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WEAK COMPETITIVENESS OF EU R&D INTENSIVE INDUSTRIES – RESULT OF INSUFFICIENT INVESTMENT IN COMPLEMENTARY INTANGIBLE ASSETS?

BACKGROUND PAPER FOR
"THE COMPETITIVENESS OF EUROPEAN INDUSTRY:
1999 REPORT"

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1. Introduction

The present and future economic success of the EU depends strongly on the competitiveness of and structural change towards R&D intensive industries. However, it is already known that European R&D intensive industries characterised by relatively high technology inputs show a relatively weak economic performance (measured by high tech trade) in comparison to the USA (European Commission. Second Report on S&T Indicators 1997). Likewise, the Competitiveness Report 1998 (European Commission. The Competitiveness of European industry 1998) reveals the relatively weak performance of EU in industries with fast growing demand on the world market (measured by apparent consumption). These products are often technologically sophisticated.

The recent economic literature emphasises the role of all types of intangible investment - besides R&D investment - for economic performance. In particular, it has been noted that although the creation of new technology is a difficult process in itself, arguably even more difficult is the commercialisation of the innovation. Although a company may accelerate large stocks of valuable technological assets, if it does not have the complementary capacities to exploit those assets commercially, the result is poor economic performance (for example Teece 1998, Paasi 1997).

Based on this literature and on the empirical observations about competitive weaknesses in the EU, this paper considers whether the inadequate complementary investment related to the commercialisation of technological innovations can explain the relatively weak EU economic performance in high tech industries. However, it does not exclude the possibility that the level of R&D investment itself is too low in the EU, and that the problem may not lie exclusively in insufficient complementary investments.

2. Dynamics of high demand and high R&D intensive industries in the EU and USA

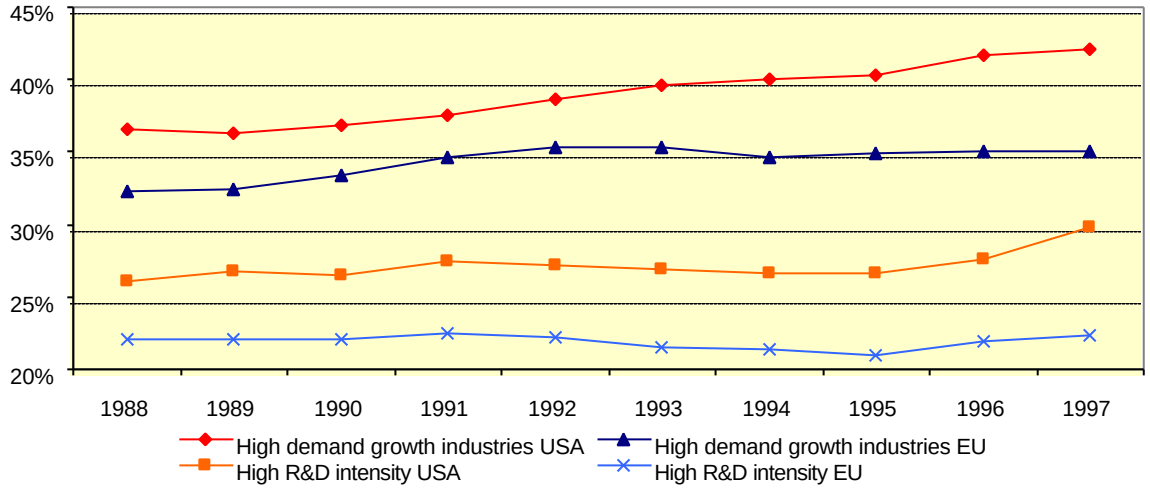
The most dynamic markets are usually characterised by products with high technological sophistication and high income elasticity. The competitiveness of such products is based on their qualitative features at competitive prices. The growth dynamics of a country is driven by the production of such products as they generate high labour productivity and income.

