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A PRIMER ON INNOVATION AND GROWTH

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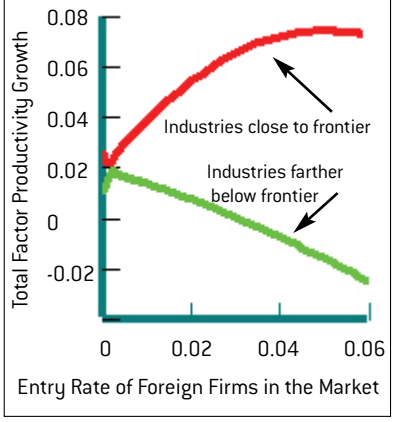
SUMMARY In sharp contrast with the post-war period, over the last 10 years income per head in the EU has begun to decline in comparison to that of the US. **Against this background, the revival of growth and productivity has become an overriding priority of European policymakers.** While fostering innovation has become a necessity in Europe, R&D investments alone will not do the job.

Impact of New Firm Entry on Productivity

UK firms data (1987-93) shows that entry has a more positive effect on productivity growth in industries close to the technological frontier



Source: Aghion et al (2006)

POLICY CHALLENGE

To get back on a high growth path, Europe needs a comprehensive and coherent strategy which also involves: (i) more competition and entry on the product markets; (ii) more investment in higher education; (iii) more developed financial sectors and markets and more flexible labour markets; (iv) a more pro-active macroeconomic policy over the business cycle. Finally, there should be a clearer recognition that structural reforms may entail winners and losers; hence the importance of complementary policies aimed at correcting the inequalities caused by these reforms.

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OVER the last ten years, the average annual growth of GDP per capita in the EU15 has been 0.4 percentage points below that of the US. The gap may not seem large, but cumulated over long periods, such small gaps end up producing large differences in income per capita. Furthermore, this gap implies that, in sharp contrast with the previous decades where per capita GDP growth was much higher in Europe than in the US, in the last decade income per head in the EU has begun to decline in comparison to that of the US.

Against this background, the revival of growth and productivity has understandably become an overriding priority of European policymakers. But how can we explain this change of fortune and reverse the trend? Classical growth theories do not have much to tell us on this question. Indeed these theories emphasise capital accumulation and savings rates as the engines of growth. However, in spite of the US investment revival of the last fifteen years, both the capital-labour ratio and the investment rate are still higher in Europe than in the US. Europe may need to renew its capital stock, but it is hard to claim that its growth performance primarily results from underinvestment in physical capital.

An alternative explanation, which underlies the so-called Lisbon Agenda, is that Europe has not invested enough in research and development (R&D) nor in the knowledge economy. As a result, the region has not been able to take full advantage of recent technological revolutions, particularly in information and telecommunications. The Lisbon objectives in this respect are far from being met and high sustainable growth still remains a challenge for EU countries. But why is it that technology and R&D have suddenly become so important?

Another frequently mentioned possibility is that Europe has failed to reform overregulated labour and product markets. There is indeed a sharp contrast between the US and EU countries in terms of product and labour markets regulation, but again, this contrast has been there for a long time – it was already apparent when Europe was growing much faster than the US.

Finally, macroeconomic policy is sometimes blamed for being too restrictive. But while there have been episodes of fiscal consolidation and monetary tightness, the overall policy has not been overly restrictive in recent years.

'By the late 1980s, Europe had largely exhausted capital accumulation and technological imitation as its main sources of growth.'

There is, therefore, a puzzle about the deterioration of Europe's growth performance. The purpose of this note is to identify the main reasons for this deterioration and to suggest ways to reverse it.

Section 1 looks at the importance of innovation for EU countries; Section 2 examines indirect means of fostering both innovation and growth; and Section 3 draws some policy conclusions.

