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EUROPE'S MISSING YOLLIES

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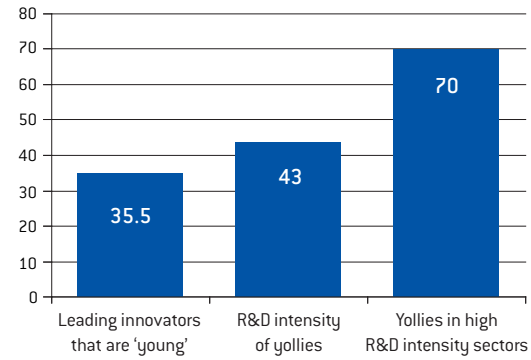
SUMMARY The age profile of companies and the sectoral specialisation structure are key to understanding Europe's innovation and growth shortcomings. The European Union's business research and development deficit relative to the United States can be almost entirely accounted for by the EU having fewer young leading innovators (or ***yollies***) and, even more importantly, having yollies that are less R&D intensive. The lower R&D intensity of EU yollies is in turn largely explained by their different sectoral composition. Europe has fewer yollies in young, high R&D-intensity sectors, primarily in health and information technology. There is nevertheless considerable heterogeneity across young sectors in the relative importance and performance of the EU's yollies.

POLICY CHALLENGE

Policies aimed at raising R&D expenditure across all types of industries and firms do not address the root causes of the EU's innovation deficit. Such an overall innovation policy remains necessary, but is not sufficient. Policy makers must also tackle the specific barriers faced by new firms in new sectors. Some of these barriers, such as access to early-stage risk financing, reflect general, non sector-specific failings, and can therefore be addressed by non sector-specific measures. However, there is also substantial heterogeneity across new sectors, which calls for at least some sector-specific policy attention. Developments in emerging markets must also be monitored with an eye to the future, and the mix of policy instruments evaluated.

The EU's R&D deficit compared to the US: relative EU performance (US = 100)



Source: Bruegel/European Commission JRC-IPTS. 'Yollies' = young leading innovators.

* This work was done under a grantholdership of Michele Cincera at the JRC-Institute for Prospective Technological Studies (JRC-IPTS)

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THE EUROPEAN UNION IS CONFRONTED with a daunting post-crisis growth challenge that is likely to continue to test it at least until 2020. But even before the crisis, Europe's growth performance was poor, attributable to a great extent to productivity shortcomings, and by an inability to mobilise innovation for growth. Policymakers have tried to overcome the deficiencies but the EU's innovation environment remains weak, especially in terms of investment by the business sector in research and development.

A common explanation for the EU's tame business R&D performance is its specialisation in medium-tech, rather than high-tech, sectors. Compared to the United States, the EU has fallen behind particularly in key information and communications technology (ICT) sectors, which were the drivers of US growth in the late 1990s[1].

But that still leaves the question of why the EU, on average and in contrast to the US, has been unable to redirect its specialisation pattern so that these new growth sectors are covered. The limited firm-level analysis available for ICT sectors suggests that the problem is not the level of investment *per se*, but rather that in the EU, unlike in the US, there are constraints holding back the rapid growth of new, technology-based firms[2].

The EU's R&D spending deficiency seems therefore to be a symptom rather than a cause, with the cause rooted in the structure and functioning of industry and enterprise in the EU.

This policy brief demonstrates that the EU's business R&D deficit compared to the US can be almost entirely explained by the EU having fewer young leading innovators and, even more importantly, having fewer of them in new high R&D-intensity sectors. This has serious implications for the design of the EU's research and innovation policies. Rather than focusing on the symptom – the R&D deficit – policy makers should address the cause, with policies to rectify the EU's enterprise and industry structure shortcomings.

1 WHAT THE US HAS BUT THE EU LACKS: YOLLIES

In what follows, we summarise the main results from an analysis of the firms that spend most on R&D, focusing on differences by sector and age of firm[3]. We use the EU's Industrial R&D Investment Scoreboard (European Commission, 2008), which contains information on R&D and sales for the largest EU and non-EU firms across all sectors (see Box 1). Together these firms represent more than 80 percent of total worldwide R&D in the private sector. We augment this data with information on the age of firms.