In the USA, the relative share of the industries with high growth of market demand[1] in the value added of total manufacturing industry is with 42.0% not only higher than that in the EU with 35.1% in 1997 (see Fig. 1). Moreover, the US share had also a clearly increasing trend in comparison to the EU where this share increases only weakly from 32.3% in 1988 to 35.1% in 1997. Alternatively, considering the strategically important R&D intensive industries, once more the USA has a significantly higher share in the value added of total US manufacturing industry with 29.8% in comparison to that of the EU (22.3%) in 1997. In particular, again the USA has been capable to increase the share of R&D intensive industries while their share remains stable in the EU (see Fig. 1). These empirical observations imply serious problems for the growth dynamics in the EU. That is, the EU does not only allocate its resources relatively

[1] Market demand is measured by apparent consumption (production plus imports minus exports) in the EU, the USA and Japan during the period 1988-97. The third of industries belonging to the group with highest demand growth are defined as high demand industries (see European Commission 1998).

less towards industries with high market growth and/or high technological sophistication but structural change towards these industries has been much weaker than in the USA.

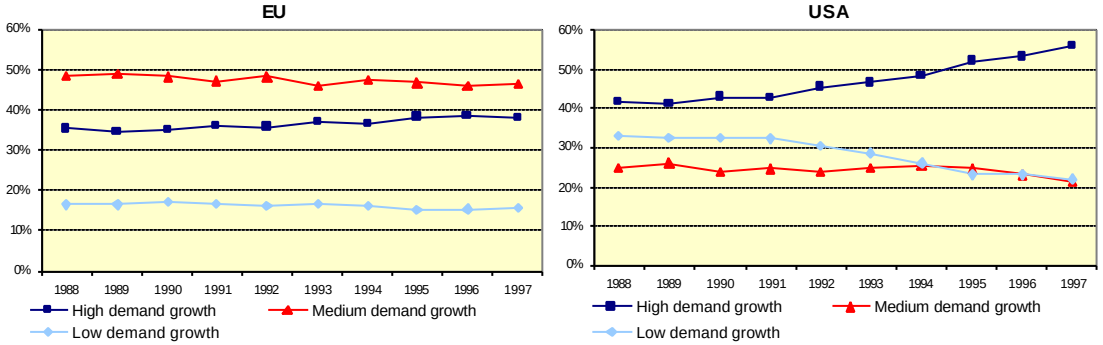
Fig. 1 - High demand growth and high R&D intensive industries in total manufacturing 1988-97, in %



Source: Eurostat. European Commission calculations. Classification of industries, see Appendix 1.

When the R&D intensive industries are analysed according to their market growth, the divergence between the EU and the USA becomes even more evident (see Fig. 2). In particular, in the USA the share of the high demand growth industries within the R&D intensive industries has not only the highest share but it has also increased strongly from 41.9% in 1988 to 56.3% in 1997. In contrast, in the EU, the medium demand growth industries have the highest share (48.5%) within the R&D intensive group. The R&D intensive, high demand growth industries come only second with a share of 35.2% in 1997. More positive for Europe is, however, that the share of industries with low demand growth is considerably lower (15.8%) than in the USA (22.2%) in 1997.

Fig. 2 - High, medium and low demand segments in R&D intensive industries 1988-97, in %



Source: Eurostat. European Commission calculations. Classification of industries, see Appendix 1.

Consequently, the European problem in the high R&D intensive industries does not only lie in the relatively low shares in high market growth segments, but also in the absence of structural change towards those in the period 1988-97. In contrast to the USA, where the share of high growth market segment is increasing strongly and that of low market segments is decreasing, these relative shares remain constant in Europe.