1. INNOVATION: A NECESSITY

In 1945, Europe's stock of physical capital had been largely destroyed and its technological knowledge, as reflected by its average level of per capita GDP, was far behind the per capita GDP in the US. So, at that time, what Europe needed to do to grow was essentially to accumulate capital and to imitate or adapt technological innovations made elsewhere. And this is what Europe did quite successfully during the *trente glorieuses*, with the support of economic institutions and policies that were adapted to those goals, in particular: limited competition in the product market; large firms financed by banks and by government subsidies; educational systems emphasising primary, secondary, and specialised undergraduate education; and rigid labour markets that favoured the accumulation of experience within firms over mobility across firms.

However, by the late 1980s, the advanced European countries had largely caught up with the world's best performers in terms of the capital-labour ratio and productivity levels: they were reaching the world technology frontier. This in turn implied that Europe had largely exhausted capital accumulation and technological imitation as its main sources of growth, and had to turn to an alternative source, namely innovation; that is, the ability for firms and workers to move rapidly into new activities or to improve production processes.

In the meantime, the IT revolution resulted in a revival of US growth in the late 1980s and early 1990s. Since Europe did not have the institutions and policies to benefit from this new technological revolution, the result was a reversal of Europe's approach to the frontier.

A first way to foster innovation is thus to invest more in R&D. As we all know, EU15 countries have been investing, on average, about 1.9% of their GDP in R&D in the last decade, against 2.6% in the US. That R&D investment becomes more essential when industries move closer to their technological frontier is evident when one analyses the relationship between the distance to the frontier and R&D intensity at the industry level.

Some industries are evidently more R&D intensive than others.

But, in fact, R&D intensity increases in *all* industries when an economy gets closer to the technological frontier, because the survival and growth of *all* industries in a high-cost, high-productivity economy depends on their ability to innovate. Thus, for example, pharmaceuticals are more R&D intensive than clothing, but both sectors are more R&D intensive in a developed economy than in a catching-up economy (Box 1).

'It is not enough to invest more in R&D here and there to get the economy to grow faster.'

Thus, now that they have moved closer to the world technological frontier, EU countries should invest more in R&D – and within the EU, the most advanced countries should invest proportionally more as they benefit from a higher productivity of R&D.

However, it would be naive to assume that patent protection and R&D subsidies would be sufficient to foster innovation and productivity growth. It is not enough to invest more in R&D here and there to get the economy to grow faster. In the same way that R&D becomes essential when an economy develops, it becomes vital to create the micro and macro-economic conditions for innovation-based growth. In the remaining part of this policy brief, we point at several such conditions: competition and entry, education, efficient labour markets, financial development, and the conduct of macroeconomic (particularly fiscal) policy over the business cycle. These are indirect ways to foster innovation and growth in maturing economies.

2. FOUR WAYS OF FOSTERING INNOVATION & GROWTH

(i) COMPETITON & MARKET ENTRY

As stressed by the Sapir report[3], competition policy in Europe has emphasised competition among incumbent firms, but paid insufficient attention to entry. Entry, as well as exit and turnover of firms, are more important in the United States than Europe. For example, 50% of new pharmaceutical products are introduced by firms that are less than 10 years old in the United States, versus only 10% in Europe. Similarly, 12% of the largest US firms by market capitalisation at the end of the 1990s had been founded less than twenty years before, against only 4% in Europe, and the difference between US and European turnover rates is much bigger if one considers the top 500 firms[4] .

The higher entry costs and lower degree of turnover in Europe compared to those in the US are an

BOX 1

PROXIMITY TO THE TECHNOLOGICAL FRONTIER AND R&D INTENSITY AT INDUSTRY LEVEL

Let us define "proximity to the technological frontier" for an industry *i* in a given country at a given time – PTF – as the ratio of TFP (total factor productivity) in that industry and the highest TFP in industry *i* at time *t* among all countries. Proximity varies from zero (for very inefficient industries) to 1 (for the most efficient). We obtain estimates of the proximity to the frontier, as well as data on R&D intensity (R&D divided by sales), for the years 1974-1990[1] .

Table 1 reports the correlation coefficients between the proximity to the frontier and R&D intensity. All columns show a significant positive correlation between these two measures: industries closer to their respective frontier are more R&D intensive. Moreover, as further empirical work shows, as an industry approaches the world technology frontier more rapidly than others, it becomes relatively more R&D intensive[2]. These results are consistent with the view that R&D gains in importance as industries or countries approach the world technology frontier.

