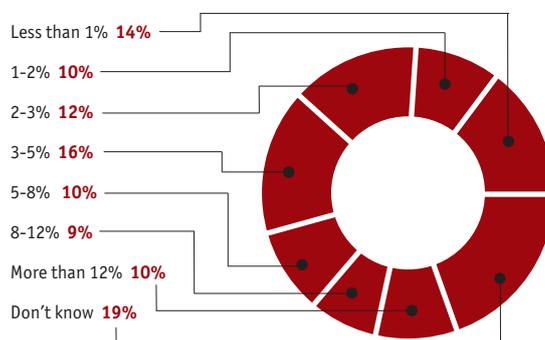
provided clues as to how innovation fits into the economic growth equation. In turn, this has spurred governments throughout the developed world and in some emerging economies to re-examine their policies for fostering innovation.

According to growth accounting, the missing ingredient that accounts for any increase in output that cannot be explained by increases in capital and labour is termed “total factor productivity” (TFP). This is calculated as a residual—the difference between

output growth and the weighted growth rates of capital and labour input. And although the return on investment may decline as more capital is added to an economy, this decline is more than offset by the leveraging effects of TFP growth. This explains why long-run average rates of growth in output have remained remarkably steady in industrialised countries.

The actual size of TFP remains uncertain and various empirical studies give very different estimates of TFP. When labour input is adjusted for quality and other measurement issues are addressed, the contribution of TFP to growth tends to decline.

Approximately how much does your organisation invest in R&D as a proportion of total annual revenue? (% of respondents)



Furthermore, since TFP is calculated as a residual, it may also capture the influence of factors other than innovation or technological progress. Clearly, any claims that innovation is the sole driver of economic growth are nonsense. However, there is plenty of evidence that innovation makes a significant contribution to growth, and not only in the technologically advanced countries.

**The bubble and beyond** One of the most puzzling examples of recent economic growth performance is the way in which productivity growth in the United States strengthened markedly from the mid-1990s onwards, especially when compared with the EU, where it has slowed since 1995. Whereas annual labour productivity growth in the United States doubled from 1.1% during 1987-95 to 2.2% in 1995-2006, the first 15 countries in the EU saw productivity growth decline from 2.3% a year to 1.4% over the same period. It is not clear why the United States should have outperformed so. It is believed that among the significant factors were the heavy investment in computing

### KEY POINTS

- Governments can determine much of the environment within which firms innovate.
- Many economists said that the richer countries would have to run faster and be more innovative in order to maintain their rates of productivity growth. To date, these economies have performed well by investing heavily in computers and other kinds of technology.



power and network technologies associated with the dotcom boom.

Another factor may have been the arrival in the market of many products borne from innovations begun a decade earlier when the US government allowed universities to sell the results of their government-funded research (see page 27). Interestingly, productivity growth in the United States continued after the collapse of the dotcom bubble, despite widespread cuts in IT investments. The question, however, is whether the performance

of the US economy over the past decade is sustainable in the future.

So much for the view from the summit. How do things seem at ground level? For one thing, we can say with even more confidence than at the macroeconomic level that there is a strong link between innovation and performance. Even if, after all is said and done, the contribution of innovation to economic growth is uncertain, at the microeconomic level things are more clear-cut: corporate innovation promotes corporate performance.

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## Organisational innovation helps redefine the firm

**T**hose who did not watch carefully may have missed it. Over the past five years, organisational behaviour has been affected by dramatic changes in organisational dynamics that will create more corporate value than we have seen in several decades.

During the past century, when information was scarce, most business was accomplished by leveraging interpersonal relationships. This was the foundation of many business disciplines; in fact, the very word “discipline” connoted a wall between one function and another. Engineering or New Product Development had its own set of rules; Marketing, another; Finance, yet another. In these environments, management innovation focused primarily on processes to optimise the “command and control” functions within the firm.

Information technology has begun to change this by accelerating the flow of information, effectively democratising the business process. For the first time, individuals at all levels of the organisation can share

in the vision and strategy of the business, collaborating to unlock the potential of their specialised knowledge. Decentralising knowledge brings strategy and organisation together: For example, through Bloomberg News and independent on-line user communities, Microsoft employees can see how Wall Street and customers view their new Vista product launch and make rapid adjustments to their plans. By linking operations and sales, dramatic opportunities can emerge, as in the case of UPS, which now sells business data, not merely logistics services.

New technology is only part of the answer, however. Along with the information systems to communicate freely, some companies are changing their processes and their culture in order to enhance performance. To be successful, effective collaboration requires the creation of measurable objectives that encompass the entire enterprise, and incentives to encourage all teams to meet these goals. This means having processes in place that require the participation of all functions to achieve

the objectives. Some firms are encouraging employees to take a more entrepreneurial attitude to their work, and are setting up processes that nurture innovation, autonomy and collaborative environments. Leaders in these areas include Apple, whose culture has allowed it to reinvent itself many times, and Siemens, whose new-product ideas follow a well-defined development path.

To align networks, culture and processes in support of a fast-moving company that can outperform its competitors, the manager of tomorrow is likely to move beyond the command-and-control paradigm of the industrial era towards a more organic approach—one that is holistic, omnidirectional and interactive. Dell’s customer service staff has wide latitude to please the customer. Procter & Gamble gathers new product ideas through its field staff. Wal-Mart’s management of its 1.8 million employees is all about communication. In this new era, the alignment among culture, systems and processes is the new form of organisational innovation. ■



## View from the bottom up

**T**he strongest evidence to support the view that innovation has a powerful connection with growth comes from looking at how firms and sectors function. For instance, many studies on the subject conclude that the economic returns

from process R&D tend to be higher than the returns from product R&D (see sidebar on page 20). And the returns on R&D vary considerably from one industry to another—with the highest returns being found in research-intensive industries such as aerospace, healthcare, pharmaceuticals, computing and telecommunications.

One of the more intriguing aspects of some studies (including our own research) on total factor productivity is the finding that the law of diminishing returns applies just as much to TFP as it does to capital and labour. In short, innovation yields less and less, in terms of incremental increases in economic growth, the higher the level of national income.

This raises questions about the sustainability of the rate

of innovation and economic growth in high-income countries such as Japan and Germany. In both countries, incremental improvement is the preferred form of innovation and this is less risky than some forms of innovation. But even in the United States, where there is a somewhat greater emphasis on more risky,

technological breakthroughs, innovation cannot be relied on continually to deliver the goods.

**The survey** In order to dig deeper into the corporate world, in November 2006 the Economist Intelligence Unit conducted a survey that was answered online by a worldwide panel of business leaders. Some 485 qualifying responses were received, with statistically significant numbers in all categories polled.

**Respondents** The largest groups of respondents were in financial services, followed by IT and technology, professional services, manufacturing, healthcare, pharmaceuticals and biotechnology, consumer goods, and energy and natural resources. A total of 48% of the respondents worked for companies with annual sales of up to US\$500m, whereas 26% were employed by enterprises with revenue in excess of US\$5bn. Fully 30% were board members or had C-suite job titles; another 35% were SVPs, VPs, directors, heads of business units or departmental heads; and the remainder were managers or held other titles. Their functional roles were predominantly in strategy and business development, general management, finance, and sales and marketing—making the respondent sample ideal for our purposes. A total of 56% of the respondents were based in Europe and the Middle East, 25% in the Americas and 20% in the Asia-Pacific region (these numbers add to 101 due to rounding).

**Research or die** The firms we polled invested above the national average on research and development. Forty-four percent spent more than 3% of sales annually on R&D. Twenty-nine percent spent more than 5%, while one in 10 respondents said their firms in-

### KEY POINTS

- There is a close link between high R&D and corporate performance.
- Firms need to be more innovative in order to regenerate themselves.
- In our survey, 49% of respondents said that their best ideas came from changes in industry and market structure and only 21% said they came from scientific breakthroughs.
- Of those companies that are in, or connected to, high-tech clusters such as Silicon Valley, 56% of respondents said they performed better than their peers, compared with only 36% of firms outside of a high-tech cluster.



vested over 12%. This makes them fairly research-intensive—even though only a small proportion (13%) of firms were located in high-tech clusters such as Silicon Valley, the Cambridgeshire Fens, Israel or Singapore.

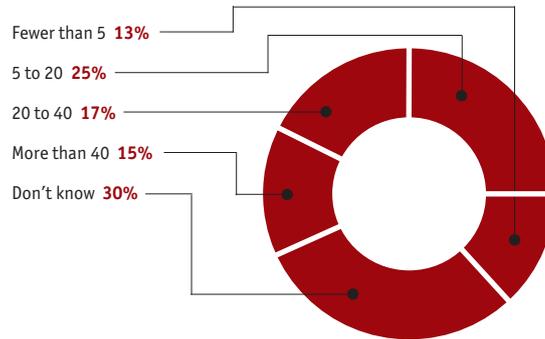
The overwhelming majority (87%) of respondents declared innovation to be important to their long-term success, and almost one-half (47%) said that innovation was critically important to it. Many respondents thought successful innovation at their companies was more important than its share price (38%) or market share (36%). More than 70% of the firms in our survey received less than 10% of their R&D budget from the government, and 61% said that they received no public help at all.

The panel's responses regarding the sources of their most successful innovations contradict the commonly held view that innovations tend to come from scientific breakthroughs. A total of 49% of respondents said that their best ideas arose from changes in industry and market structure, and only 21% said they came from scientific breakthroughs. Another popular, low-risk source of innovation (46% of respondents) was inadequacy in a process, product or service that was subsequently rectified.

Also, our survey showed that more good ideas for future products come from sales and marketing (one-half of respondents say so) than from R&D (42%). This is less surprising than it may seem. First, it is more useful to give customers what they want (and have asked for) than to consider in the abstract what new products to develop. Second, people employed by R&D are often or mostly finding out ways to put other departments' ideas into products, services or processes.

Survey results yielded another surprise. The general consensus had been that the winnowing process in innovation requires something like 3,000 bright ideas to end up with four development programmes—the minimum required to get one blockbuster prod-

Approximately how many institutions of technological excellence (eg, universities, government labs, contract research labs, think tanks) reside within the cluster? (% of respondents)



uct. “You have to kiss a lot of frogs to find a prince,” said Art Fry, the legendary innovator at 3M. Yet 52% of our respondents reckoned they needed fewer than 25 good ideas for each successful innovation!