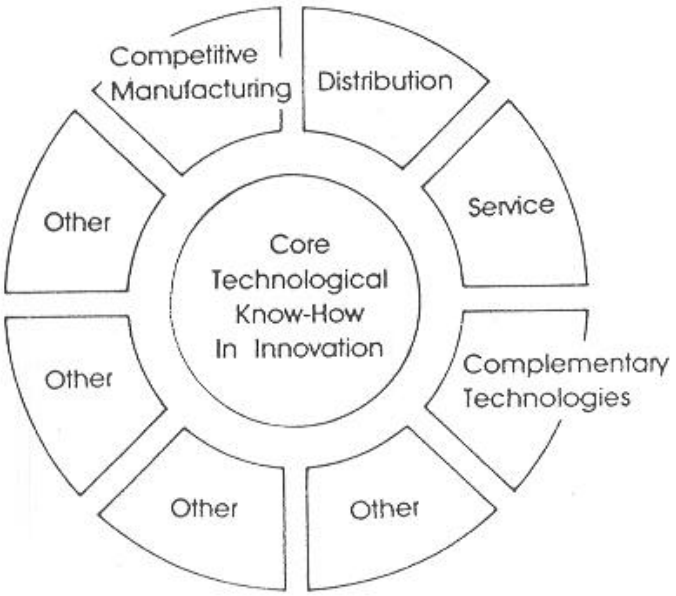
As the EU is relatively less specialised in the high demand and/or high R&D intensive industries (with high income elasticity of demand), it faces a relatively strong price competition from the low wage countries. This type of competitive pressure can be assumed to become even fiercer in the future. Furthermore, the sluggish structural changes within the R&D intensive industries have additional consequences for the EU economy. The relatively strong specialisation in the medium (and low) market demand segments of the R&D intensive industries implies lower interactive learning between producers and users, which slows down learning and market developments. Usually, the profits are lower in the low demand segments than in the high demand, product differentiated segments where the price margins can be set higher. These factors can affect the growth of the firms and, in the end, that of the economy. Therefore, a policy aimed to support the economic growth in Europe needs a correct understanding for the underlying reasons for these phenomena.

3. Competitive advantage in technologically sophisticated industries

3.1. Complementary assets to R&D

In technology intensive industries the competitiveness is based primarily on the R&D investments and - outputs. However, possessing superior technology is rarely enough to build up competitive advantage of a firm. Complementary assets are required for the commercialisation of innovation, i.e. when new products are introduced to the market (Teece 1998, p. 72). As a matter of fact, the competitive advantage of firms depends on the ownership of and capability to manage intangible assets additional to R&D such as skills, marketing, firm's organisation and entrepreneurial know-how embodied in the people (Dosi et al 1993, Teece/Pisano 1994, Teece 1998, Eliasson 1998). Yet, also "tangible" complementary assets to an innovation are necessary and comprise such factors as competitive manufacturing, distribution facilities and complementary technologies, along with many types of services (Teece 1986, p. 288). The relationship between an innovation and its complementary assets can be seen in Fig. 3.

Fig. 3 - Complementary assets needed to commercialise an innovation



Source: Teece 1986

Nowadays, - in the emerging knowledge based economy - the number and importance of intangible assets for economically successful innovations are drastically increasing. Therefore, Fig. 3 can be complemented by different types of intangible assets mentioned on page 4 (for example skills, firm's organisation and marketing) as well as ICT products and -services.[2]

When imitation is easy, it is of crucial importance to create the complementary assets for the commercialisation of the innovation. But even in strong appropriability regimes patents seldom provide perfect and permanent protection while their effectiveness depends on the respective industry. Therefore, the availability of tangible and intangible assets, as well as the business strategy of a firm with respect to complementary assets (decision to integrate and collaborate) are absolutely critical for the profitability of an innovation (Teece 1989, p. 290). The firms can either accumulate the intangible assets themselves or they can try to acquire them from other firms. However, as the intangible assets often imply tacit knowledge, they cannot be easily traded because there is no well-developed market for such firm-specific assets (Teece 1998, Dosi 1993 et al p. 515, Teece/Pisano 1994 p. 541).

The complementary assets with respect to an innovation can be categorised as generic, specialised and co-specialised assets (Teece 1986, p. 293ff). The generic assets are not bound to a specific innovation and they are available on the market. The specialised assets, on the other hand, have a unilateral relationship with the innovation and are accumulated inside the firm. Finally, the co-specialised assets have a bilateral dependence on the innovation as a firm gains access to the co-specialised assets by having a contract about their production with another firm. All but generic complementary assets involve irreversibilities (Teece 1986, p. 289).

[2] The present discussion on the concepts and empirical measurement of intangibles reveals the numerous types of intangibles in the modern economy (see for example Panorama 1997, European Commission 1998, Young 1998).

The control of specialised assets and the positive spillovers from an increasing demand for the innovation present positive incentives for their internalisation. The control over fixed supply (avoiding bottlenecks) is particularly important. In practice, however, an innovator may not have enough time to accumulate the specific assets related to an innovation. The choice of co-specialised assets has the benefit of avoiding certain investment costs, but this strategy is feasible only when these assets are available in competitive supply. This externalisation strategy has, however, the disadvantage that it is difficult to induce suppliers to afford expensive and irreversible investments whose reward depends on the (uncertain) success of the respective innovation (Teece 1986, p. 293-295). Nowadays, the utilisation and fast diffusion of information and communications technologies gives industries with the possibility to outsource many strategic activities and to organise their production in totally new ways. Consequently, a competitive business-service sector is emerging which provides the manufacturing industry more intensively by competitive and individually designed services (co-specialised assets) on a flexible basis.