Table 1

R&D Intensity Increases as Industries Get Closer to the Frontier

	SPECIFICATIONS		
	(1)	(2)	(3)
Proximity to the frontier	**0.031**	**0.018**	**0.009**
	(0.006)	(0.004)	(0.004)
Year dummies	YES	YES	YES
Country dummies	NO	YES	YES
Industry dummies	NO	YES	YES
Country-Industry dummies	NO	NO	YES
No. of observations	1801	1801	1801

Note: Standard errors are in parentheses. The dependent variable is the ratio of R&D added at the industry level

Source: Acemoglu, Aghion & Zilibotti (2006)

[1]For more details, see Rachel Griffith, Stephen Redding, and John Van Reenen (2004).

[2]More detailed empirical results are available from the author upon request.

[3]André Sapir et al (2004).

[4]Ibid.

important part of the explanation for the differences in growth patterns between the two continents. While churning, (i.e. the replacement of old, less efficient firms by new, innovative ones) plays an important part in US productivity growth, most productivity gains in Europe take place within existing firms, as shown by Guiseppe Nicoletti and Stefano Scarpetta[5].

'The cost in terms of innovation, of having too little competition grows as the economy gets closer to the frontier.'

What frequently fails to be realised, however, is that the economic costs of less dynamic firm demographics actually *rises* as the economy gets closer to the technological frontier. This is shown in Figure 1, where we look at patenting rates within a panel of UK manufacturing firms over the period 1973-1992 as a function of the degree of competition in the industry.

In general, there is an inverted-U relationship between competition and innovation: firms have little incentive to innovate if they are not stimulated by competition, but too much competition discourages innovation as firms are not able to reap the benefits of their efforts. There is, therefore, an optimal degree of competition.

What Figure 1 shows is that if we restrict the set of industries to those that are closer to their world technological frontier, the upward sloping part of the inverted-U relationship between competition and innovation is steeper than for the whole sample. Thus, the cost in terms of innovation, of having too little competition, grows as the economy develops and gets closer to the frontier.

What is true for competition is also true for entry. Figure 2, again based on firm-level UK panel data over the period 1987-1993, shows that entry has a more positive effect on productivity growth in industries that are close to the technological frontier than in those that are not.

During the immediate post-war period, the European (or Japanese and Korean) firms were predominantly technological laggards, whose catching-up could have been diminished by very intense competition. Thus, for some time, the relatively non-competitive nature of European markets was favourable to productivity growth in European firms. However, as Europe approached the global technological frontier, competition and entry have become increasingly important catalysts for innovation and productivity growth.