Such differences probably stem from the historical nature of the literature. The traditional view was that corporate innovation tended to operate at the more risky end of the spectrum—based on inventions, discoveries and other forms of new knowledge. This survey indicates that correcting underlying flaws and listening to customers (both of which are at once less risky and less pricey) can lead to profitable innovations. An example is Mindstorms, a robot-building kit launched a few years back by Lego, a Danish toymaker. The company was guided by feedback from its customers—robot enthusiasts—to make improvements, in particular to the software operating system and applications.

In addition, previous innovation studies have tended to focus on larger corporations with track records of bringing inventions and discoveries successfully to the marketplace. A total of 58% of our respondents worked for firms with sales of less than US\$1bn. This may explain why just 11% of respondents reported obtaining ideas for new products/services/processes from universities.



## Innovation: Transforming the way business creates

**Encouraging corporate innovation** Our survey shows that in support of planned innovation initiatives, respondent firms tend to establish dedicated teams to develop the product and leave them alone to get on with it (41%). Furthermore, ideas for innovations start to gain momentum due to middle management support (29%) and board-level backing (28%); support from the C-suite is less important (17%), while the approval of the rank-and-file workers is less important still (11%). In the business world, there are many cases of this form of innovation, such as the classic “skunk works” model, pioneered by Lockheed. Another well-known example is the development of the PC by IBM, at their Boca Raton facility in Florida.

Our survey indicates that public recognition and prizes are the best innovation motivators. In line with our findings, Netflix recently announced a US\$1m prize to the team that can improve their Cinematch accuracy by 10%. And the X prize of US\$10m was given in 2004 for the first private manned flight into

space. Grants are important, says the economist Robert Hanson, “But prizes are often more effective if what you want is scientific progress.”<sup>1</sup>

Perhaps the most significant way for a CEO to encourage innovation is to locate the company—or at least an outpost—within a high-tech cluster, such as Silicon Valley, the Cambridgeshire Fens, or Israel’s Silicon Wadi. Of those companies that are in, or connected to, such clusters, 56% of respondents said they performed better than their peers, compared with only 36% of respondents at firms that are outside of a high-tech cluster.

By forming part of a network of innovative companies, firms are able to collaborate to introduce new products and services to the market. In a separate, concurrent research study of the Economist Intelligence Unit sponsored by Cisco, firms that exchange ideas and share intellectual property with other

<sup>1</sup>*New York Times*, January 31st 2007.

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## Case Study: The power of a new process

**M**ost executives think of innovation as merely the introduction into the marketplace of new products and services. But although less obvious, innovation as applied to the processes a company uses to make and deliver those products is at least as important as product innovation.

The ability to innovate in the process as well as the product domain enhances a company’s competitiveness. It is typically far easier for rivals to copy a product or service than to replicate the processes used to make or deliver it.

Process innovation is becoming increas-

ingly important. This is especially so in mature, commoditised, highly competitive industries, where the uniqueness of a company’s processes can be a powerful differentiator from its rivals. Indeed, some of the greatest successes in recent business history—Dell, Cemex, JetBlue and Wal-Mart—derive directly from process innovation in such industries.

Probably the best-known process innovator is Dell. The company implemented a “built to order” production system that revolutionised the personal computer industry, differentiating Dell from product-oriented rivals such as Compaq. The system

allowed customers to order computers that exactly matched their individual needs. At the same time, Dell re-engineered its supply chain of global manufacturers to reach unprecedented levels of efficiency.

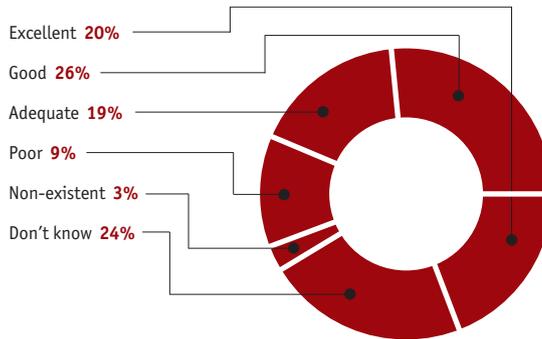
Cemex, a leading cement firm founded in Mexico in 1906, streamlined its delivery process by equipping its trucks with computers that map routes and times. Global positioning satellite technology is used to track the trucks. Customers order online or by phone premixed concrete for just-in-time delivery to their sites.

JetBlue, a no-frills airline, reinvented flying for millions of passengers, squaring the



companies, ie, collaborate outside the organisation, tend to be more innovative. One such firm is Procter & Gamble, a consumer-products maker. It has set up a collaborative venture called Connect + Develop. According to the company, “by developing mutually beneficial relationships with innovators from other organisations and industries, we can take advantage of cross-boundary innovations and knowledge to create greater opportunities for new and existing P&G brands” (See sidebar on page 22 titled “Arch-rivals join forces to develop new products”).

**How knowledgeable about your business are the financial services within the cluster?**  
(% of respondents)



**Getting your money back** One surprising survey finding is the speed with which respondents expect to recoup their innovation-based investment costs. More than one-half (53%) of respondents said their company expects to recover its innovation-based investment costs within two years. This rate of ROI is nearly twice as fast as the rate of cost recovery of other forms of capital investment (eg,

investments in plant and equipment).

Still more encouraging is the speed with which the firms in question are using innovation to regenerate themselves. Fully 71% of respondents told us that more than one-half of their firm’s annual sales came from products or services that are five years old or less.

circle by offering a high-quality product for a low fare. One way the company cut its costs was by redesigning the reservation process and call-handling software to allow its reservationists to work from home. This eliminated the need for expensive call-centre real estate. It shows how process innovation can improve job satisfaction as well as productivity.

One of Wal-Mart’s best-known process innovations is “cross-docking.” This enables goods to be transferred directly from supplier trucks to the store’s delivery vehicles without an intervening warehouse stage. This process is fundamental to logistical efficiency, which in turn allows Wal-Mart to

lower the prices it charges customers. It’s not glamorous, but it works.

A common element in all these process innovations is heavy investment in sophisticated information and communications systems. But spending big on technology is no guarantee of success in this domain.

An efficient process does not make companies infallible. JetBlue’s difficulties after a single snowstorm caused the airline to cancel hundreds of flights in February 2007 is a case in point. And yesterday’s state-of-the-art process is today’s commodity, as Dell recently discovered. There is only so much gold to mine from any given

vein—competitors eventually catch up.

Process innovation is not a one-time activity. Rather, it is a continuous series of incremental improvements. Leading-edge companies such as Toyota stay on top through continuous innovation in both the product and process domains.

Attempting to duplicate the amazing success of such firms is non-trivial. It requires a deep knowledge of practice, an openness to new ideas, and a willingness to make—and learn from—mistakes.

Such an attitude to innovation cannot be bought: it must evolve over time, becoming ingrained in corporate culture. ■



## Innovation: Transforming the way business creates

### *Those firms where innovation is critically important tend to perform better than their peers*

Forty-three percent said more than one-half of their company's revenue is from products or services that are three years old or newer, and nearly one-quarter (23%) said most revenue is derived from products and services that are two years old or less. This is impressive regeneration.

It is puzzling, however, that the firms in our survey reporting that at least one-half of their revenue comes from products less than three or even five years old do not self-report a better performance than the firms that rely upon older products.

Is it better to talk the talk than to walk the walk? Although companies actually selling the newer products do not report any advantage, firms saying that innovation is critically important for their success do much better than firms that do not. Among

respondents who rate innovation as critically important, 46% say their firm performs better than its peers; this can be compared with only 32% among the respondents who do not believe innovation is critically important.

Similar results are recorded for the link between a firm's R&D intensity and its financial performance. Among respondents saying their firm's R&D spending is equal to at least 5% of their revenue, 44% say their firm performs better than its peers; this compares to 35% among those who say their firm spends less than 5% of revenue on R&D.

The performance of firms in our sample is assessed on the basis of answers to the question: "How would you rate your company's recent financial performance compared to that of its peers?" Three answers are possible: ahead of peers, on a par with peers and behind peers. This form of assessment of a firm's performance relative to its peers has the benefit of automatically controlling the influence on performance of different industrial sectors.

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## Arch-rivals join forces to develop new products

**M**any firms scour the world for useful innovations. But one of the few to work in concert with the labs of competitors is Procter & Gamble, which recently teamed up with Clorox to develop and market the innovative (and jointly owned) Glad ForceFlex garbage bag.

The joint innovation is a sign of a change in attitude towards intellectual property at both companies. Procter & Gamble and Clorox are fierce rivals in product categories worth billions in revenue. Both firms have traditionally spent heavily on internal R&D to develop the innovations that drive growth. And both had avoided partnerships

that could compromise company secrets.

But when Alan Lafley became Procter & Gamble's CEO in 2000, he called for a new approach. In Mr Lafley's view, progressively larger R&D budgets were generating smaller incremental pay-offs. Instead, he said that at least 50% of the company's innovations should come from outside the firm; on current trends, the company will reach this target by 2010. By seeking new ideas elsewhere, then using Procter & Gamble's resources to commercialise and distribute them, Mr Lafley bet that the company could fill the pipeline with innovative products faster and cheaper than before.

The initiative is called "Connect + Develop"

(<http://pg.t2h.yet2.com>), where the company seeks to find the new products, packaging, technologies, processes and commercial connections that can be marketed to the world's consumers. Procter & Gamble claims that Connect + Develop has increased R&D productivity by nearly 60% and helped the company to launch more than 100 new products since 2000.

Connect + Develop led P&G to the labs of Clorox. In 2002, Procter & Gamble was pondering how to introduce a strong type of plastic food wrap, but the company was worried that it would cost too much to develop. After considering partnerships with half a dozen



**Best places to innovate** By a wide margin, the United States is considered by survey respondents to have the best conditions for innovation, with 40% of respondents citing it as the best place to innovate. India is in second place, with 12%. The UK is considered the best by 6% of our respondents, whereas only 2% consider Japan the best place to innovate.

The survey response with regard to Japan as a good place for innovation, is supported by our innovation ranking for Japan: although it is in first place in innovation output (performance), it is in 11<sup>th</sup> place in direct innovation inputs. And it ranks poorly as an innovation environment (25<sup>th</sup> place). There may also be a language bias: our survey was conducted only in English. Without doubt, the common view among executives is that Japan is not the most conducive place to innovate.

When considering countries in which to carry out innovation, most executives agreed that the most valued places for innovation are countries with the following national characteristics: robust protec-

tion of intellectual property (60%), political stability (56%), an efficient regulatory environment (54%), and a sound institutional framework (53%). Japan fulfils these requirements very well, yet these are not the only considerations in choosing a country in which to conduct innovation activities.