3.2. Reasons for the inadequate structure of complementary assets

Consequently, a reason for weak economic performance in dynamic technologically sophisticated industries may be found in insufficient availability of complementary assets. However, it is not a priori clear what economic reasons might be responsible for the possibility of a mismatch in complementary investment to innovations ("wrong structure of intangible assets"). Generally, under-investment in intangibles can be explained by such factors as irreversibilities in investment of these assets or the (tacit, uncertain) characteristics of knowledge accumulation. Further, a mismatch often exists within the firms between the sets of organisational processes (Dosi 1993 et al p. 520) or the dynamic capabilities of a firm might be weak at that particular time. Simultaneously, firms might not easily acquire these complementary assets as their markets are imperfect (Teece 1998, p. 72).

Yet, these factors do not really explain why the structure of complementary assets should be inadequate in the sense that the level of complementary investment relatively to the technological investment is too low. As a matter of fact, R&D investment in a weak appropriability regime also has an under-investment problem. Therefore, one has to explain why investing in R&D is relatively easier than in "other" intangible investment. Obviously, the uncertainty about R&D success leads to a problem of timing in creating the complementary tangible and intangible assets. Although all these investments are complementary for the economic performance, it is the prospective success of particular R&D-projects which makes related complementary investment necessary and profitable. This represents a problem because especially in a weak appropriability regime, the investment in complementary assets must take place fast enough to prevent imitation by competitors and to create the markets for the innovation.

However, the accumulation of complementary assets can start once the success of R&D become apparent which can take a while. In particular, the accumulation is costly and bound with irreversibilities. In addition, there might be internal resource constraints for the accumulation of the assets and/or the imperfections in the factor markets such as finance, or internal constraints due to inertia. Substantial time-lags are therefore possible. Thus, even if the complementary investment is needed for the commercialisation of the innovation, it is the (expected) success of the R&D investment that stands at the beginning of the process. The complementary assets will be sequentially accumulated whereas their speed must be faster than the speed of imitation by competitors.

3.3. Types of firms and creation of complementary assets

Intangible assets are path-dependent which implies that, for example, the commercialisation activities of innovations themselves build up commercial competencies of firms (Dosi/Teece/Winter p. 195). This characteristic has consequences for the competitive position of new entrants in comparison to already established firms. On the one hand, new firms have to accumulate new competencies which requires time and resources, while existing firms already own some specific intangible assets likely to provide a competitive advantage. However, in a fast changing environment, existing assets can easily become obsolete. When technical change is fast, even large firms may face financial problems as new competitive assets must be built to bring the advanced products fast and cost effectively to the market (Teece 1986, p. 295). However, large firms may have an additional disadvantage with respect to fast changes. Their existing assets may prevent changes as they present sunk costs. Therefore, even if the new entrants must accumulate new competencies, they might still overtake existing firms locked into "old" competencies. This is more likely, the more favourable are the conditions not only for innovative start-ups but also for the development of the business related service sector whose main function is to supply firm-specific co-specialised assets to the innovating enterprises.

In a globalised, knowledge-based economy additional sources for acquiring competitive advantages based on intangible assets emerge. As the mobility of capital has increased, foreign firms and FDI from a best-practice country may improve competitive advantages diffusing the right and best complementary assets to an innovation.

4. Intangible investments and relative competitiveness of the EU vis-à-vis the USA: A regression model

Hypothesis

It is argued that the competitive advantage of high demand growth, high technology industries is not only based on the R&D expenditure but also on various types of (complementary) tangible and intangible investments. This means that both the level and structure of these investments matter. In particular, the better economic performances of the high demand growth, high tech industries in the USA in comparison to the EU is expected to result from differences in tangible and intangible investments, whereby the commercialisation efforts of the innovative firms are of special interest. The contribution of research investments to the economic performance in the R&D intensive industries is expected to be high. According to the underlying theory the innovation potentials (R&D results) induce complementary tangible and intangible investments such as skills, capital goods and advertising and determine their profitability. However, one may expect that the utilisation efforts of an innovation depend also on the (expected) demand for that innovation. Therefore, the contributions of various investment types to competitiveness are expected to differ across the high and lower (medium and low) demand growth R&D intensive industries.