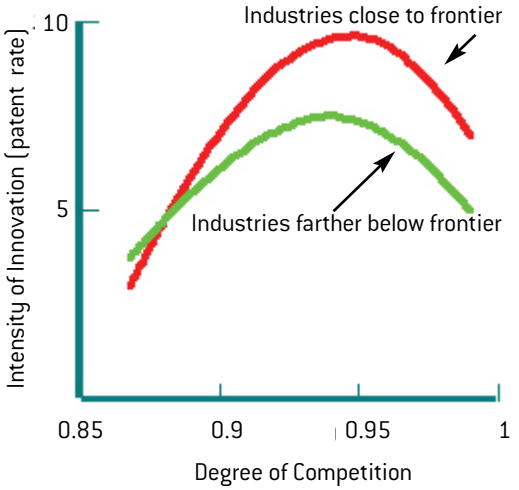
(ii) INVEST IN HIGHER EDUCATION

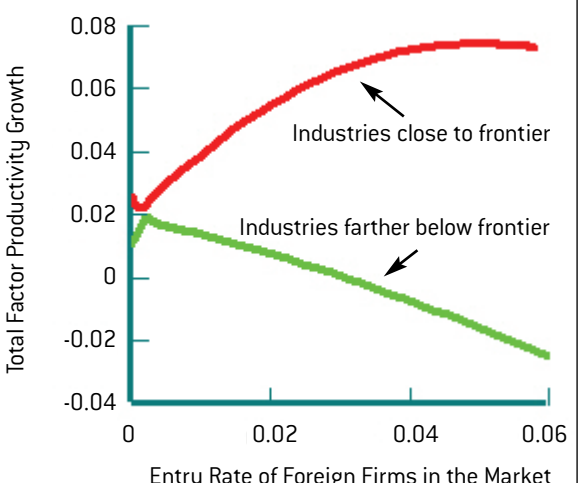
Is the European education system growth-maximising? A first look at the US versus the EU in 2004 shows that 39% of the US population aged 25-64 had attained tertiary education, against only 23% of the EU population. This educational attainment comparison is mirrored by that of tertiary education expenditure, with the US devoting 2.3% of its GDP to tertiary education versus only 1.3% in the EU (2003)[6].

Is this European deficit in tertiary education investment a big deal for growth? The answer is a clear 'yes' if one takes the view that higher education investment increases a country's ability to make leading-

Fig. 1 Competition **Fig. 2 Entry**

Beneficial Effects of Competition & Entry in Industries Close to the Technological Frontier





Source: Aghion, Bloom, Blundell, Griffith, Howitt (2005)

Source: Aghion, Blundell, Griffith, Howitt, Prantl (2006)

[5]See Nicoletti and Scarpetta (2003).

[6]See "Education at a Glance", OECD (2006).

edge innovations, whereas primary and secondary education are more likely to make a difference in terms of the country's ability to implement existing technologies. This view is supported by recent empirical evidence, both across countries[7] and across US States[8]. Both studies show that the closer a country's or a State's productivity is to the frontier productivity, the more growth-enhancing it is to invest in higher (in particular post-graduate) education. In countries or States that are further below the frontier, growth is primarily enhanced by investments in primary, secondary, and undergraduate education (Box 2). Thus, as Europe has moved closer to the world technological frontier, it should invest more in tertiary education in order to increase its innovative potential.

For Europe, putting the emphasis on primary/secondary education was fine as long as the continent was technologically far from the US and therefore relying more on imitation as a main source of growth; but now that the growth potential of imitation is wearing out, it becomes more urgent to invest more in higher education in order to foster innovation. Evidence actually shows that the IT and globalisation waves of the 1980s have further increased the growth potential of higher education investment in all OECD countries.

BOX 2

EDUCATION, DEVELOPMENT AND GROWTH

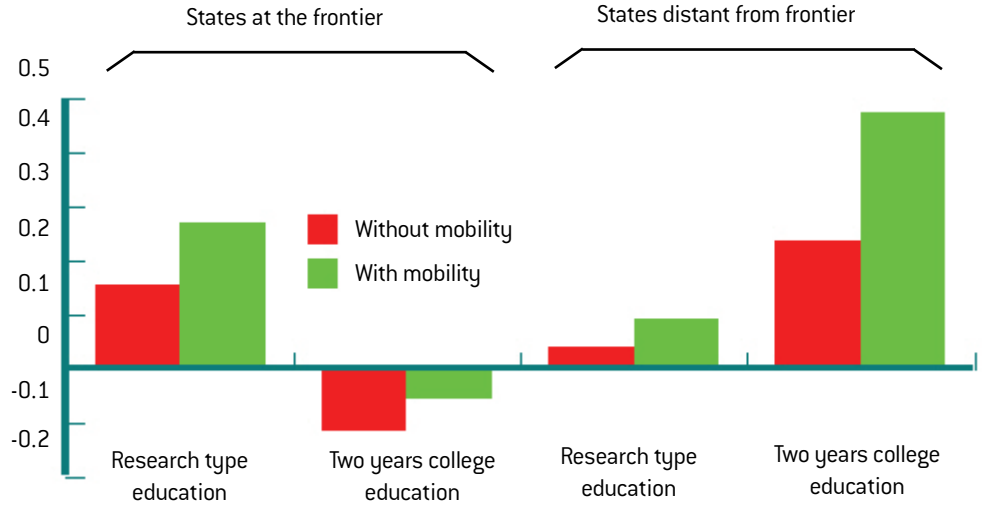
Using annual panel data on growth and education spending and attainment by state over the period 1970-2000, Aghion, Boustan, Hoxby and Vandenbussche regress productivity growth during a ten year period in a state, over the composition of education spending on the cohort that just reaches working age, respectively for frontier States and far-from-frontier States. They instrument education spending as follows:

(i) For Research-University education, they look at whether a state has a congressman on the appropriations committee which allocates funds for research universities but not other types of schools;
(ii) For "low-brow" post-secondary education (community colleges, training schools), they look at whether the chairman of the state's education committee represents voters whose children attend one or two-year post-secondary institutions.

The first stage regressions yield the result that every additional representative on the House Appropriation Committee increases the expenditure on reseach-type education by $597 per cohort member, which is condiserable. In second-stage regressions the authors find that an additional $1000 per person in research education spending raises the state's per-employee growth rate by 0.27% if the state is at the frontier, whereas it raises it by only 0.09% if the state is far from the frontier. Finally, migration reinforces the extent to which investing in higher education is more growth-enhancing for a state which is closer to the frontier: students with college degrees are more likely to defect to a frontier state if they are born in a state which is far from the frontier. This will benefit growth in the recipient state, but not in the state of origin.

Fig. 3

Long-term growth effects of $1000 per person spending on education, US States



Source: Aghion, Boustan, Hoxby and Vandenbussche (2005)

[7] Vandenbussche, Aghion and Meghir (2006)

[8] Aghion, Boustan, Hoxby and Vandenbussche (2005).

(iii) REFORM CREDIT MARKETS NOT JUST LABOUR MARKETS

Both credit constraints and labour market rigidities are likely to act as barriers to entry and innovation. Credit constrained firms may not be able to pay the required fixed costs to enter new markets or introduce new production technology. And labour market rigidities should make it harder for a firm to move to a new activity, as it will be more costly to find new workers adapted to that activity and to reduce employment in the old activity.

As it turns out, labour market rigidities are often presented as the main impediment to firms' entry, mobility and post-entry growth, whereas financial constraints are considered to be less important. A recent study[8] provides the opposite picture, however. This latter work looks at firms from 14 OECD countries over the 1990s, and examines how the entry of new firms and their post-entry growth are affected by three factors: 1) financial development; 2) regulations affecting start-up costs; and 3) regulations on the hiring and firing of workers.

Financial development is measured either by the ratio of private credit to GDP or the ratio of stock market capitalisation to GDP. Start-up costs and restrictions on firing are measured by the corresponding OECD indicators.[9] The main finding from this research is that financial development facilitates the entry of small firms especially in sectors which in the US rely more on external finance. In these sectors, however, labour market regulations do not inhibit the entry of smaller firms (although they do for larger firms).

Table 2 summarises the relative impacts of financial development and labour market regulations on the growth of a new firm in its first years of existence (post-entry growth). In the table, financial development is interacted with the sector's dependence on external financing; and employment protection legislation is interacted with the sector's labour intensity (measured by the labour-capital ratio). Financial development is further decomposed into private credit and stock market capitalisation.

The table shows that financial development facilitates the post entry growth of firms in sectors that are intrinsically more dependent upon external financing. In contrast, labour market regulations do not seem to be significantly correlated with post-entry growth of firms. These results suggest that political reformers in the EU should go beyond labour regulations and also emphasise financial development: on average, the ratio of private credit to GDP is far lower in the EU (0.76) than in the US (1.32), and this gap is even bigger if we look at stock market capitalisation indexes or at venture capital indicators.

'Political reformers in the EU should go beyond labour regulations and also emphasise financial development.'