Other important factors according to survey respondents in considering where to conduct innovation activities include: quality IT and communications infrastructure, technical skills of the workforce, availability of scientists and engineers, and availability of university graduates. Notably fewer than 20% of respondents consider spending on R&D or access to investment finance as important factors in choosing a country for innovation activities.

firms, it opted to work with Clorox, which was already established in the food wrapping business, to make and market the product.

Jeff Weedman, vice-president for external business development at Procter & Gamble, says the success of this agreement depended on careful planning. The two sides mapped out the limits of their partnership, so that each would feel comfortable that they weren't giving away company secrets.

They also decided how they would share the workload, revenue and intellectual property, and how each side could end the partnership if it didn't work. They also require both companies to speak plainly about potential

results. He says that sometimes it is difficult for companies to determine what part each has played in the development of a product.

According to Mr Weedman, the two firms' groundwork and regular communication created "a robust trust level". This made it easier for the companies to reach an agreement when Procter & Gamble saw an opportunity to apply its plastic compound to garbage bags. The resulting ForceFlex bag has greater tensile strength—the ability to hold narrower, sharper objects without bursting. In its first full year on the market, the ForceFlex bag generated more than US\$100m in sales, about 10% of US market share.

The ForceFlex bag was so successful that Procter & Gamble exercised an option in its contract with Clorox to increase its stake in Glad from 10% to 20%. The purchase price was a reported US\$130m.

Mr Weedman and other employees from both sides meet regularly to ensure that the partnership stays on track. Procter & Gamble is in no doubt that its innovation partnership with Clorox has been a great success, and the firms are already discussing where to go next. Mr Weedman has developed a theory that Procter & Gamble executives call Weed's corollary: second partnerships are twice as easy, if the first is successful. ■



## A recent history of innovation

The current wave of enthusiasm for innovation started about five years ago, with a host of conferences, books, reports and government initiatives on the topic. Now, innovation has almost become an industrial religion. Business leaders see it as a tool for increasing profits and market share.

Governments reach out for it in the hope that it will lead to national economic growth.

Perhaps the sudden passion for innovation has its origins in the corporate soul-searching that followed the Nasdaq meltdown in the wake of the dotcom and telecom crashes of 2000-01. Such factors may, indeed, have played a part, but for decades the boardrooms of Fortune 500 companies have been well aware that innovation can be a bottom-line boon.

Rather than leave innovation to chance, many companies believe it important to have their own corporate research laboratories (as distinct from testing labs). Their task has been to search systematically for new technologies, techniques and materials to power the corporate innovation machine. One

of the oldest and most prolific, Bell Laboratories, was founded in 1925. Since then, its scientists have garnered 11 Nobel prizes for their discoveries.

When functioning correctly, the mission of a corporate laboratory is to produce inventions and, above

all, enabling technologies. It is the company's job as a total enterprise, however, to produce the innovations.

**From laboratory to production** Getting clever ideas from the laboratory to the rest of the company is not easy. Blueprints or scientific papers cannot simply be tossed over the laboratory wall—as happened too often at Xerox's Palo Alto Research Center (PARC). PARC is attributed with inventing many of the features found in today's computers. But Xerox never managed to turn PARC's many clever inventions into innovations, whereas firms such as Apple Computer profited handsomely from them.

The only PARC invention that became a multibillion-dollar business for Xerox was the laser printer. This was simply because the research team that had developed the technology moved lock, stock and barrel out of the lab and into the commercial side of the company to help build the business. The moral of the PARC experience is that ideas are embodied in people rather than reports, drawings and prototypes; and that the most effective way to transfer a technology from laboratory bench to factory floor is to encourage the researchers concerned to run with it commercially. If that means giving them a stake in any future business that results, so be it.

Whichever way the technology transfer process is managed, it is imperative that it be done well. Innovation is difficult and expensive enough without interdepartmental squabbles causing additional roadblocks. When the transfer process works smoothly, as it did with Xerox's laser printer, then the return on investment can be very impressive indeed. One study carried out a few years ago found that the overall rate of return on 17 successful innovations brought to market in the 1970s averaged 56% annually over the

### KEY POINTS

- An effective way to transfer a technology from laboratory bench to factory floor is to encourage the researchers concerned to run with it commercially.
- Seventy-one percent of those responding to our questionnaire reckoned that one-half of their company's annual revenue came from products and services less than five years old.
- A single US law, the Bayh-Dole Act, has helped to accelerate the commercialisation of inventions by transforming ownership of the IP in any invention or discovery made at taxpayers' expense from the government agency funding the research to the individuals and institutions doing it.



subsequent 30 years. This compared with an average rate of return of 16% for all investment carried out by the whole of American business over the same 30-year period. In short, the pay-off from innovation can be huge—far exceeding that of any other form of investment companies can make.

**Reinventing the firm** Thanks to the accelerating pace of innovation, information technology has just witnessed the equivalent of a century-long industrial revolution packed into a single decade. As a result, firms have never been more productive. But the rules of the game have changed.

According to Peter Cochrane, a professor at University College London and former chief technologist at British Telecom, the half-life of companies (the number of years required for half of them to die) has gone from 50 years before the IT revolution to five years today. In many organisations, information now has a half-life of only six months. That is, half of it is outdated in only half a year, although it continues to be hoarded and accessed as though it had value. The implication is that companies have to regenerate themselves continuously.

One firm that has been reinventing itself longer than most is 3M. In the 1970s, the Minnesota company was unique in being able to claim that one-quarter of its annual revenue came from products less than five years old. Today, that would be considered well below par. As we have seen, three out of four firms responding to our questionnaire reckoned that one-half of their revenue came from products less than five years old. The median age of a company's product range is becoming an important way to assess its ability to reinvent itself.

**The Bayh-Dole Act** In the last few years, the United States has been a leader in creating well-paid, knowledge-based jobs. It is now widely accepted that one reason for its surge in innovation capacity since

the late 1980s has been the Bayh-Dole act, which freed up great swathes of IP that had previously been gathering dust on government shelves.

Essentially, what the Bayh-Dole act did was to switch ownership of the IP in any invention or discovery made at taxpayers' expense from the government agency funding the research to the individuals and institutions doing it. The act also allowed the new owners of the IP to sell exclusive licences to private firms to commercialise academic discoveries. This meant that the public would, in effect, have to pay twice for any product or process developed from a discovery made with public funds at a university or national laboratory: once for the federal research grant and a second time at the checkout counter. While this may seem unfair, in previous years the product probably would never have seen the light of day.

*The median age of a company's product range is becoming an important way to assess its ability to reinvent itself.*

Critics in the United States worry about the distorting effect the Bayh-Dole Act has had on academics, as universities reward enterprising researchers for coming up with patentable discoveries. Patents by academics can now generate university revenue from licences and royalties or through campus start-ups and spin-outs. The University of Wisconsin, for instance, has been a big beneficiary of the biotech research performed by its professors. There is a perception that at a number of academic institutions the quality of teaching has suffered as a result.

There are also concerns that academic research could suffer as the possibility of short-term financial bonanzas shifts the emphasis from long-range, blue-sky investigation (the pursuit of fundamental knowledge and truth traditional to universities) to more practical studies with commercial potential. Never-



## Innovation: Transforming the way business creates

theless, to encourage their own academic institutions to become more entrepreneurial, all major countries have enacted similar legislation to the Bayh-Dole act.

**Technology transfer** To streamline things, many universities have set up technology transfer offices to identify promising discoveries made on campus and to help turn them into revenue streams through licensing or spin-outs. By 2003, there were almost 300 such offices at American universities, and 117 at British universities.

Figures from the Association of University Technology Managers (AUTM) show that patents granted to universities rose from around 300 a year before 1980 to a peak of more than 3,200 in 2003, and then declined to less than 3,000 in 2005. The recent fall contrasts with the increasing number of patent applications, and reflects a growing backlog of applications at the United States Patent and Trademark Office (USPTO). The income flowing to American universities from technology transfer has continued to rise. The AUTM found that in the United States the number of licences and options executed increased by several percent between 2003 and 2005, with overall income from licensing reaching more than US\$1.6bn in 2005.

American universities now spend more than US\$100m a year in legal fees associated with licensing activities according to statistics published by the US National Science Foundation. Studies also reveal that the average income of a successful disclosure that is patented and marketed by a university comes to no more than US\$10,000, which is less than the cost of administering the project. After accounting for their direct and indirect costs, not many technology transfer offices on campuses in the United States and elsewhere have made a profit for their universities. From a national perspective, however, university technology transfer offices have accelerated the flow of proven ideas from academic research to private enterprises.

**The cluster effect** Nowhere are ideas developed more effectively than where universities with strong science and engineering departments are surrounded by high-tech hinterlands—as with Stanford University in Silicon Valley and, to a lesser extent, with MIT near Kendall Square and Route 128 around Boston. Much attention is focused these days on such geographic clusters of high-tech firms that have a powerful academic institution at the centre and perhaps a national laboratory in the neighbourhood. Because such clusters account for a disproportionate amount of innovation being undertaken in a country, efforts are under way to replicate them regionally and nationally.

There are many such clusters around the world—like the tool and die makers of Higashi Osaka, or the pulp and paper manufacturers in Finland. But most are in fairly mature industries where innovation is at best incremental and unlikely to be patentable. In the more dynamic, high added-value fields, none of the Silicon Wannabes around the world has come close to replicating the success of Silicon Valley. Special financial, entrepreneurial and cultural intangibles are invariably missing.

Israel has come the closest to establishing clusters like those in California. It is not hard to see why. Both societies reward risk but do not punish failure unduly. Both have an open-minded, can-do attitude to solving problems. Both respect learning and have raised networking to a fine art. And both are blessed with a steady stream of well-educated immigrants. Thanks to the talent that continues to flee Russia and the former Soviet republics, Israel now has 135 engineers and technicians per 10,000 population (compared with 18 per 10,000 in the United States). It is therefore no surprise that Israeli innovations attract almost as much venture capital as all of that of California, which has more than ten times the population of Israel.



## Conclusion: The mothers of innovation

**T**his paper has shown that governments and companies are no longer paying lip service to innovation, if they ever did. Heightened global competition is forcing both to find new ways to increase productivity. They have little choice but to innovate, or at least to encourage the innovators.