Our focus is young firms, which we label 'young leading innovators', or *yollies*. These are firms in the R&D Scoreboard that started up after 1975. It is important to stress that these young firms are NOT small

BOX 1: The young leading innovators dataset

Our analysis uses data on the EU-1000 and non-EU-1000 highest R&D spenders contained in the 2008 edition of the EU Industrial R&D Investment Scoreboard*. This dataset has been augmented with information on the age of the establishment of firms, which allows us to categorise leading innovators as old (meaning established before 1975) or young (post-1975). It should be noted that 'young' firms are not small start-ups. On average, the young firms in our sample have 10,000 employees worldwide.

Because of missing data in some cases, the final sample covers 1077 firms, representing 96.1 percent of the R&D carried out in 2007 by the top 2000 corporations worldwide listed in the Scoreboard. This is itself representative of more than 80 percent of total worldwide private sector R&D.

Firms are considered EU or US-based depending on their ownership, rather than by the location of their activities. Of our sample firms, 29 percent are EU-based, 38 percent from the US, 19 percent from Japan and 14 percent from the rest of the world**.

* The European Commission has collected this data since 2004, see http://iri.jrc.ec.europa.eu/research/scoreboard.htm.

** Further details on the data can be found in Veugelers and Cincera (2010), and see footnote 3 of this policy brief.

1. Eg O'Mahoney and van Ark (2003), van Pottelsberghe (2008), Moncada-Paterno-Castello *et al* (2010).

2. Eg Aghion *et al* (2008), Bartelsman *et al* (2004), Cohen and Lorenzi (2002).

3. The full analysis is reported in Bruegel Policy Contribution 2010/08 and a European Commission JRC-IPTS Working Paper 2010/08, 'Young leading innovators and EU's R&D intensity gap' (both forthcoming).

start-up companies. They are firms that have in a short period grown into world leaders on the basis of their substantial R&D effort, while still remaining independent. Some top yollies in our sample are Amgen, Cisco, Google, Microsoft, Qualcomm and Sun.

The central question we want to ask is if the EU's private sector R&D shortfall compared to the US can be explained by these yollies. Figure 1 shows for the EU and US the proportion of leading innovators that are young, and their contribution to R&D, sales and employment.

Figure 1 shows compellingly that EU-based yollies play little meaningful role relative to their US counterparts. Only one out of every five leading innovators based in the EU is 'young'. This compares to more than half in the US. Furthermore, the EU yollies' share of the EU's total leading firms' R&D expenditure is a mere seven percent, versus 35 percent in the US.

The yollies that the EU does have are less R&D intensive than their US counterparts. US-based yollies have an R&D-to-sales ratio of 10.2 percent (2007) versus 4.4 percent for EU yollies.

Furthermore, EU 'old' leading innovators (which we shall call *ollies*, meaning all leading innovators established before 1975) are somewhat less R&D intensive than their US counterparts, but this gap is markedly smaller than for the yollies, as Figure 2 shows.

The shortfall in the R&D intensity of the EU's leading innovators compared to those in the US can thus be accounted for by the combination of the following factors:

1. There are fewer EU-based than US-based yollies. This matters because yollies are more R&D intensive than ollies;
2. The EU-based yollies are less R&D intensive than their US counterparts;
3. In addition, the EU-based ollies are less R&D intensive than their US counterparts.

Figure 3 shows the contribution of each of these factors to the total EU-US R&D intensity gap.

Figure 1: Share of yollies in number of firms, R&D, sales and employment by region (2007)

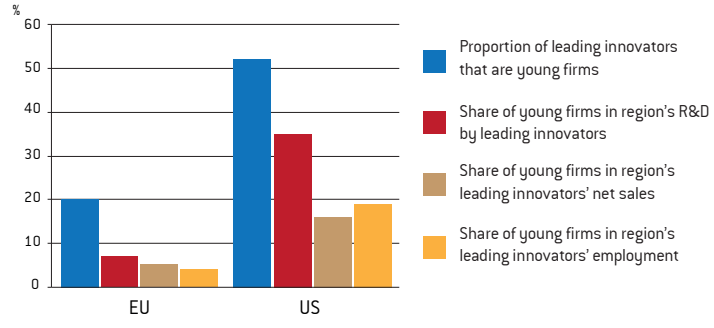


Figure 2: EU R&D intensity gap with the US (US = 100)