Model

It is assumed that the labour productivity differences between the EU and USA depend on the various investment types in the USA. The parameters tell us on which investment types the relative competitive position of the USA vis-à-vis the EU is based. We assume a multiplicative function between the EU/USA labour productivity (Y) the investment intensities for real capital (K), R&D expenditure (R), advertising (A) and skills (S) across industries, Z is a constant. Industry is denoted by k, thus:

$$Y_k = Z\, K_k^{\alpha}\, R_k^{\beta}\, A_k^{\gamma}\, S_k^{\varphi} \quad (1)$$

For the empirical testing of this relationship, the function is made linear by taking logarithms. As we are using investment intensities as explanatory variables, the coefficients will be interpreted as percentage changes of the labour productivity ratio due to an increase of the respective investment intensities by one percentage point. Demand dummies are introduced to capture the expected differences of demand across industries. The OLS-method is applied using White-heteroskedastic variance-covariance matrix.

Data

Labour productivity in industry k is an average of the ratio of value added in ECU to the number of employed persons over the period 1993-1997. Productivity differences are measured by the EU/USA ratio of average labour productivity across industries (Y_k). The investment intensities in real capital, research and advertising are taken from the WIFO typology for industries (for data sources and methodology see Peneder 1999a a,d 1999b). The investment ratio is measured by the ratio of the real investment to value added in 1990 – 1994, the R&D intensity by the average ratio of R&D expenditure to sales in 1993 – 1995 and the advertising intensity by the average ratio of advertising outlays to sales in 1993 – 1995. The skill intensity is measured by the number of white collar skilled persons to total employment for the USA in 1994. The data on these investment variables limits the specification of the model. For example, the data brings about lags between the labour productivity gap and the various investments but which do not correspond to theoretical considerations.

The equation (1) is estimated across 41 industries noted by k (k=1,..,41) which comprises industries with high demand growth and/or high R&D intensity. The industries with highest demand growth (1988 – 1997) are identified by the growth of apparent consumption in the EU, USA and Japan (upper 30% of the industries, see Appendix 1 and European Commission 1998). The R&D intensive industries are identified by the WIFO typology (see appendix 1). The differences in demand regimes are captured by introducing dummies for high and lower (medium and low) demand growth, R&D intensive industries.

Regression results

The model (1) is taken in logarithms and tested in two forms, which differ according to the demand regime dummies for high and lower (medium and slow) demand growth, R&D intensive industries. As in this period, the labour productivity is always higher in the USA than in the EU, the value of the labour productivity ratio is less than one. Therefore, the relationship between the productivity ratio and the various types of investment intensities in the USA is

expected to be negative. Model 1 identifies which types of investment contribute most to the competitiveness lag of the EU in comparison to the USA in the high growth of demand, non-R&D intensive industries and in R&D intensive industries. In particular, in high demand growth, non-R&D intensive industries the competitive lag is mainly explained by the US marketing efforts, as proxied by advertising expenditure. For example, when the advertising intensity in the USA increases by one percentage, the EU's productivity relative to the USA deteriorates by 0.21%. The same is in weaker extent true for the US investment in skills while research intensity is insignificant. This result implies that the US relative performance in the competitive race is mainly based on its relatively stronger and/or more efficient marketing efforts and skills in high growth of demand, non-R&D intensive industries.