But what is the best way to become more innovative? One thing is clear from this study: there is no single, right method. Take, for example, the diversity of the countries at the top of the ranking. Some are large and some are small. Some value rote learning, others improvisation and spontaneity. Innovation is certainly not a Western preserve; witness the position of Japan at the top of the innovation ranking, as well as the strong performance of Taiwan and Singapore, not to mention the emergence of China. All heavily emphasise the use of government policies to encourage innovation, along with educational systems that produce large numbers of scientists and engineers.

Our forecast for innovation rankings over the next five years highlights the rise of China in the league table. But it would have been more surprising if the ranking had not predicted that the world's second-largest economy in terms of purchasing power would climb up the ladder. Less predictable was the strong showing of Mexico and Lithuania, hardly countries famed for their innovation prowess. This is particularly so for the former, being part of a region, Latin America, not noted for its innovativeness.

Clearly, it helps to be close to the United States, which ranks number three in the innovation league. The same is true for companies too. Our survey found that many more firms that are located in or

near high-tech clusters in such countries as Israel perform better than their peers than companies that are not in such a location. One answer is to move to a high-tech cluster. A less drastic course, however, would be simply to open an outpost there and breathe the same air.

Despite the diverse reasons for success in innovation, some common themes emerge:

- There is no real substitute for a good education—and a good education system. Whether you are China or BMW, it is highly advantageous to be able to tap deep, wide reservoirs of technical expertise.
- Investments in IT and communications infrastructure provide a good pay-off in terms of innovation.
- Sizeable spending on R&D is likely to yield dividends in terms of new products and services. In our survey, among respondents who say their firm's R&D spending is equal to at least 5% of their revenue, 44% say their firm performs better than its peers; this compares with 35% among those who say their firm spends less than 5% of revenue on R&D.
- Irrespective of performance, the pace of innovation overall is faster than ever. Seventy-one percent of those responding to our survey said that more than one-half of their sales came from products and services that are five years old or less.
- Innovative scientists and researchers work best when given a high degree of autonomy, and then allowed to work closely with the business functions to put ideas into effect.

Without these people—the designers, the entrepreneurs, the scientists and the marketers—economies and companies would not grow as fast and we would all be less well off.

## Appendix A: Innovation index

2002-2006

	Innovation performance			Innovation enablers					
	Patents per m	Innovation performance index	Rank	Direct inputs index	Rank	Innovation environment index	Rank	Aggregate innovation enablers index	Rank
Japan	1213.103	10.00	1	9.50	11	6.88	23	8.71	14
Switzerland	501.797	9.71	2	9.88	4	8.50	5	9.46	4
USA	350.495	9.48	3	9.88	4	8.53	3	9.47	3
Sweden	334.625	9.45	4	9.94	2	8.24	10	9.43	5
Finland	321.717	9.43	5	10.00	1	8.48	6	9.54	1
Germany	300.296	9.38	6	9.56	7	7.95	14	9.08	9
Denmark	259.764	9.29	7	9.94	2	8.61	1	9.54	2
Taiwan	253.973	9.28	8	9.06	14	7.68	16	8.65	16
Netherlands	198.294	9.12	9	9.63	6	8.37	8	9.25	6
Israel	192.058	9.10	10	9.56	7	6.85	24	8.75	12
Austria	141.320	8.91	11	8.69	18	7.31	22	8.27	19
France	139.483	8.90	12	9.44	12	7.52	19	8.86	10
Canada	127.846	8.84	13	9.50	9	8.20	12	9.11	8
Belgium	119.155	8.80	14	9.06	14	7.69	15	8.65	15
South Korea	115.598	8.78	15	9.13	13	6.53	35	8.35	18
Norway	106.303	8.73	16	8.44	19	7.38	21	8.12	21
Singapore	105.291	8.72	17	8.81	16	8.61	2	8.75	11
UK	105.108	8.72	18	8.81	16	8.52	4	8.73	13
Ireland	69.879	8.46	19	8.44	19	8.42	7	8.43	17
Italy	64.284	8.41	20	7.06	26	6.35	40	6.85	28
Australia	59.981	8.37	21	9.50	9	8.28	9	9.13	7
New Zealand	44.076	8.17	22	7.38	25	8.10	13	7.59	23
Hong Kong	43.094	8.16	23	8.13	21	8.23	11	8.16	20
Slovenia	20.178	7.68	24	7.50	23	6.26	43	7.13	25
Spain	14.418	7.47	25	7.94	22	7.44	20	7.79	22
Cyprus	11.738	7.34	26	5.19	46	6.83	25	5.68	41
Hungary	10.351	7.26	27	6.94	27	6.76	27	6.89	27
Czech Republic	5.253	6.83	28	7.44	24	6.50	36	7.16	24
Estonia	4.628	6.75	29	6.94	27	7.54	18	7.12	26
Croatia	4.471	6.73	30	6.00	36	5.54	56	5.86	39
South Africa	3.701	6.61	31	4.75	52	6.06	46	5.14	49
Greece	3.553	6.59	32	5.88	38	6.03	50	5.92	35
Portugal	3.485	6.58	33	6.75	29	6.75	28	6.75	29
Malaysia	3.007	6.48	34	6.44	32	6.55	34	6.47	31
Kuwait	2.407	6.34	35	5.19	46	6.04	49	5.44	46
Slovakia	2.122	6.26	36	6.50	30	6.70	30	6.56	30
Russia	1.567	6.07	37	6.06	35	4.59	72	5.62	42
Argentina	1.512	6.05	38	6.25	33	5.86	52	6.13	34
Latvia	1.182	5.89	39	5.63	39	6.59	32	5.91	36
Venezuela	1.046	5.82	40	4.25	56	5.22	60	4.54	60
Saudi Arabia	1.040	5.81	41	3.19	71	4.80	68	3.67	70

**2007-2011**

	Innovation performance				Innovation enablers					
	Expected innovation performance index	Rank	Growth expected during the next 5 years	Expected change in rank	Expected direct inputs index	Rank	Expected innovation environment index	Rank	Expected aggregate innovation enablers index	Rank
Japan	9.91	1	-0.9	0	9.56	12	7.36	25	9.01	14
Switzerland	9.80	2	1.0	0	10.00	1	8.53	4	9.63	2
USA	9.56	3	0.9	0	10.00	1	8.53	5	9.63	3
Sweden	9.55	4	1.1	0	10.00	1	8.45	9	9.61	4
Finland	9.38	7	-0.4	-2	10.00	1	8.33	10	9.58	5
Germany	9.51	5	1.3	1	9.63	7	8.22	13	9.27	9
Denmark	9.32	9	0.3	-2	10.00	1	8.55	3	9.64	1
Taiwan	9.42	6	1.6	2	9.25	13	7.71	21	8.87	16
Netherlands	9.11	13	-0.1	-4	9.63	7	8.33	11	9.30	8
Israel	9.33	8	2.5	2	9.63	7	7.44	23	9.08	12
Austria	9.16	10	2.8	1	8.81	18	7.82	20	8.57	18
France	9.15	12	2.8	0	9.63	7	7.95	16	9.21	10
Canada	9.15	11	3.5	2	9.94	6	8.28	12	9.52	6
Belgium	9.00	15	2.2	-1	9.25	13	7.92	18	8.92	15
South Korea	8.97	17	2.1	-2	9.19	17	7.00	35	8.64	17
Norway	8.94	18	2.4	-2	8.50	19	7.92	19	8.35	20
Singapore	9.03	14	3.5	3	9.25	13	8.67	2	9.11	11
UK	9.00	16	3.2	2	9.25	13	8.47	8	9.05	13
Ireland	8.60	20	1.6	-1	8.50	19	8.74	1	8.56	19
Italy	8.74	19	3.9	1	7.25	27	6.83	37	7.15	29
Australia	8.50	21	1.5	0	9.63	7	8.47	7	9.34	7
New Zealand	8.42	22	3.0	0	7.69	23	8.18	14	7.81	23
Hong Kong	8.24	23	1.0	0	8.13	21	8.50	6	8.22	21
Slovenia	7.91	24	3.0	0	7.63	24	6.72	41	7.40	27
Spain	7.57	27	1.4	-2	8.00	22	7.67	22	7.92	22
Cyprus	7.85	25	6.9	1	5.69	48	7.06	32	6.03	45
Hungary	7.78	26	7.2	1	7.44	26	7.34	26	7.41	26
Czech Republic	7.07	31	3.5	-3	7.50	25	7.22	28	7.43	25
Estonia	7.07	30	4.7	-1	7.25	27	7.98	15	7.43	24
Croatia	7.32	29	8.8	1	6.63	35	5.91	58	6.45	36
South Africa	7.46	28	12.8	3	5.50	50	6.67	42	5.79	48
Greece	6.80	34	3.2	-2	6.00	43	6.41	47	6.10	42
Portugal	6.98	32	6.2	1	7.25	27	7.05	33	7.20	28
Malaysia	6.89	33	6.3	1	7.06	30	6.53	45	6.93	31
Kuwait	6.43	38	1.3	-3	5.25	53	6.15	51	5.48	55
Slovakia	6.62	35	5.7	1	6.81	31	7.28	27	6.93	32
Russia	6.58	36	8.4	1	6.44	39	5.39	67	6.18	41
Argentina	6.26	43	3.5	-5	6.50	38	6.03	56	6.38	39
Latvia	6.52	37	10.6	2	6.31	40	7.21	29	6.54	35
Venezuela	6.21	45	6.7	-5	4.81	56	5.01	71	4.86	59
Saudi Arabia	6.28	41	8.1	0	3.31	73	5.59	63	3.88	73

