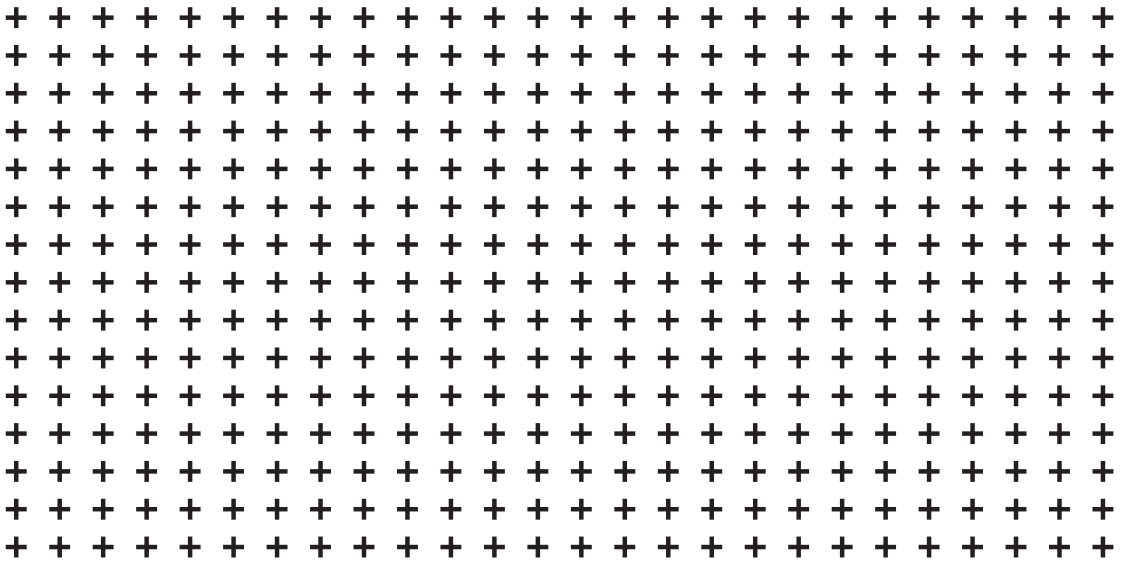

Reports of the Public-Private Sector Research Center 2

Competitiveness in Catalonia. *Selected Topics*

Pankaj Ghemawat and Xavier Vives

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Foment del Treball Nacional

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Public-Private Sector Research Center

Competitiveness in Catalonia
Selected topics

Pankaj Ghemawat and Xavier Vives,
Public-Private Sector Research Center
IESE Business School

July 2009

SUMMARY

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Foreword

This report is the second in the series of reports of the Public-Private Sector Research Center of IESE Business School which plans to review issues at the interface of public and private economic policy with particular emphasis on regulation. The series of Reports intends to contribute to the debate between practitioners, policy-makers and academics on economic regulation matters.

The aim of this report is to provide a perspective on key selected topics relevant to assess Competitiveness in Catalonia. The report goes in depth to study the factors behind the poor productivity performance of the Catalan economy and public and private policies to improve it. It should be of interest beyond the experience in Catalonia given that this region faces typical problems of an industrial area facing global competition in the crisis context.

This report is the outcome of a collective effort and has been written by Pankaj Ghemawat and Xavier Vives summarizing the contributions of a group of researchers detailed in the Introduction.

The report arises out of an initiative of Foment del Treball Nacional and its Chairman Joan Rosell to whom we are very grateful for his support.

Jordi Ollé and Salvador Estapé made a significant contribution to the processing of the manuscript and the production of the report.

Xavier Vives
Academic Director
Public-Private Sector Research Center
IESE Business School

Public–Private Sector Research Center – IESE Business School

The Public-Private Sector Research Center was established in 2001. Its mission is to strengthen cooperation between the private and public administration through research and education. The Center's main objectives are to promote high quality scientific research on the business sector and public administration and consolidate a group of international research excellence in the fields of regulation and competition, innovation, and regional economics and industrial policy.

The sponsors of the Center are: Accenture, Ajuntament de Barcelona, Caixa Manresa, Cambra Oficial de Comerç, Indústria i Navegació de Barcelona, Consell de l'Audiovisual de Catalunya, Departament d'Economia i Finances and Departament d'Innovació, Universitats i Empresa de la Generalitat de Catalunya, Diputació de Barcelona, Endesa, Fundació Agbar, Garrigues, Mediapro, Microsoft, sanofi-aventis and VidaCaixa.