(iv) MANAGE THE ECONOMIC CYCLE

There is currently a debate about the conduct of macroeconomic policy in the euro area. It has been noticed that structural budget deficits and short-term interest rates fluctuate much less over the cycle in the EMU zone than in the US and UK, and some policymakers have raised the concern that this in turn may inhibit growth in the euro area. Are these concerns at all justified?

'If firms can borrow enough funds to maintain their R&D investments throughout the business cycle, governments should let markets operate.'

This depends on whether firms can borrow enough funds to maintain their R&D investments during bad times and, therefore, throughout the cycle. If they can, the best would be, at least from a growth perspective, to recommend that governments do not intervene over the business cycle, and instead let markets operate.

However, the prescription might be quite different when credit market imperfections prevent firms from borrowing enough in recessions. For example, suppose that the borrowing capacity of firms is proportional to their current earnings. In a recession, current earnings are reduced and so, therefore, firms' ability to borrow in order to maintain R&D investments. In this case, a countercyclical policy will foster innovation and growth by reducing the negative consequences of a recession (or a bad aggregate shock) on firms' innovative invest-

Table 2

Financial Development Favours Entry

Impact of selected interactions on post-entry growth	
Fin. development x dependence on external financing	POSITIVE
Credit Development x external financing	POSITIVE
Stock market development x external financing	POSITIVE
Employment protection legislation x labour intensity	INSIGNIFICANT[10]

Source: Aghion, Fally, Scarpetta (2006)

[8] Aghion, Fally and Scarpetta (2006).

[9] To minimize the scope for endogeneity problems, AFS uses industry-level indicators (the dependence on external finance of the corresponding sector in the US or the capital labour ratio in the sector) to differentiate the effect of credit constraints on entry and the post-entry growth of firms after six years into the market, across industries.

[10] Negative but statistically insignificant.

ments. For example, the government may decide to increase the volume of its public investments, thereby fostering the demand for private firms' products. Or the government may choose to lower taxes on private enterprises, thereby increasing their liquidity holdings and thus making it easier for firms to face idiosyncratic liquidity shocks without having to sacrifice R&D or other types of longer-term growth-enhancing investments.

In a recent empirical study using annual data from 17 OECD countries, Aghion and Marinescu (2006) show that the pro-cyclicality of fiscal policy is actually detrimental to growth; but they also show that the same degree of pro-cyclicality is *less* detrimental to growth in countries with a higher degree of financial development.

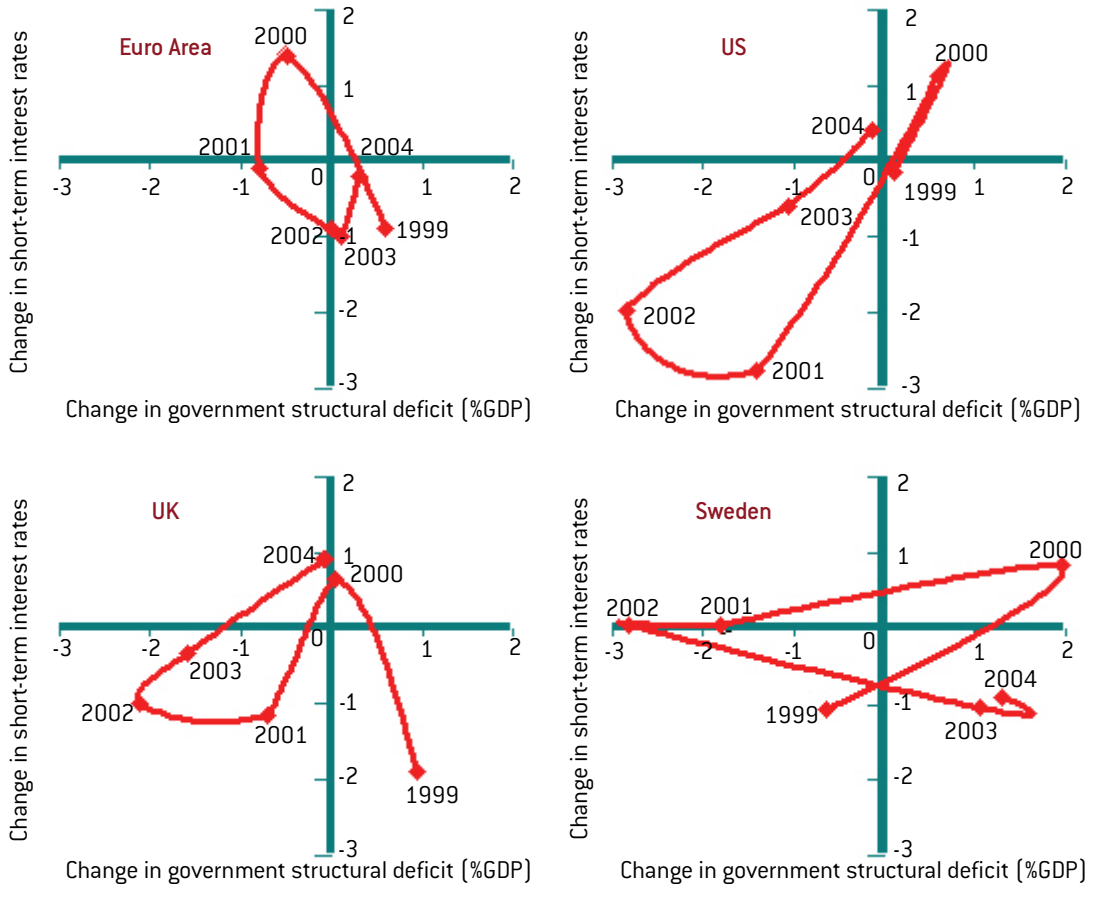
'The pro-cyclicality of fiscal policy is actually detrimental to growth.'