## Appendix

### Innovation: Transforming the way business creates

#### 2002-2006

	Innovation performance			Innovation enablers					
	Patents per m	Innovation performance index	Rank	Direct inputs index	Rank	Innovation environment index	Rank	Aggregate innovation enablers index	Rank
Bulgaria	1.000	5.79	42	5.63	39	5.51	58	5.59	43
UAE	0.981	5.78	43	4.25	56	6.75	29	5.00	53
Cuba	0.981	5.78	44	6.50	30	3.40	81	5.57	44
Mexico	0.930	5.74	45	5.00	48	6.34	41	5.40	47
Costa Rica	0.892	5.72	46	5.56	42	6.48	37	5.84	40
Chile	0.858	5.69	47	5.94	37	7.66	17	6.46	32
Brazil	0.810	5.66	48	5.50	44	6.79	26	5.89	37
Poland	0.805	5.65	49	6.25	33	6.57	33	6.35	33
Bahrain	0.704	5.57	50	4.38	54	6.61	31	5.05	51
Lithuania	0.653	5.52	51	5.63	39	6.43	39	5.87	38
Ukraine	0.513	5.37	52	5.25	45	3.82	78	4.82	56
Thailand	0.463	5.30	53	3.88	61	6.10	45	4.54	59
Romania	0.426	5.25	54	4.69	53	5.85	53	5.04	52
Jordan	0.405	5.22	55	3.81	63	6.06	47	4.49	61
Turkey	0.400	5.21	56	4.38	54	5.93	51	4.84	54
Qatar	0.372	5.17	57	4.88	50	6.47	38	5.35	48
India	0.371	5.16	58	4.88	50	5.70	54	5.12	50
China	0.326	5.08	59	5.56	42	5.54	57	5.56	45
Philippines	0.222	4.84	60	4.06	60	6.05	48	4.66	58
Colombia	0.219	4.83	61	4.19	58	6.15	44	4.78	57
Kazakhstan	0.166	4.66	62	3.19	71	4.69	71	3.64	74
Kenya	0.156	4.62	63	2.88	77	4.15	76	3.26	76
Ecuador	0.154	4.61	64	3.06	74	5.07	61	3.67	71
Tunisia	0.151	4.60	65	4.13	59	4.97	64	4.38	62
El Salvador	0.149	4.59	66	3.38	68	6.29	42	4.25	64
Serbia	0.134	4.52	67	4.94	49	4.59	73	4.83	55
Peru	0.127	4.49	68	3.38	68	5.58	55	4.04	65
Egypt	0.097	4.32	69	3.56	66	4.97	65	3.98	67
Azerbaijan	0.090	4.27	70	3.44	67	4.74	69	3.83	69
Dominican Republic	0.086	4.24	71	3.63	65	4.99	63	4.03	66
Sri Lanka	0.061	4.03	72	3.88	61	5.44	59	4.34	63
Morocco	0.040	3.77	73	3.31	70	5.05	62	3.83	68
Indonesia	0.039	3.75	74	3.19	71	4.72	70	3.65	73
Nigeria	0.019	3.29	75	1.75	81	4.84	67	2.68	81
Algeria	0.015	3.16	76	3.00	75	3.82	79	3.24	77
Iran	0.014	3.12	77	3.75	64	3.42	80	3.65	72
Pakistan	0.011	2.97	78	2.63	78	4.55	75	3.20	78
Vietnam	0.009	2.83	79	3.00	75	4.96	66	3.59	75
Bangladesh	0.002	1.82	80	2.25	80	4.56	74	2.94	79
Angola	0.001	1.44	81	1.19	82	2.82	82	1.68	82
Libya	0.001	1.44	81	2.38	79	4.01	77	2.86	80
World average		6.22		5.90		6.24		6.01	

Note: Patents data are averaged over 2002–05 and expressed as patents per million population for each country. The innovation enablers indexes is based on the average for 2002–06.

## 2007-2011

	Innovation performance				Innovation enablers					
	Expected innovation performance index	Rank	Growth expected during the next 5 years	Expected change in rank	Expected direct inputs index	Rank	Expected innovation environment index	Rank	Expected aggregate innovation enablers index	Rank
Bulgaria	6.21	46	7.2	-4	5.88	46	6.36	49	6.00	46
UAE	6.22	44	7.6	-1	4.81	56	6.81	38	5.31	56
Cuba	6.14	51	6.2	-7	6.69	33	4.18	81	6.06	43
Mexico	6.41	39	11.6	6	5.94	44	6.40	48	6.05	44
Costa Rica	6.27	42	9.7	4	6.19	41	7.03	34	6.40	38
Chile	6.20	48	8.8	-1	6.69	33	7.93	17	7.00	30
Brazil	6.06	52	7.2	-4	6.13	42	6.84	36	6.30	40
Poland	6.14	50	8.6	-1	6.81	31	7.18	30	6.91	33
Bahrain	6.20	47	11.3	3	5.19	54	6.76	40	5.58	53
Lithuania	6.28	40	13.8	11	6.63	35	7.13	31	6.75	34
Ukraine	6.19	49	15.3	3	5.94	44	4.85	73	5.67	52
Thailand	5.37	59	1.3	-6	4.00	65	6.03	57	4.51	64
Romania	5.93	53	12.9	1	5.44	52	6.43	46	5.69	51
Jordan	5.35	60	2.6	-5	4.00	65	6.04	55	4.51	63
Turkey	5.61	58	7.6	-2	4.63	59	6.66	43	5.13	57
Qatar	5.81	55	12.5	2	5.50	50	7.39	24	5.97	47
India	5.74	56	11.1	2	5.56	49	6.13	52	5.70	50
China	5.82	54	14.5	5	6.56	37	6.07	53	6.44	37
Philippines	5.33	62	10.2	-2	4.69	58	6.31	50	5.09	58
Colombia	5.62	57	16.4	4	5.19	54	6.64	44	5.55	54
Kazakhstan	5.09	63	9.3	-1	3.50	69	5.20	69	3.93	72
Kenya	4.78	68	3.4	-5	2.88	78	4.56	78	3.30	78
Ecuador	4.77	69	3.5	-5	3.31	73	4.97	72	3.73	75
Tunisia	4.85	67	5.4	-2	4.31	60	5.38	68	4.58	61
El Salvador	4.91	65	6.9	1	3.63	68	6.78	39	4.41	65
Serbia	5.34	61	18.0	6	5.75	47	5.81	59	5.77	49
Peru	4.57	71	1.7	-3	3.50	69	5.54	65	4.01	69
Egypt	5.00	64	15.6	5	4.25	62	5.64	62	4.60	60
Azerbaijan	4.85	66	13.6	4	4.13	64	5.04	70	4.35	68
Dominican Republic	4.64	70	9.5	1	3.94	67	5.66	61	4.37	66
Sri Lanka	4.29	72	6.4	0	4.19	63	5.71	60	4.57	62
Morocco	3.95	74	4.9	-1	3.44	71	5.44	66	3.94	71
Indonesia	3.98	73	6.3	1	3.19	77	5.56	64	3.78	74
Nigeria	3.41	77	3.8	-2	2.00	81	4.65	77	2.66	81
Algeria	3.64	76	15.1	0	3.38	72	4.76	74	3.72	76
Iran	3.68	75	17.9	2	4.31	60	4.50	79	4.36	67
Pakistan	3.41	78	14.8	0	3.31	73	4.71	75	3.66	77
Vietnam	3.22	79	13.8	0	3.31	73	6.05	54	4.00	70
Bangladesh	1.89	81	4.0	-1	2.38	80	4.71	76	2.96	80
Angola	1.90	80	32.6	1	1.75	82	3.73	82	2.24	82
Libya	1.62	82	12.9	-1	2.88	78	4.23	80	3.21	79
World average	6.56		6.89		6.27		6.63		6.36	

The world average is the arithmetic average of the innovation index for each of the 82 countries.

## Appendix B: Innovation indices

We constructed three indices of innovation for 82 countries, drawing on the Economist Intelligence Unit's Business Environment Ranking (BER) model.

The first index measures innovation output or performance, and is based on international patents data. There are also two composite indices, constructed on the basis of BER scores, that measure innovation inputs, or innovation enablers. The first covers direct innovation inputs and the second the innovation environment, the broad economic, social and political backdrop that facilitates innovation activity.

There is a fourth aggregate innovation inputs or innovation enablers index that combines the direct innovation and the innovation environment indexes. The weights used—0.7 for direct inputs and 0.3 for the environment index—correspond to weights based on the estimated coefficients in the regression equation described below that relates innovation performance to innovation inputs.

The patents data are 2002-05 averages, whereas the innovation enablers are indices based on 2002-06 averages. All indices are expressed on a 1 to 10 scale using the following conversion formula:

$$9 * (\text{indicator value for country} - \text{minimum value for the indicator}) / (\text{maximum value for the indicator} - \text{minimum value for the indicator}) + 1$$

Because the BER contains forward-looking assessments (for the next five years), as well as historical data, we are also able to construct forecast innovation performance indices (average for 2007-11).

### Innovation performance

Although the use of patent data has a number of problems, this is the single best available proxy measure for innovation outputs—a common conclusion that is bolstered by our examination of alter-

native indicators of innovation performance (see below). The data are averaged over 2002-05 and expressed in terms of patents per million population for each country. The natural logarithms of patents per million population are converted into an index on a 1-10 scale on the basis of the formula given above. The maximum value is taken to be 800, which is below the actual value for Japan of 1,213 per million population. Japan scores a maximum of 10 on the index, but the latter procedure reduces its differential with other countries and offsets to some extent the upward bias for Japan in the JPTO data. For example, in Japan, a different patent application had until recently to be submitted for each claim; in other countries multiple claims can be made in each application. This helps to explain the exceptionally high level of patenting activity in Japan.

A composite measure of performance can be constructed that consists of these indicators as well as our patents measure. The composite index gives very similar results as the patents only measure (for example, the top three remain Japan, Switzerland and the US). Furthermore, the relationship with innovation drivers is very similar to the results obtained for patents only—some 90% of the inter-country variation in the composite performance index is explained by the two drivers indices (see below, section on explaining innovation performance).

On the following page is a correlation matrix for the various innovation performance indicators. Patents are most highly correlated with scientific citations and less so, but still considerably, with the other two indicators. But the correlation between patents and each of the other indicators is higher than (in one case equal to) the correlation between any two of the other indicators. This also suggests

	Patents	Medium- and high-tech manufacturing	Citations	Survey on technology absorption
Patents	1.00			
Medium- and high-tech manufacturing	0.75	1.00		
Citations	0.90	0.70	1.00	
Survey on technology absorption	0.70	0.59	0.59	1.00

that patents are a robust measure of innovation performance.

Finally, one of the possible criticisms of using patents data is that there are many other significant forms of innovation activity not captured by the number of patents. Comparable cross-country surveys on various types of innovation are generally unavailable. A rare exception is the European Commission's periodic Community Innovation Survey (CIS), which tries to measure various forms of innovation by firms. However, the surveys are conducted only in some European countries and may also suffer from defects (revealed, for example, by implausibly big variations in results for particular countries between years), such as insufficient comparability across even the small sample of relatively homogeneous countries. It has also been found that the relationship between the CIS results and other indicators of innovation tends to be quite weak.

Nevertheless, we look at the results and construct a composite measure of innovation based on four survey questions from the CIS (European Innovation Scoreboard 2005). Data are available for 2002 for up to 25 European countries and for 2002 for 16 countries.