Foment del Treball Nacional

Founded on 1771, the Catalan business association integrates most associations of territorial and sector in Catalonia, as well as large companies and SMEs, as well as working closely with professional institutions, chambers of commerce and other institutions or entities connected with the business.

The main purposes of Foment are: to safeguard the interests of the business community of Catalonia, contributing to economic and social development, helping businesses to develop policies and services in coordination with its partners, representing the productive sectors, territories and large companies and SMEs with government and public institutions, economic organizations, political, union and social from Catalonia, Spain and also international institutions. It also promotes and coordinates the activities of partner organizations, as well as establishing collaborative frameworks with other entities or business organizations for the benefit of enterprises.

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Executive summary

Catalonia is ending an extraordinary period of growth since 1996 which has been based on low interest rates, a large immigration inflow, wage moderation, and very substantial employment creation. This pattern of growth has been sustained with an important contribution from the construction and real estate sectors (as well as tourism) and not with increases in productivity. This model is not sustainable and even when the present crisis is overcome it will not come back. At the same time Catalonia has maintained a core of medium sized firms which are very dynamic in exporting (mostly in medium technology sectors). This has contributed to a diversified industrial base which together with a high quality of life provides two key assets for the future.

Catalonia is competing with other advanced regions of the world, in order to do so effectively it needs to have a first class infrastructure, skilled human capital and a vibrant competitive environment. Productivity, human capital, renovation and innovation, and internationalization are the name of the game. The exit from the present crisis will need a changed pattern of growth. The industrial landscape of Catalonia after the crisis will have to look quite different from the current one.

Globalization has posed many questions that now, in a crisis context, are becoming urgent. The increase in competition that the globalization process has fostered, coupled with the crisis, puts on the line several key sectors of the Catalan economy. The crisis will add tremendous pressure to cut costs. Will the automotive sector follow the same odds as the textile sector? Or we need to go back to sector specific industrial policies to save declining sectors?

Certainly, the industrial sector is crucial for a country like Catalonia and this not only because of tradition. First, industry is the engine of productivity growth with manufacturing firms being very active in R&D and innovation activities. This is so, among other thing because of the intense competitive pressure that the sector is subject to after the lowering of trade barriers with European integration and world competition. Second, productivity improvements in industry have important external effects in technology adoption in the rest of the economy and lower prices of inputs. Finally, industry has direct important forward and backward links with the rest of the sectors in the Catalan economy.

The report summarizes the findings of an extensive research on some *selected* key issues related to the competitiveness of Catalonia performed by experts in the different fields. It starts with a review of recent macroeconomic performance and assessment of some competitive endowments of Catalonia prepared with a contribution of Joaquín Trigo and material gathered by Jordi Ollé under supervision of Vives. We move on then to analyze performance and prospects in three key areas: secondary education (Antonio Ciccone and Walter García-Fontes), the links between productivity, innovation, trade and competitiveness (with contributions from Jordi Jaumandreu, Bruno Cassiman and Elena Golovko, and Pankaj Ghemawat, Carlos Llano and Francisco Requena), and the relations between the science and innovation system and business (Bruno Cassiman and Jordi Mas). In so doing we draw the lessons from the analysis of a low tech sector (food and drink), a medium tech sector (automotive)-with work in both by Ghemawat, and a high tech sector (biotechnology, with work by Núria Mas). Finally, we analyze company strategy (Ramon Casadesús-Masanell and Joan Enric Ricart). We end by setting an agenda for action.

Findings

Macroeconomic performance and endowments

Catalonia has been immersed in the globalization process driven by technological change, liberalization, and market integration. The application of information technology has transformed production and trade of goods and services. The end result is a decrease in the trade and transport costs of goods, capital, people and, indeed, information. Several consequences have followed: market enlargement, increase in competition and the irruption of emergent economics like the BRICs (Brazil, Russia, India and China). The process has forced a capital reallocation and corporate restructuring. This has included several waves of mergers and acquisitions. How have Catalonia (and Spain) fared in the globalization process?

The macroeconomic performance of Spain and Catalonia has been conditioned by two major events after the industrial crisis suffered in the late 1970s and early 1980s. The first is the integration in the European Community in 1986 and the second the adoption of the euro in 1999. The effects and these events have been intertwined with the impact of globalization in the world economy.