One can also show that if public debt growth in the EMU zone were to become as countercyclical as in the US, long-term growth in the eurozone could increase significantly, possibly by the order of magnitude of half a percentage point[11].

Moreover, it is the investment part of government spending that appears to drive this positive effect of budget countercyclicality. Budgetary policies are currently far less countercyclical in the EU than in the US even though the US is more financially developed than the EU. As shown in Figure 4 below, both the structural deficit and the real interest rates vary much less over time in the euro area than in the US. Our discussion suggests that the absence of an active (or reactive) macroeconomic policy in the euro area is, therefore, a potential source of the growth deficit in the region.

Fig. 4

A Distinctly Less Activist Policy Mix in the Euro Area



Source: OECD

[11] Aghion and Marinescu (2006).

3. CONCLUSIONS

Four main lessons can be drawn from this discussion as to how one could best stimulate innovation and growth in the EU area.

The **first** lesson is that innovation is a main engine of growth for countries with already high per capita GDP, but that one must go beyond the obvious recommendation of increasing state spending on, or subsidies to, R&D, and protecting intellectual property rights, and also consider indirect channels whereby innovation can be fostered.

The **second** lesson is that innovation-based growth requires complementary policies. We have emphasised here the necessary coherence between R&D and structural reforms and policies such as competition, higher education, labour market flexibility and financial market development. But the coherence must also be between structural and macroeconomic policies as they become more proactive over the business cycle. This coherence in policy design is lacking in Europe and this, more than particular failures here or there, is the main problem to address.

'Innovation-based growth requires a coherence that is lacking in Europe. This is the main problem to address.'

Third lesson: reforms entail winners and losers. For example, liberalising entry boosts innovation in sectors closer to the technological frontier but less so in sectors far below the frontier; this in turn points to the importance of complementary structural policies aimed at helping workers reallocate from lagging to more advanced sectors, and of policies aimed at compensating potential short-term losers from structural reforms. Failing to do so might result in further protracting the implementation of those reforms.

Fourth lesson: structural reforms need careful agenda-setting and prioritisation, based on a comparative cost-benefit analysis where the value of each reform would be measured by the ratio of its contribution to the overall growth potential of the country over the (social) cost of implementing the reform. This in turn would enable us to "rank" the reforms; that is, to get a more precise view as to what should be undertaken first, or as to which reforms should be implemented jointly because of complementarities in their growth impacts.

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