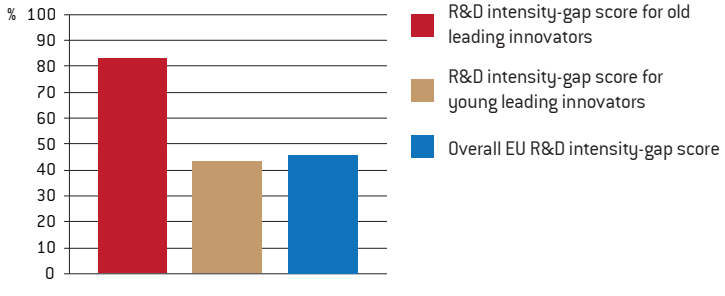
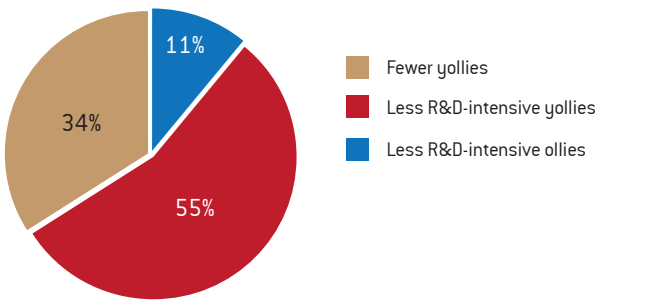


Figure 3: Decomposing the EU-US R&D-intensity gap



Source for Figures 1-3: Bruegel/European Commission JRC-IPTS on the basis of the EU Industrial R&D Investment Scoreboard (European Commission, 2008). Note: Figure 3 decomposes the total R&D intensity gap between the EU and the US (which is equal to the blue bar in Figure 2) into three factors: the *fewer-yollies factor* (blue), the *lower R&D intensity yollies factor* (red) and the *lower R&D intensity ollies factor* (beige).

It matters that the EU has fewer yollies than the US among its leading innovators, as this explains one third of the EU-US R&D intensity gap. However, the more significant factor explaining the gap is that the EU's yollies are less R&D intensive than their US counterparts (accounting for 55 percent of the gap). The fact that the EU's ollies are less R&D intensive than their US counterparts only accounts for 11 percent of the overall R&D gap.

These results allow for a few interesting back-of-the envelope calculations, on the basis of which we put forward three scenarios illustrating how the EU could most efficiently close the R&D intensity gap with the US. The scenarios are illustrated by Figure 4, and detailed below.

Scenario 1: More yollies

- What? The EU should aim to have as many young firms among its leading innovators as the US. These yollies would on average have the same profiles as the current EU-based yollies, ie with the same R&D intensity.
- How? Doing this would require achieving a target of 52 percent of leading innovators being young, which means increasing the current number by 2.5 times;
- Result: if successful, EU R&D intensity relative to the US would increase from 46 to 53 percent, and the EU-US R&D intensity gap would be reduced to 47 percent.

Scenario 2: Better yollies

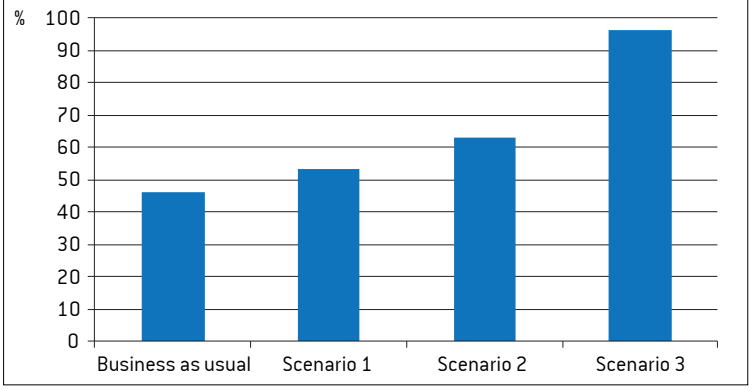
- What? The EU should aim to increase the R&D intensity of its current crop of yollies to the level seen in the US.
- How? The current yollies in the EU's Industrial R&D Investment Scoreboard should increase their R&D-to-sales ratio to 10.2 percent, ie an increase of 2.3 times compared to their current R&D intensity.
- Result: if successful, EU R&D intensity relative to the US would increase from 46 to 63 percent, and the EU-US R&D intensity gap would be reduced to 37 percent.