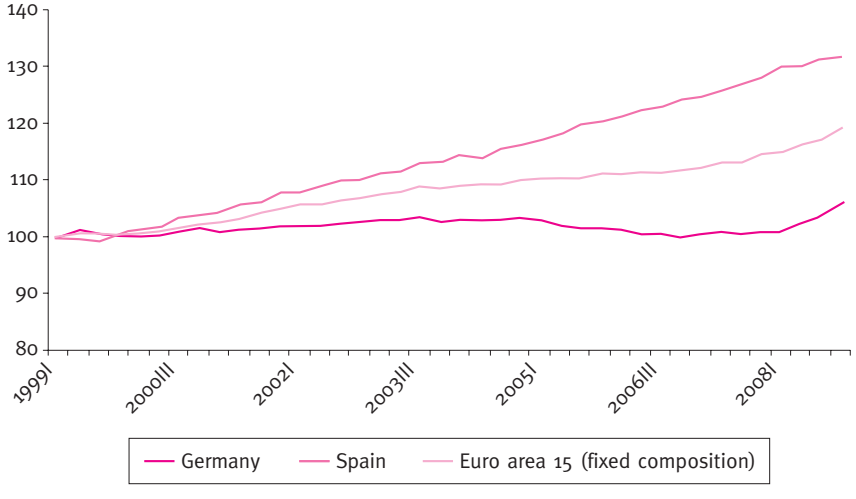
The joining by Spain of the common market in 1986 opens the economy and makes both imports and exports increase (in particular with the EU), strengthens the tendency for the industrial sector to decrease its weight in terms of value added and employment and of services to increase it, and increases considerably the flows of foreign direct investment and, more recently, of direct investment abroad.

Spain has caught up with the EU (since 1996 it has grown consistently above the mean of EU-15, Spanish real growth rate being at least 0.7 points higher than EU-15 until 2007). In this period

growth has been driven by a strong increase in internal demand accompanied by intense job creation, wage moderation, and fuelled by low and decreasing interest rates and a marked increase in immigrations flows. The result has been a stagnation of productivity. The catching up process has not been smooth, with a crisis post 1992 which was dealt with competitive devaluations between 1992 and 1994. Income per capita (PPS corrected) goes from about 80% of EU-15 in the mid nineties to more than 90% in 2007.

Since joining the euro competitive devaluations are no longer possible and this may be problematic since the weight of Spain in the formulation of monetary policy for the euro area is small. This has implied that interest rates have been very low, even negative in real terms (in the period 2002-2005), and have contributed to a huge boom in construction and real estate accompanied with the expansion of financial intermediation. Labor force for this construction boom has been found mostly abroad with a very important increase in immigration (foreign population was 2.8% of the total in 1999 while 15% in 2008). By 2007 the weight of construction in employment was 13%, compared with a mean of around 8% in the EU. In total 4.850.100 jobs have been created in the period 2000-2007 in Spain (representing a staggering 31% of EU-15 new employment). Employment has grown an average of 3.5% in 2000-2007 (1.2% in the EU-15). Spain has had a consistent inflation differential with the EU, up to the recent recession, and recently it has been about 1% point, and in the past years Spain has lost competitiveness as measured by the evolution of unit labor costs (with respect to Germany for close to 30% since 1999).

Unit Labor Costs Index Growth

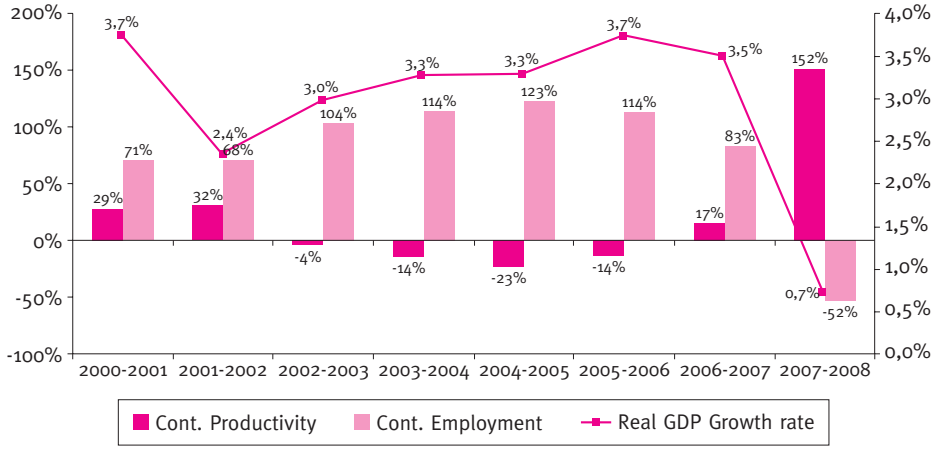


Index: 1999I = 100. Seasonally adjusted (ECB).