Table 1 - Estimation results of the EU/USA labour productivity relation

	Specification 1			Specification 2	
	Coefficients	t value		Coefficients	t value
Constant	0.443	1.2	Constant	-	-
Capital	- 0.132	- 1.1	Capital	-	-
Research	0.023	0.3	Research	-	-
Advertising	- 0.210	- 1.9	Advertising	- 0.173	- 1.9
Skills	- 0.178	- 1.8	Skills	- 0.113	- 3.8
Dummies			Dummies		
Constant*RD	- 1.560	- 2.0	Constant*RHI	- 2.106	- 5.3
Capital*RD	0.038	0.1	Capital*RHI	0.059	0.9
Research*RD	0.133	0.6	Research*RHI	0.244	12.6
Advertising*RD	0.006	0.0	Advertising*RHI	- 0.238	- 2.6
Skills*RD	0.309	1.6	Skills*RHI	0.375	4.7
			Constant*RML	- 4.677	- 3.8
			Capital*RML	0.519	1.9
			Research*RML	0.208	0.6
			Advertising*RML	- 0.177	- 0.9
			Skills*RML	1.012	4.2
Adj R^2	0.28		Adj R^2	0.49	

Source: Data from Peneder 1999a. European Commission calculations. White-heteroskedastic variance-covariance matrix is applied. Dummy variables measure the difference of coefficients in comparison to the reference group. Dummies: RD=R&D intensive industries; RHI=R&D intensive industries with highest demand growth, RME=R&D intensive industries with medium and low demand growth. In model 2: insignificant variables in model 1 are not included.

The model 1 tests further whether the contribution of various investments differs between the R&D intensive industries and the high demand growth, non-R&D intensive industries. Surprisingly, none of the investment variables in R&D intensive industries are significant, i.e. the contributions of investments to the relative competitiveness in the US R&D intensive industries do not differ from those in the high growth non-R&D intensive industries. In particular, not even research effort in the USA does contribute to its relative competitiveness in the R&D intensive industries. Indeed, the only significant coefficient is the constant implying that the USA has generally a much higher technological efficiency level in R&D intensive industries which explains a large part of its relative competitiveness vis-à-vis the EU. The higher technological efficiency in the USA is a result of various factors such as more favourable institutional set-up or more innovative business service sector delivering co-specialised assets.[3]

[3] Unfortunately, it is not possible to introduce a trend variable in model 1 because the data is based on averages across periods.

These unexpected results for the R&D intensive industries, however, change when the differences in their demand dynamics are considered. Model 2 splits them into high and lower (medium and low) demand growth, R&D intensive industries. This reflects the idea that innovations do not only induce complementary investments but their strength depends on the (expected) demand for this innovation as well. Now important differences across R&D intensive industries become apparent. Particularly, the relative competitiveness of the USA in the high demand segments of R&D intensive industries is strongly based on its marketing efforts (0.411) which are considerably higher than in the high demand, non-R&D intensive industries. These results confirm the idea that innovations need to be accompanied by complementary commercialisation efforts in order to be commercially successful. Surprisingly, in the lower demand segments the US research, skill and capital intensities seem to have a negative effect on the relative competitive position of the USA vis-à-vis the EU. Again, the constant is very important for the USA competitive position both in the high and lower demand growth, R&D intensive industries.

It appears that the relative EU competitiveness lags most noticeably in those industries having high demand dynamics and in which the US advertising intensity has the highest impact on the productivity gap. Obviously, the commercialisation strategies (in particular the role of advertising) are successful in high demand growth industries – both non-R&D intensive and R&D intensive. Consequently, these industries also increase their shares in the total US manufacturing (see Figs 1 and 2). In contrast, the relative shares of the lower demand industry group in R&D intensive industries is declining in 1988-97 and both intangible and tangible investment intensities have a negative influence on the competitive position of the USA. However, in the EU the relative shares of the R&D intensive industries and the industries according to their demand regime in total manufacturing and R&D intensive industries are almost unaffected, no matter whether the EU has a disadvantage or a relative advantage vis-à-vis the USA (see Figs 1 and 2). Apparently, the European problem is not only that the resources are allocated to R&D intensive industries lacking dynamics in demand while the USA continuously allocates its resources towards high demand segments. An even more serious problem seems to be the lack of change and flexibility within the European manufacturing industries and especially in the R&D intensive ones.

5. Identifying possible reasons behind the productivity gap

The structural problems in the EU industry might be connected with problems in creating and managing complementary assets, especially with those connected directly with commercialisation. However, a more robust conclusion would require more data at industry level in order to compare the levels of advertising intensities between the EU and USA, and to find out whether the European problem lies in insufficient level or inefficient management of commercialisation efforts.