Scenario 3: More and better yollies

This scenario combines Scenarios 1 and 2. If EU could have as many yollies as the US, at the same level of R&D intensity, the EU-US R&D intensity gap would almost disappear: EU R&D intensity relative to the US would increase to 96 percent, meaning a negligible remaining gap of four percent.

Scenario 1, more yollies, is a less attractive option than Scenario 2, better yollies. But perhaps more importantly, the different scenarios indicate that working on both dimensions simultaneously – more and better yollies – would effectively eliminate the EU's R&D intensity shortfall compared to the US. These scenarios clearly illustrate the importance of young leading innovators for explaining and reducing the EU-US R&D intensity gap: the EU needs more yollies, but even more importantly more R&D-intensive yollies.

Figure 4: Reducing the EU-US R&D intensity gap (US = 100%)



Source: Bruegel/European Commission JRC-IPTS on the basis of the EU Industrial R&D Investment Scoreboard (European Commission, 2008).

2 WHY ARE EU YOLLIES LESS R&D INTENSIVE?

The questions the EU must ask itself are therefore how can it stimulate the creation of more yollies, and how, in particular, can it stimulate the creation of yollies that are more R&D intense than currently? This brings us to the question of what explains the lower R&D intensity of Europe's yollies at present. In line with the literature, we examine if this differ-

ence is due to Europe's yollies being found in less R&D-intensive sectors than their US counterparts.

Almost all of the explanation for the lower R&D intensity of EU yollies can be found in a different sectoral composition, as the upper bar of Figure 5 shows. Europe simply has fewer yollies in the high R&D-intensity sectors. This provides an explanation for EU yollies, on average, being less R&D intensive than their US counterparts. The highest levels of R&D intensity are found in either health or ICT sectors which, with the exception of pharmaceuticals, are all 'young': sectors in which an above-average share of total R&D is done by yollies. These sectors are biotechnology, computer hardware, computer services, health equipment, internet, software, semiconductors and telecoms equipment.

Differences in sectoral specialisation also explain – and to an even greater degree – the difference in R&D intensity between the EU and the US for ollies. The negative 'within sector' effect shown by the lower bar in Figure 5 indicates that, in fact, the EU's ollies outperform their US counterparts when comparing within sectors.

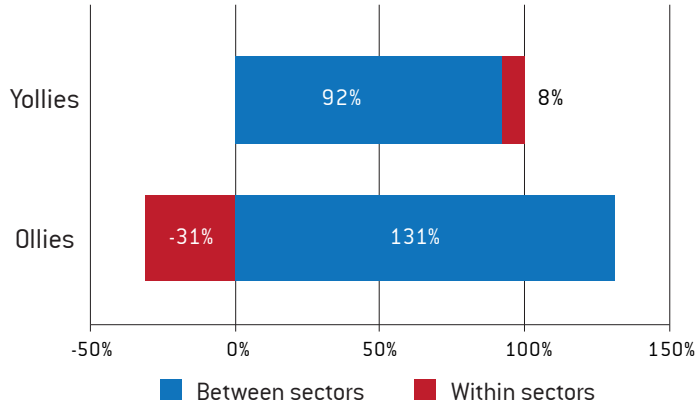
Table 1 details the R&D intensity of key sectors, identifying the sectors most responsible for explaining the lower average R&D intensity of EU yollies relative to US yollies.

In the semiconductors sector, the EU has fewer young firms among its leading innovators, and these yollies are less R&D intensive than US yollies, but the difference in R&D intensities is small.

The biotechnology sector stands out most as the sector in which the EU not only has markedly fewer yollies than the US, but the few EU-based biotechnology yollies are much less R&D intensive than their US counterparts.

In the telecoms equipment sector, where the EU has a strong technological position, EU ollies make up the bulk of the leading innovators

Figure 5: Decomposing the EU-US R&D intensity gap for yollies/ollies



Source: Bruegel/European Commission JRC-IPTS. Note: a positive 'between-sectors' effect (shown in blue) indicates that the US has more of its yollies/ollies in high R&D intensity sectors. A positive (negative) 'within-sectors' effect (red) indicates that the US firms are on average more (less) R&D intensive than their EU counterparts within the same sector.