Catalonia has had a positive growth trend and has indeed caught up with Europe. In GDP per capita (PPS corrected) it has gone from the level of 96.3% of the Euro Area (111.6% of UE-27) in 1995 to 111.7% (122.6%) in 2007. In 2005 Catalonia in the EU-15 would have a GDP per capita (PPS corrected) between the 6th country position (Sweden) and the 7th (Belgium) while Spain would be 13th just below Italy. GDP per worker (in PPS) in relation to EU-25 (= 100) has gone from 112 in 1995 to about 105 in 2005 (in Spain it goes from 104 to 97). This is below the EU-15 level which is 106.5 in 2005. If the reference is EU-15 Catalonia has gone from being above at 102 in 1995 to being below at 98 in 2005 while Spain has gone from 95 to 91,4.

As in Spain, recent growth per capita in Catalonia has been driven by internal demand, and due to job creation (employment over population) and not productivity increases.

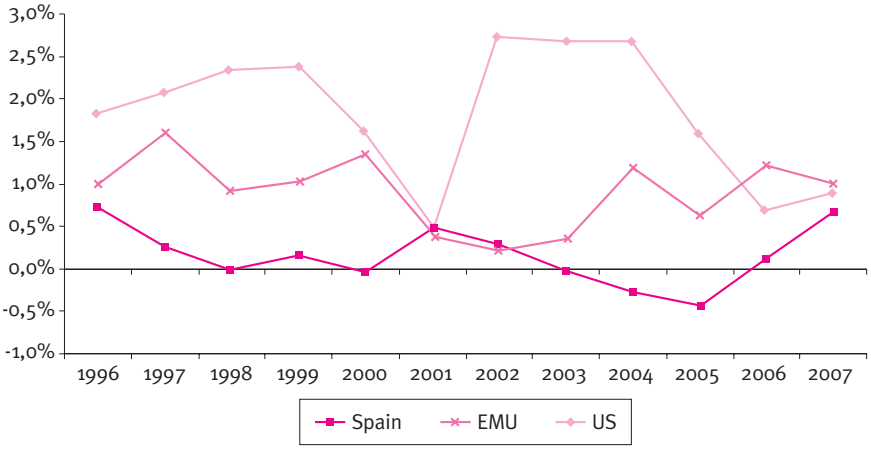
Real GDP growth in Catalonia (right scale) and contribution of employment and productivity to it (left scale) 2000-2008



It is worth noting that the negative contribution of productivity of 2003-2006 is reversed in 2007 and, dramatically so, in 2008. The reason is that job destruction has been much more marked that the output fall.

The performance of productivity in Spain (and Catalonia) has been weak not only in relation to the US but also to the EMU area.

Labor productivity annual growth rates



Bank of Spain, AMECO.

Catalonia maintained in the mid 1990's a small advantage on the EU-15 average level of productivity (GDP per person employed). This advantage has been lost and by 2005 its productivity has fallen below the EU-15 level (although it is still above the EU-25 level). With regard to *total factor productivity*, from the 1990s Catalonia has had lower TFP growth than the Spanish average (with negative growth in 1996-2000 while Spain had barely positive growth).

In summary, increases in employment explain increase in GDP per capita and not increases in productivity, which are now between the lower EU-25 level and higher EU-15 level. This creation of employment has been accompanied by an important demographic dynamism with big increases in population due to immigration. Unemployment has remained relatively high even in the boom period.

Catalonia is an industrial region typically more diversified than other industrial regions of reference in Europe. The tendency has been for the weight of industry to decrease overtime (for example, in 2000 it represented 25.8% of Gross Value Added (GVA) while in 2008 this is down to 19.2%). It is interesting to note that the weight of the public sector in GVA at 17,4% is below Spain (21%). The size distribution of Catalan firms is biased towards SMEs, family-owned firms and industrial firms. It is worth noting that the percentage of firms with less than 20 workers is just above 97% (the figure for Spain is similar).

The *endowments* behind the economic performance of Spain and Catalonia are natural (geography and climate), and capital (infrastructure, productive, technological, human, and social). To this we have to add the legal and regulatory environment.

Catalonia has lagged behind in *public infrastructure* (non-toll roads, water, train, airports, ports...) since 1975, with a per capita public infrastructure endowment from the 1990s which oscillates around 90% of the average Spanish region. Catalonia has received systematically public investment below its weight in Spanish GDP (at 18.7% in 2007). On average between 1991 and 2004 Catalonia has had about 19% of Spanish GDP, 15.5% of the population but 12% of public infrastructure investment. For example, since 2000 Catalonia has received between 11% and 16% of the total centrally regionally allocated public investment. Furthermore, in the period 1997-2007 only 66% of the budgeted investment was executed.