The CIS questions were:

**1. SMEs innovating in-house** (% of all sample SMEs). Innovative firms are defined as those that introduced new products or processes.

**2. Innovation expenditures** (% of sample firms turnover). Innovation spending includes the full range of innovation activities: R&D, machinery and equipment linked to product and process innovation, spending to acquire patents and licences, industrial design, training and the marketing of innovations.

**3. Sales of new-to-market products** (% of turnover of sample firms).

**4. Sales of new to firms, but not new-to-market products** (% of turnover of sample firms)

We then look at the relationship for 2000 and 2002 between the CIS-based index and our patents index. The correlation based on data for all available countries is for both years in the modest 0.5–0.55 range, but rises to a relatively high 0.75 if implausibly high scores for Portugal and Spain are excluded and treated as outliers (the alternative is to take the result at face value and conclude that south European firms have very high rates of innovation).

Overall, this exercise seems to suggest that our patents data, to a significant extent, is also a proxy for apparently unrelated forms of innovation performance.

#### Direct innovation inputs

This index is based on an unweighted average of the following indicators:

- R&D as a % of GDP
- Quality of the local research infrastructure
- Education of the workforce

## Appendix

### Innovation: Transforming the way business creates

- Technical skills of the workforce
  - Quality of IT and communications infrastructure
  - Broadband penetration
- All indicators are rated on 1-5 scale based on original raw values where relevant and as defined below. The composite index is converted to a 1-10 scale.

#### Innovation environment

The innovation environment index is based on the following 12 factors:

- Political stability
- Macroeconomic stability
- The institutional framework
- The regulatory environment
- Tax regime
- Flexibility of labour market
- Openness of national economy to foreign investment
- Ease of hiring foreign nationals
- Openness of national culture to foreign influence
- Popular attitudes towards scientific advancements
- Access to investment finance
- Protection of intellectual property

The source for all the indicators is the BER, with the exception of popular attitudes towards science, which is taken from the World Values Survey.

To construct the composite innovation environment index, the 12 indicators were weighted on the basis of our survey results on the relative importance for innovation of the various factors.

#### Weights for the innovation environment index

Political stability	0.109
Macroeconomic stability	0.089
Institutional framework	0.107
Regulatory environment	0.108
Tax regime	0.075
Flexibility of labour market	0.072
Openness of national economy to foreign investment	0.083

Ease of hiring foreign nationals	0.069
Openness of national culture to foreign influence	0.063
Popular attitudes towards scientific advancements	0.058
Access to investment finance	0.056
Protection of intellectual property	0.112

#### Explaining innovation performance

The explanatory power of our two input indices in explaining innovation performance across countries is very high. A regression for the 82 countries shows that the two indices explain more than 90% of the inter-country variation in patents per million population. The direct inputs index has a more powerful influence on international patenting, but the innovation environment also has a significant impact.

#### Dependent variable: International patents index

	Coefficients	t Stat
Constant	0.3603	1.0552
Innov1	0.2944	3.3845
Innov2	0.6779	13.0785
Japan	1.4383	2.2563
Adj R2	0.915	
N	82	

*Innov1: Innovation environment index*

*Innov2: Direct innovation inputs index*

*Japan: Dummy variable taking value of 1 for Japan, 0 for other countries.*

#### International patents index in some major economies, 2002-05 av, per million population

	Predicted	Actual
France	8.97	8.90
Germany	9.18	9.38
Netherlands	9.35	9.12
Ireland	8.56	8.46

Sweden	9.52	9.45
Switzerland	9.56	9.71
United States	9.56	9.48
United Kingdom	8.84	8.72
Brazil	6.09	5.66
China	5.76	5.08
India	5.34	5.16
Mexico	5.62	5.74
Russia	5.82	6.07

The estimated equation above can also be used to predict innovation performance over the next five years. Forecast values of the two innovation input indices, based on BER forecast scores, are inserted into the equation to yield forecasts of innovation performance (based on expected patents activity) in 2007-11 (the procedure assumes that estimating errors for the performance equation in 2002-06 also apply in 2007-11).

*Predicted values based on above regression equation.*

## The business environment rankings methodology

The business rankings model measures the quality or attractiveness of the business environment in the 82 countries covered by The Economist Intelligence Unit's Country Forecasts using a standard analytical framework. It is designed to reflect the main criteria used by companies to formulate their global business strategies, and is based not only on historical conditions but also on expectations about conditions prevailing over the next five years. This allows the Economist Intelligence Unit to use the regularity, depth and detail of its forecasting work to generate a unique set of forward-looking business environment rankings on a regional and global basis.

The business rankings model examines ten separate criteria or categories, covering the political environment, the macroeconomic environment, market opportunities, policy towards free enterprise and competition, policy towards foreign investment, foreign trade and exchange controls, taxes, financing, the labour market and infrastructure. Each category contains a number of indicators which are assessed by the Economist Intelligence Unit for the last five years and the next five years. The number of indicators in each category varies from five (foreign trade and exchange regimes) to 16 (infrastructure),

and there are 91 indicators in total.

Almost half of the indicators are based on quantitative data (for example, GDP growth), and are mostly drawn from national and international statistical sources (see sources below) for the historical period (2002-06). Scores for the forecast period (2007-11) are based on Economist Intelligence Unit forecasts. The other indicators are qualitative in nature (for example, quality of the financial regulatory system), and are drawn from a range of data sources and business surveys, frequently adjusted by the Economist Intelligence Unit, for 2002-06. All forecasts for the qualitative indicators covering 2007-11 are based on Economist Intelligence Unit assessments.

### Calculating the rankings

The rankings are calculated in several stages. First, each of the 91 indicators is scored on a scale from 1 (very bad for business) to 5 (very good for business). The aggregate category scores are derived on the basis of simple or weighted averages of the indicator scores within a given category. These are then adjusted, on the basis of a linear transformation, to produce index values on a 1-10 scale. An arithmetic average of the ten category index values is then cal-

culated to yield the aggregate business environment score for each country, again on a 1-10 scale.

**Sources**

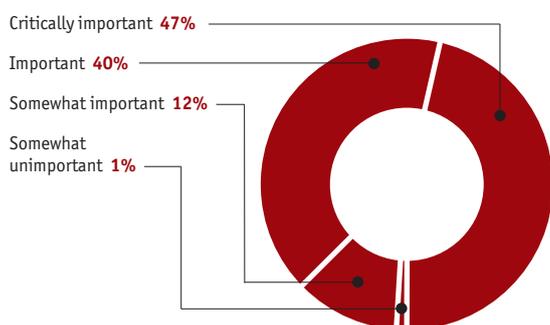
The main sources used for the historical period scores include CIA, *World Factbook*; Economist Intelligence Unit, *Country Risk Service*; Economist Intelligence Unit, *Country Finance*; Economist Intelligence Unit, *Country Commerce*; Encyclopaedia Britannica, *Annual Yearbook*; Freedom House, *Annual Survey of Political Rights and Civil Liberties*; Heritage Foundation, *Index of Economic*

*Freedom*; IMF, *Annual Report on Foreign Exchange Restrictions*; International Institute for Management Development, *World Competitiveness Yearbook*; International Labour Organisation, *International Labour Statistics Yearbook*; UN Development Programme, *Human Development Report*; UN, *Monthly Bulletin of Statistics*; UN, *Energy Statistics Yearbook*; Social Security Administration, *Social Security Programs Throughout the World*; World Bank, *World Development Report, World Development Indicators and Doing Business*; World Economic Forum, *Global Competitiveness Report 2006*.

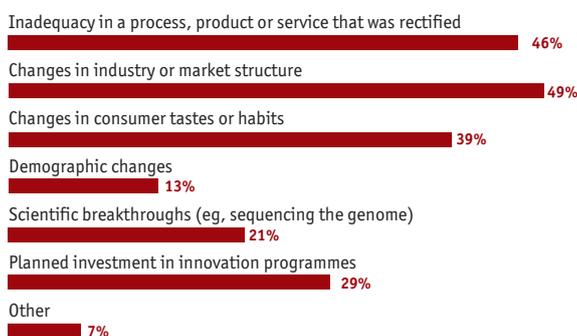
## Appendix C: Survey results

In November 2006 the Economist Intelligence Unit conducted an online survey of 485 senior global executives on their companies' approach to innovation. Our sincere thanks go to all those who took part in the survey. Please note that not all answers add up to 100%, because of rounding or because respondents were able to provide multiple answers to some questions.

### How important is innovation to your organisation's long-term success? (% of respondents)

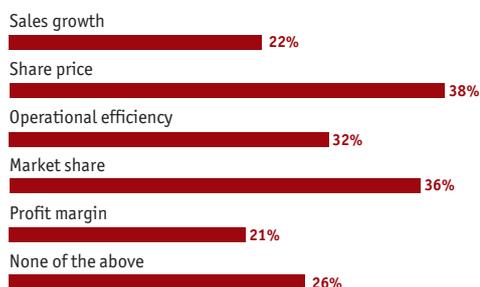


### How would you describe the origins of your organisation's most successful innovations? Select all that apply. (% of respondents)

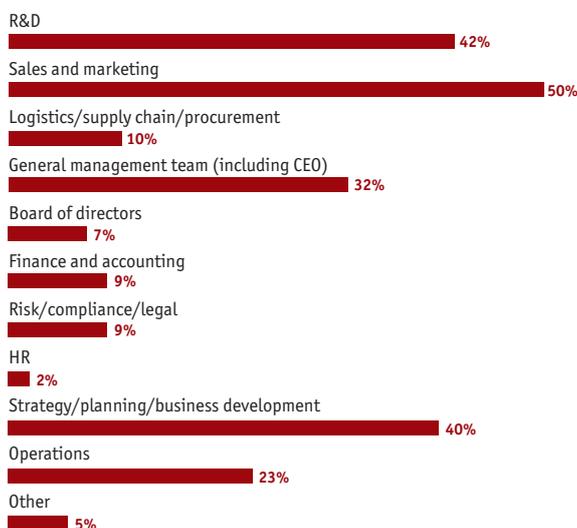


### For your organisation, is successful innovation more or less important than other metrics of success?

#### For my organisation, innovation is more important than... Select all that apply (% of respondents)



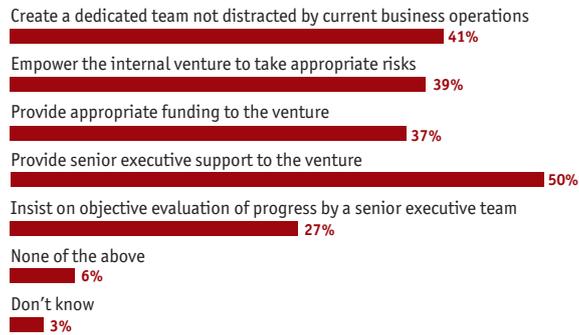
### In which area of your organisation are ideas for new products/services/processes most often generated? Select up to three. (% of respondents)