Another aspect related to the commercialisation intention of EU firms is that in the EU the number of patents is much lower in comparison to the USA. In 1995, in eight of these R&D intensive industries the number of patents granted in the USA (USPTO) amounted to 32.599 in the USA and only to 9.288 in the EU. This result matches with the generally lower patent intensity in the EU (Eaton et al 1998). The lower number of patents in the EU can be a result of higher costs and more complicated regulations for patenting in Europe, but more importantly patenting behaviour also reflects the identification of the potential commercial value of an invention. Obviously, in the EU both the propensity to patent and the investment in

complementary commercial assets are relatively weak in comparison to the USA. This results in low efficiency of R&D inputs to generate economic performance.

What economic reasons could explain these findings about complementary intangibles and tangibles, especially about marketing activities? As already pointed out (see section 3.3) the type (size and age) of a firm also determines the conditions for creating strategic assets. Therefore, the distribution of firm types in an industry can inform about eventually underlying structural problems in the accumulation of intangible assets. If small new-starters dominate an industry, the critical intangible assets must be accumulated initially. Consequently, business environment and the specific conditions on factor markets are important determinants for the investment decisions. If, alternatively, large, already established firms dominate the industry, the problems rather lie in the difficulty of changing fast enough which can be either to sunk costs of existing assets or to organisational inertia within the firms. In order to gain first information about the reasons underlying the competitive weaknesses of the EU, the relative shares of firms by size are examined in Table 2.

Table 2 - Relative shares of firms by size in total number of firms, 1994

	Without employee	From 1 - 9 employees	From 10 - 49 employees	From 50 - 249 employees	250 or more employees
High growth of demand, non-R&D intensive industries	0.2951	0.5429	0.1300	0.0261	0.0059
R&D intensive industries	0.3184	0.4694	0.1383	0.0512	0.0227
- High growth of demand	0.3498	0.4849	0.1038	0.0422	0.0193
- Medium growth of demand	0.2987	0.3775	0.2008	0.0819	0.0411
- Low growth of demand	0.2514	0.4922	0.1840	0.0534	0.0190

Source: Eurostat. SBS-statistics. Selection of European countries only (Belgium, France, Denmark, Portugal and Finland).

The most interesting findings arise in looking at firm size in high R&D intensive industries of selected European countries in 1994, when demand dynamics is considered. In particular, the high demand R&D intensive firms are clearly more concentrated in very small firms (35.0% are firms without employees and 48.4% firms with 1-9 employees) than the medium and low growth R&D intensive industries (30.0% and 25.1% as well as 37.8% and 49.2% respectively). Obviously, the small technology oriented firms in selected European countries utilise the economic opportunities in industries with high international demand very intensively. This result indicates that in these selected European countries technology based small firms – which are also likely to be relatively new - do enter primarily into the high growth segments of R&D intensive industries. This indicates that risk capital is available, at least for a considerable share of firms.

It is after entering the high demand, R&D intensive industry that more serious problems seem to arise. This is when complementary commercialisation assets ought to be accumulated. The problem may thus lie in the conditions for finding adequate supply of co-specialised assets or finance for internal accumulation of these investments. This would explain why dynamics of this industry group is slower and the share of high demand growth R&D intensive industries stays constant in Europe while it is constantly increasing in the USA (see Figs 1 and 2).

In contrast, medium (firms with 10 to 49 employees) and large size firms are relatively more important in the medium and low demand, R&D intensive industries (20.1% and 18.4%

respectively). Yet, even though the EU should have a better competitive position vis-à-vis the USA in this group of industries, the shares of these industries in total EU manufacturing are still not increasing (see Fig. 2). Obviously some third countries are gaining market shares as the USA is declining its share in these industries. As the share of larger firms is considerably higher in these industries in the EU, the possibilities of lock-in in existing assets and inertia may explain the lack of structural change within the R&D intensive industries.

Strategic intangible assets need not to be created only domestically. They can also be imported from best practice origin, often assumed to be the USA. The strong presence of US firms in the EU and acquisition of US firms by European firms are not only important for the diffusion of technology, but for that of management, commercialisation strategies and organisational innovations. Therefore, stocks of USA capital in the EU and of EU capital in the USA are analysed in the selected industries in order to identify their relative importance. A very low stock is likely to present a further reason for the weak economic performance in comparison to the USA.