Table 1: Comparing EU to US yollies in key sectors

	European Union			United States		
	Yollies RDI	Ollies RDI	Yollies as % of firms	Yollies RDI	Ollies RDI	Yollies as % of firms
Semiconductors	17	16	10	18	16	20
Biotechnology	18	10	12	27	12	17
Telecoms eqpt.	18	13	3	14	11	8
Pharmaceuticals	25	15	5	14	15	6
Healthcare	11	4	2	10	7	4
Computer h'ware		6	-	6	4	7
Internet			-	11		3
Computer services	3	5	7	6	6	1
Electronics	6	6	9	5	5	2
Software	17	14	20	15	13	17

Source: Bruegel/European Commission JRC-IPTS. Note: Sectors are ordered according to greatest contribution to the overall between-sectors composition effect for young leading innovators (the blue component in the upper bar of Figure 5). Semiconductors, biotechnology, telecoms equipment, pharmaceuticals, health care, computer hardware and internet contribute positively (the EU has fewer young firms among its leading innovators in these sectors). Computer services, electronics and software contribute negatively (the EU has a greater share of young firms among its leading innovators in these sectors than the US).Note: RDI = R&D spend to sales ratio

and they perform better than their US counterparts. But the EU's yollies in this sector are even more R&D intensive than the ollies and, even more importantly, they strongly outperform their US 'young' counterparts. This makes it all the more unfortunate that the EU has fewer yollies in this sector than the US has.

A similar pattern is seen in the pharmaceuticals sector, where most of the leading innovators are 'old' and the few EU yollies are much more R&D intensive than their US counterparts. Among the ICT sectors, the internet sector is the clearest case of a structural EU yollies problem. All leading innovators in this sector are young, and they are all US-based. The EU has no leading innovators in this sector. In a number of ICT sectors, the EU does not have a numerical disadvantage. On the contrary it has more yollies than the US. This is most evident in the computer services, electronics and software sectors.

'There is an EU problem of missing yollies in the 'right' R&D intensive sectors, especially biotech and internet.'

To summarise, while overall there is an EU problem of missing yollies in the 'right' high R&D-intensity sectors, with biotechnology and internet being the clearest cases, there are nevertheless some positive examples from sectors in which there are either more EU yollies and/or the EU yollies exhibit a similar level of R&D intensity, or are more R&D intensive, than their US counterparts.

3 WHY DOES EUROPE HAVE FEWER YOLLIES?

What accounts for Europe's weakness, compared to the US, in new technology-based sectors, particularly biotechnology and ICT? Why are there fewer firms starting up and growing into leading innovators that spend significant resources on R&D? And why is this happening relatively less, compared to the US, in new technology-based sectors, particularly biotechnology and ICT?

The most frequently cited explanation for the differences in dynamic structure between the EU and the US is a greater willingness on the part of US financial markets to fund new firms in new sectors. A further common explanation is the more fragmented nature of Europe's product markets as potential barriers to innovation, compared to the US (O'Sullivan, 2008). For new firms in new sectors, this holds particularly with respect to markets where there are early users willing to take up and co-develop innovations. In addition, the lower exit and re-entry costs for firms in the US, and the greater flexibility of the US labour market, are factors spurring the emergence of new firms and industries in the US.

But part of the story is also the shortcomings of the EU's innovation 'eco-system', which does not effectively link the institutions and organisations that are active in innovation. In particular, a well-functioning interface between the science system and the corporate sector is important for new emerging technologies, which are often built on insights from frontier research. The importance of effective links is further demonstrated by the long-standing and continued importance of the role of the US federal government in the success of the US's biotechnology and ICT sectors, which are supported through R&D subsidies and other mechanisms, particularly procurement. In several of the health and ICT sectors, US public institutions have been an important early user, pivotal for driving R&D in the private sector (Mowery, 2009).

When considering start-ups and firm growth, the relationship between incumbents and new innovators also matters. Baumol (2002) noted how fortunate the US has been to have a symbiosis whereby young firms introduce breakthrough innovations, while the large established firms, in a mix of cooperation and competition with the young firms, produce follow-up innovations, further improving the breakthrough innovations of the former. Mowery (2009) notes how critical anti-trust policy has been for the development of ICT sectors in the US, by not only reinforcing a competitive environment for companies conducting R&D and commercialising the results, but also by contributing to relatively weak enforcement of intellectual property rights in the early years, which permits

easier inter-firm diffusion and the entry of new firms.