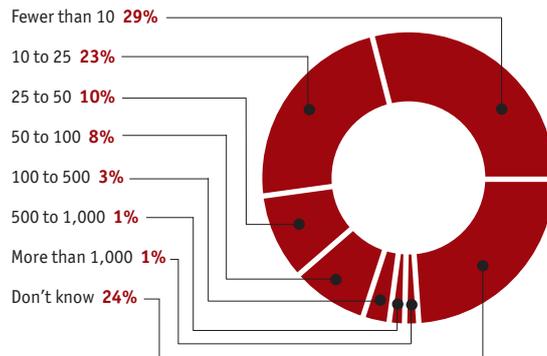
## Appendix

### Innovation: Transforming the way business creates

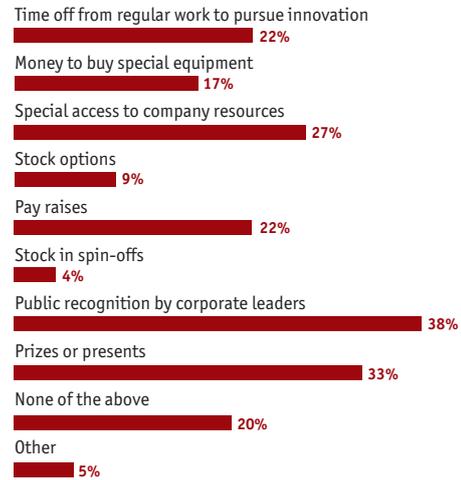
**Which of the following steps does your organisation generally take in support of planned innovation initiatives?** Select all that apply. (% of respondents)



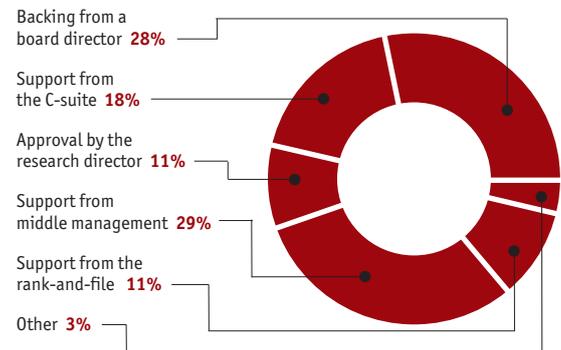
**Approximately how many documented suggestions/proposals for innovations does your organisation consider for each successful new product/service/process it rolls out?** (% of respondents)



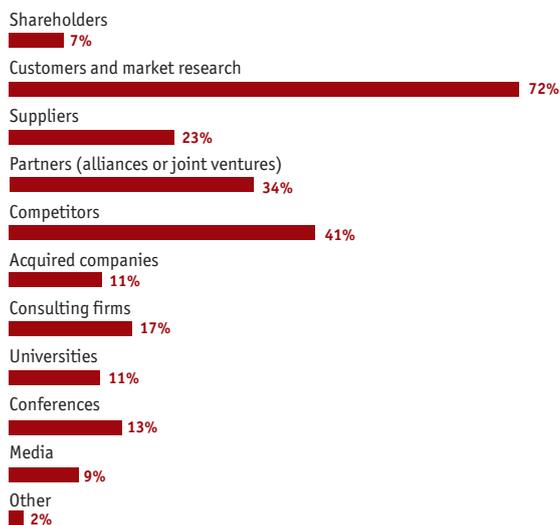
**How does your organisation incentivise employees to suggest and develop innovations?** Select all that apply. (% of respondents)



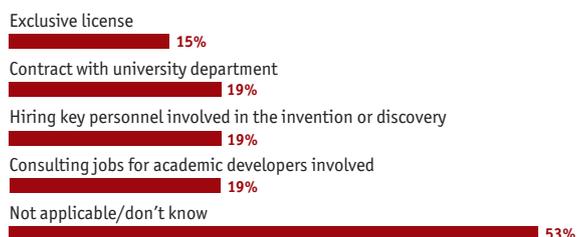
**Generally speaking, how do ideas for innovations start to gain momentum within your organisation?** (% of respondents)



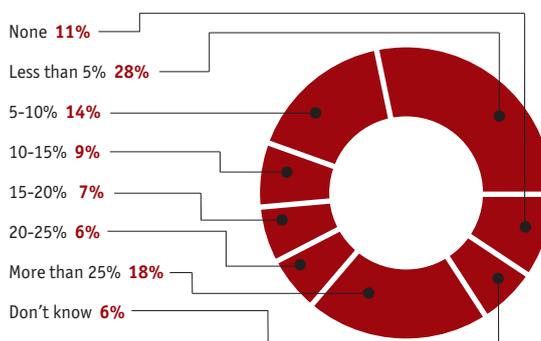
**From what outside sources does your organisation most often get ideas for new products/services/processes? Select up to three.**  
(% of respondents)



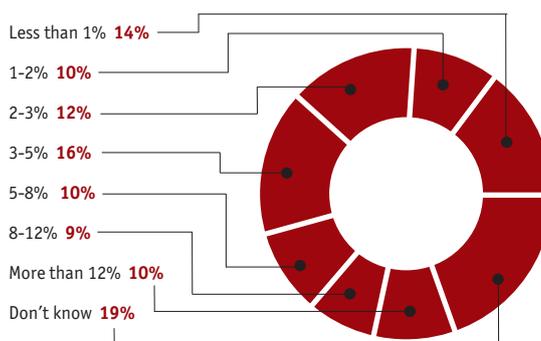
**If you sometimes obtain innovations from universities, what form of technology transfer does your organisation favour?**  
(% of respondents)



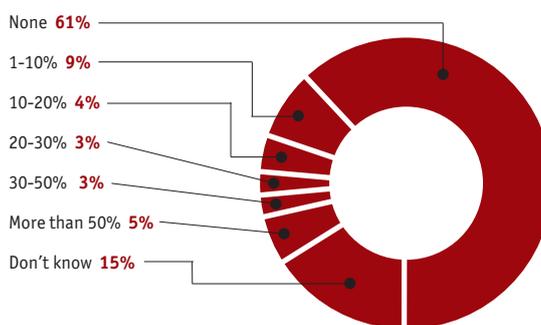
**Approximately what percentage of your organisation's employees are scientists or engineers?**  
(% of respondents)



**Approximately how much does your organisation invest in R&D as a proportion of total annual revenue?**  
(% of respondents)



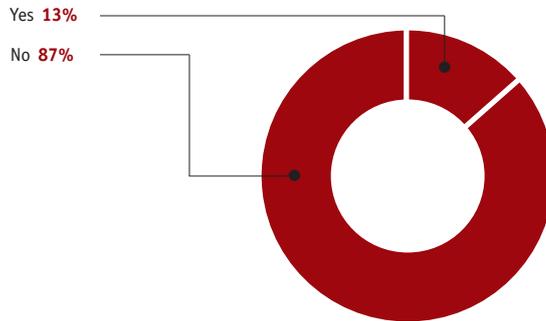
**Of the money your organisation invests in R&D, approximately how much comes from government agencies or other public bodies?**  
(% of respondents)



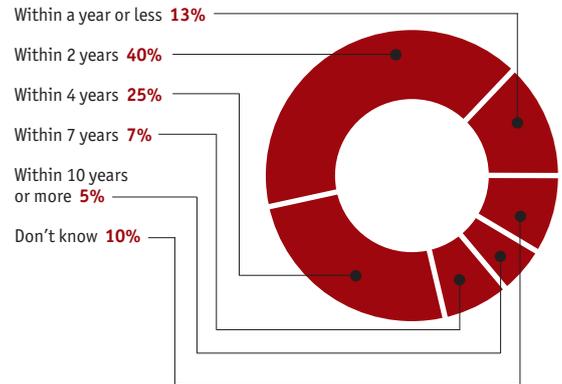
## Appendix

### Innovation: Transforming the way business creates

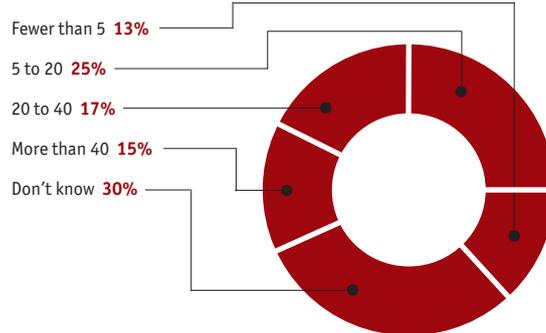
**Does your organisation reside in, or have close connections to, a high-tech cluster (eg, California's Silicon Valley, UK's Cambridgeshire Fens, Israel's Silicon Wadi)?**  
(% of respondents)



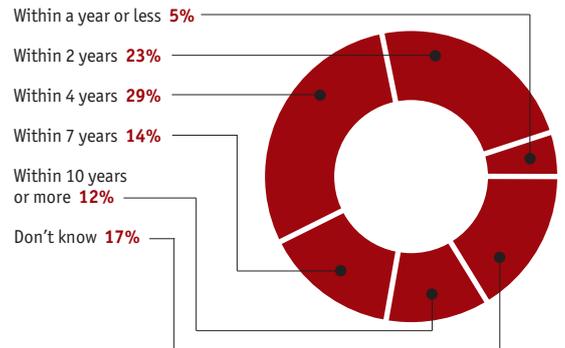
**Generally speaking, how quickly does your company expect to recover its innovation-based investment costs?**  
(% of respondents)



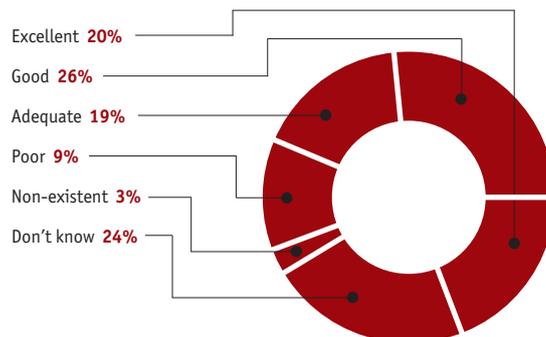
**Approximately how many institutions of technological excellence (eg, universities, government labs, contract research labs, think tanks) reside within the cluster?**  
(% of respondents)