At the end of 1996 the FDI stock in the EU total manufacturing amounted to 433.851 Mio ECU, out of which US FDI in the EU covered 25.8% and from within the EU 45.0%. Data for industries considered in this study is available only for total office machinery & radio industry (NACE 300 and 322) which comprises 8.0% of the total manufacturing FDI stock. In this industry the share of the USA came to 21.1% and that of the EU to 45.4% (Eurostat, 1998). These figures indicate that, on the one hand, the USA invests less in the high tech industries than on average in total EU manufacturing. On the other hand, even if the US share is not particularly low, the most FDI stocks come from other EU countries that do not necessarily present best practices for technological and other complementary assets.

6. Policy conclusions

The empirical results suggest that the EU labour productivity lags most behind in the high demand industries - both non-R&D and R&D intensive - where the advertising intensity is most pronounced in the USA. Another – probably related - problem is the lack of structural dynamics in the European high tech industries in comparison to those in the USA. The EU competitive position is weakened by its insufficient presence in the high growth segments of R&D intensive industries, with a large part of the European resources bound in R&D intensive industries with low growth dynamics.

Further empirical analysis about the types of firms (only in selected European countries) points to two problems behind the weak structural change and competitiveness. On the one hand, this study found out that the small firms play an important role in the high demand R&D intensive industries in the EU. Whilst this might suggest that entry seems not to be difficult and no serious problems with risk capital exist, the competitive weakness of the EU vis-à-vis the USA rather seem to lie in the insufficient supply or financial resources for accumulating complementary commercial intangible assets. On the other hand, the lower demand R&D intensive sectors possess a relative high share of medium and large enterprises which are not expected to suffer from weak internal resources. However, the problem does not lie in the accumulation of intangible assets but that these enterprises did not move towards high demand segments where the profits are expected to be the highest.

The non-growing small firms and non-changing large firms explain together the weak structural change in the R&D intensive industries of the EU (please note that data is available

only in selected European countries). Therefore, the existing European policy programmes for technology based start-ups should consider additionally the conditions for the accumulation of the assets complementary to innovations after establishment of the firms. Additionally, besides supporting the level of industrial R&D investment, technology policy should devote more attention to measures supporting structural changes within the R&D intensive industries and in large firms. Finally, as the level of technological efficiency is an important source of the relative USA competitiveness vis-à-vis the EU, the economic policy should focus on reforming the institutional set-up for innovations and supporting the emerging business related services.

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Appendix 1

High growth in apparent consumption	NACE
Fish and fish products	152
Fruits and vegetables	153
Other food products	158
Made-up textile articles	174
Builders' carpentry and joinery	203
Wooden containers	204
Articles of paper and paperboard	212
Printing	222
Pesticides, other agrochemical products	242
Pharmaceuticals	244
Detergents, cleaning and polishing, perfumes	245
Plastic products	252
Cutting, shaping, finishing of stone	267
Structural metal products	281
Tanks, reservoirs, central heating radiators and boilers	282
Forging, pressing, stamping and roll forming of metal	284
Treatment and coating of metals	285
Machinery for production, use of mech. power	291
Domestic appliances n. e. c.	297
Office machinery and computers	300
Electric motors, generators and transformers	311
Accumulators, primary cells and primary batteries	314
Lighting equipment and electric lamps	315
Electrical equipment n. e. c.	316
Electronic valves and tubes, other electronic comp.	321
TV, and radio transmitters, apparatus for line telephony	322
Medical equipment	331
Bodies for motor vehicles, trailers	342
Parts and accessories for motor vehicles	343
Railway locomotives and rolling stock	352
Motorcycles and bicycles	354
Other transport equipment n. e. c.	355
Sports goods	364

Source: European Commission 1998, WIFO calculations.

Research intensive industries	NACE
Pesticides, other agrochemical products	242
Pharmaceuticals	244
Other chemical products	246
Office machinery and computers	300
Electricity distribution and control apparatus	312
Electronic valves and tubes, other electronic comp.	321
TV, and radio transmitters, apparatus for line telephony	322
TV, radio and recording apparatus	323
Medical equipment	331
Instruments for measuring, checking, testing, navigating	332
Industrial process control equipment	333
Optical instruments and photographic equipment	334
Motor vehicles	341
Aircraft and spacecraft	353

Source: Peneder 1999b