4 EU INNOVATION POLICY: RECOMMENDATIONS

The evidence presented in this policy brief has daunting implications for the EU's innovation policy agenda, which is going through a period of reappraisal. The evidence suggests that policies aimed at raising R&D expenditure across all types of industries and firms do not address the root causes of the EU's innovation deficit. To do this, policies need to address the **specific** barriers to development of **new** high R&D-intensity sectors and firms, as the evidence has shown how pivotal these sectors and firms are for tackling the EU's R&D shortcomings.

These specific barriers are rooted in problems of access to *early risk financing*, access to risk-taking *lead customers* and access to frontier research, specialised know-how and skills. And when intellectual property regimes are not clear, open and affordable, aspiring young innovators will be hampered in their search for partners to develop, finance, produce, market, distribute and sell their breakthrough innovations. What types of EU policy intervention are needed to address these specific barriers? And how targeted do they need to be? A first important remark is that a general innovation policy aimed at improving the environment for innovation remains necessary. Because yollies need to interact with other innovators, and because innovators should not be impeded while they mature, a policy to address the lack of young firms in young highly R&D-intensive sectors needs to fit into an **overall innovation policy**. This overall innovation policy should further the integration of the EU's capital, labour, product and services markets, strengthen the EU's public research base, make it easier for players in the innovation system to interact and, at the same time, ensure healthy competition. Such an overall innovation policy will be necessary, but it will not be sufficient.

'Policies need to tackle the specific barriers faced in new sectors by new firms.'

Policy measures are also needed to tackle the **specific barriers** faced in new sectors by new firms. Some of these barriers reflect general failings of the system that are not particular to specific new sectors, and therefore can be addressed by non sector-specific measures. We concentrate here on some steps that could be taken at EU level, which are by no means intended as an exhaustive list.

An extensively discussed barrier facing young innovative companies is **access to finance**. Previous Bruegel publications (Veugelers, 2009, and Dewatripont *et al*, 2010) have proposed an EU programme of financing for the early stages of highly risky innovative projects. These proposals have also suggested ideas for reducing the cost of **intellectual property rights protection** for young firms.
As EU competition policy authorities are the guardians of the arena in which large incumbent firms interact with young innovators, dynamic competition effects and the openness of technology markets that shape the future working of innovative markets should be much higher on their priority list.

These policy recommendations, aimed at overcoming barriers that are particularly important to young firms in new highly R&D-intensive sectors, do not require targeted, sectoral approaches. However, our evidence has also clearly shown substantial heterogeneity in patterns across new sectors, which calls for at least some sector-specific policy attention. The sectoral policy toolbox includes in particular the instruments of procurement, regulations and standards.

Taking a lead from the successes of US public procurement in ICT markets, the EU should make more use of the **public procurement** instrument for nurturing early-stage innovation at least in those sectors in which the public sector can be a pivotal user. But as the US examples illustrate, public procurement for new markets is not about picking and protecting winners. Procurement policies should be designed not to replace private markets but to leverage them, stimulating the diffusion of innovation, while keeping the markets open so that they can move in new directions. Procurers should encourage the entry of new firms

and the development of complementary actors while nurturing potential competition. When done on an EU-wide scale (eg through an EU-wide public procurement programme similar to the US Small Business Innovation Research Program), member states can share risks and pool resources.

On the adoption of **regulations** and the setting of **standards** for stimulating innovative markets, past experience is mixed. Regulations and standards, by minimising market uncertainties, can enable new innovations to come to market sooner than they otherwise would. But regulations and standards might also carry the risk of creating a straitjacket, precluding the emergence of new and better technology breakthroughs. The choice of when and which regulations or standards to use should be carefully evaluated *ex ante* on the basis of their longer term impact on the development of new markets.

If and when governments intervene, regulations and standards should be designed to be technology-neutral and open, allowing new innovators to continue to compete. Regulations and standards should also be designed with a global perspective, enabling European firms to secure first-mover advantage and leadership in world markets. At this stage of the analysis, when there are still too many unknowns about whether and which interventions are effective for new markets, policy-makers are advised to engage in close monitoring of emerging innovative markets.

This is in order to evaluate if the right mix of policy instruments is present and if the mix is effective for ensuring the smooth development of firms in new sectors, and so that policies can be adapted or dropped if ineffective. Monitoring should include a strong prospective angle, able to identify new emerging markets well in advance so that a pro-active policy mix can be identified for the very earliest phases of development.

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