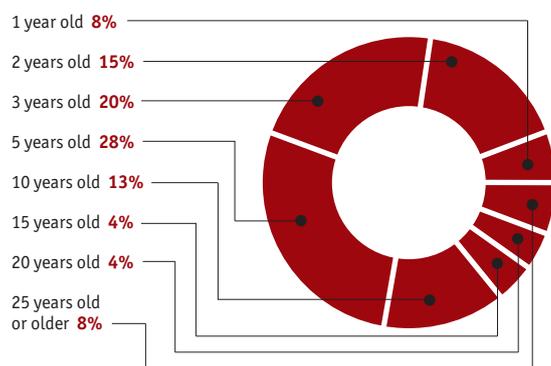
**Generally speaking, how quickly does your company expect to recover the cost of other forms of capital investment (eg, building a new factory)?**  
(% of respondents)



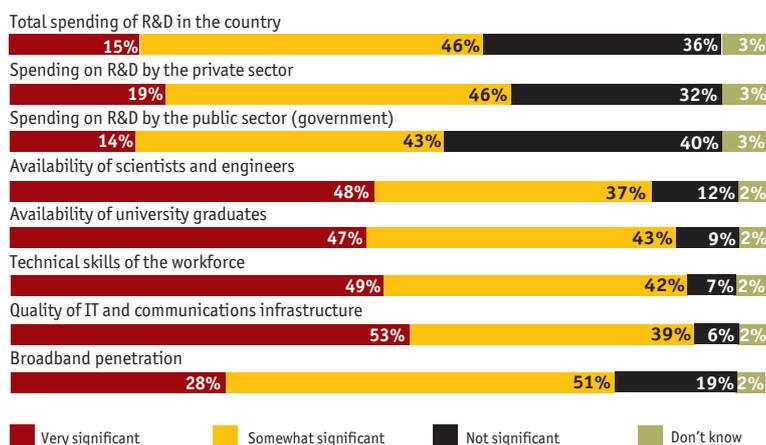
**How knowledgeable about your business are the financial services within the cluster?**  
(% of respondents)



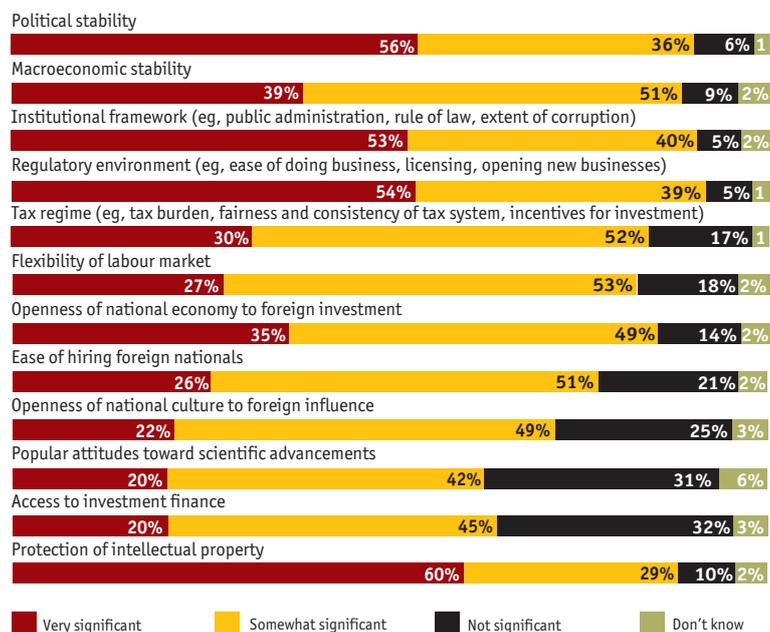
**To what extent are your company's revenues derived from new products or services?** Please complete the phrase "More than half of my organisation's annual global revenue comes from products or services that are approximately..."  
(% of respondents)



**If your organisation was looking for a country in which to conduct innovation activities, how important are these technological factors to the decision?**  
(% of respondents)



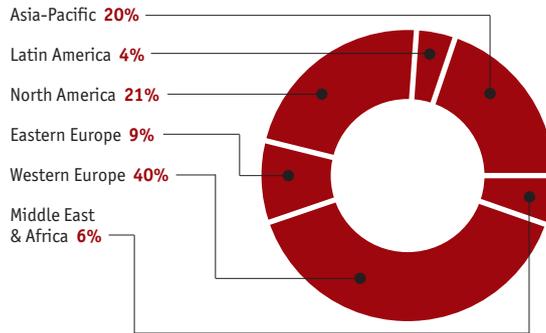
**If your organisation was looking for a country in which to conduct innovation activities, how important are these national characteristics to the decision?**  
(% of respondents)



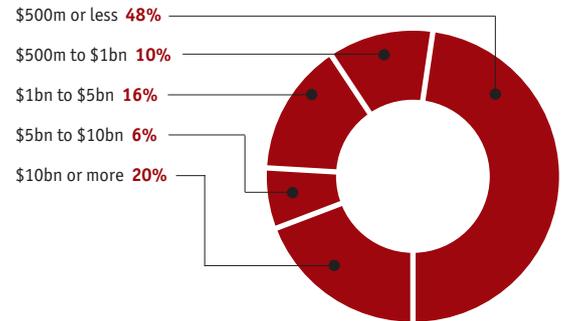
## Appendix

### Innovation: Transforming the way business creates

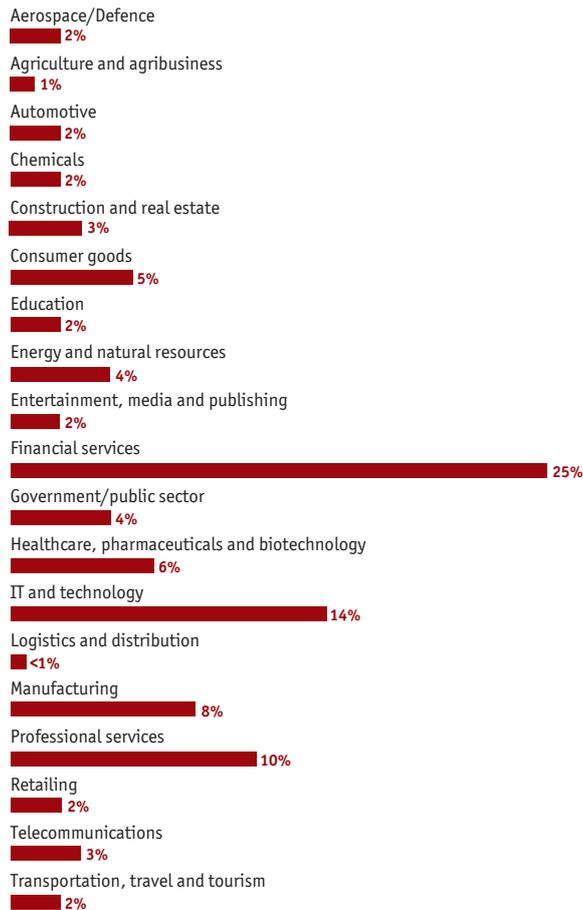
**In which region are you personally based?**  
(% of respondents)



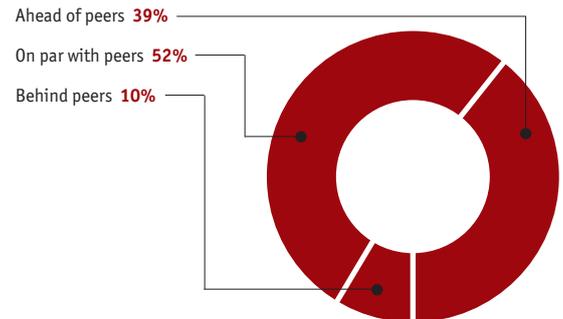
**What are your organisation's global annual revenues in US dollars?**  
(% of respondents)



**What is your primary industry?**  
(% of respondents)

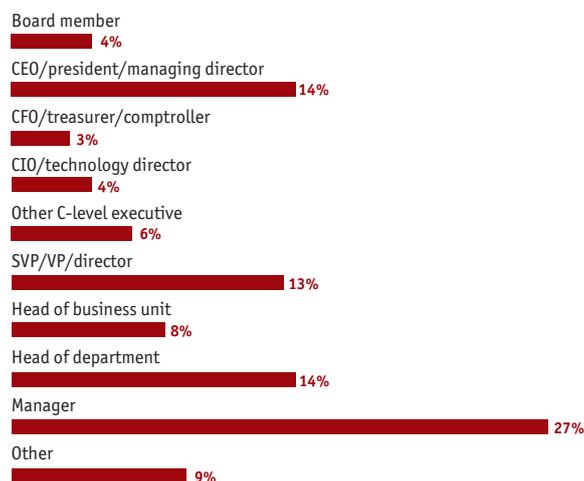
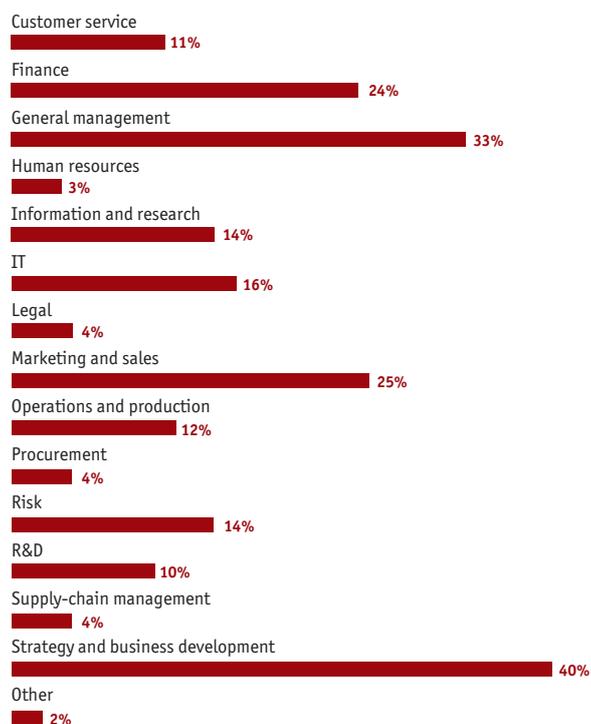


**How would you rate your company's recent financial performance, compared to that of its peers?**  
(% of respondents)



**Which of the following best describes your title?**

(% of respondents)

**What are your main functional roles? Please choose no more than three functions.** (% of respondents)

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