With respect to the level of education of the Catalan economically active population in 2007, 43% had studies up to secondary education, 25.7% up to high school and vocational training, and 31.2% University education. The corresponding percentages for 2000 were, respectively, 49.8%, 22.4% and 27.8%. This is not far from the corresponding percentages for Spain in 2007 of 44.6%, 23.6% and 31.8%, respectively. The level of education in relation to the EU-27 is low and with a low proportion of high school and vocational training (25.7% in Catalonia versus 49.2% in EU-27) but, somewhat surprisingly, Catalonia and Spain show a higher proportion of University studies (31.2% in Catalonia versus 25.2% in EU-27). It must be added that Spain has a relatively low rate of students who are in vocational training in a higher secondary education framework in the OECD, and is last in the percentage of alternation between vocational training and general education (for 2006, 2.2% versus, for example, 44.2% in Germany or 11.6% in France). In Spain, and Catalonia, professional training has not been emphasized and lacks social consideration and integration with the general education system. The result is a stagnation or even decline in the number vocational training students. This education composition of the population looks potentially dysfunctional for an industrial region like Catalonia.

The University system has improved in its research capabilities (we will see this in chapter 6) but it shows a poor performance in terms of high rates of students quitting—between 30 and 50% depending on the field—and the average years required to finish (6.3 years for a 4-5-year degree). The causes of this state of affairs, according to experts, have to be found in the burocratization of the system and the lack of autonomy and problems in the governance and financing of Universities.

In relation to *technological capital*, R&D spending as part of GDP has an increasing tendency, at 1.48% in 2007 (1.04% in 2001), above the Spanish average at 1.27% but below EU-15 at 1.91%. The private sector accounts in 2007 for 63% of R&D total spending (68.4% in 2000), an equivalent participation as in the EU-15 at around 65%. Patents per capita are far from the EU-15 level (especially on information and communications technology—ICT—and high-tech), however, the use of ICT is converging to the European level. Scientific citations are still far from EU-15 level (although scientific production per million inhabitants at 387 is not so far from OECD average at 468 in 2005). In the European Re-

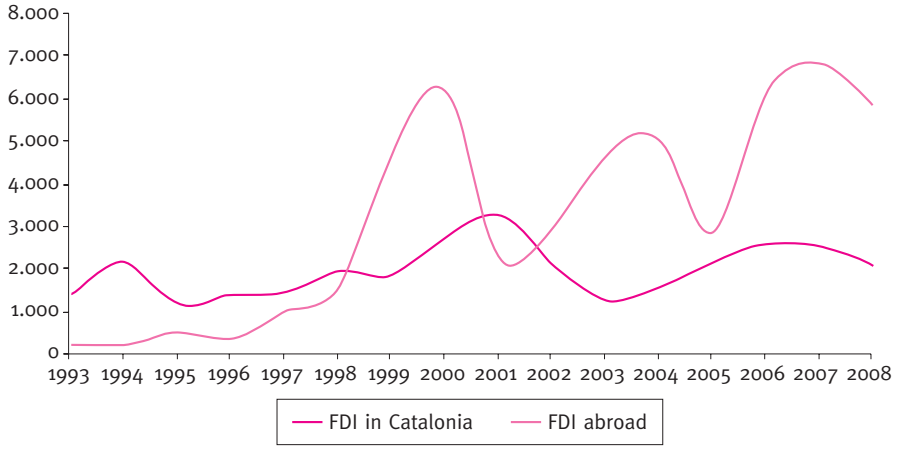
gional Innovation Scoreboard of 2006 Catalonia is in the position 82/208 (while, for example, Madrid is 31/208).

In terms of the *burden that economic regulation and public administration impose on business* Spain is doing poorly. According to the "Doing Business 2009" report by the World Bank Spain is 49/175 in ease of doing business, far from other European countries (Denmark is at 5/175 and Ireland 7/175, for example). Spain fares particularly poorly in terms of ease to start a business, employ workers, or paying taxes. Spain has heavier regulation than the average OECD country in terms of market, economic and administrative regulations which translate into higher barriers to entrepreneurial activities. The rigidity in the Spanish labor market is also particularly noticeable in the OECD context (for example, in terms of employment protection). According to a World Economic Forum poll restrictive labor regulations are, by far, the most problematic factor to do business in Spain. Other factors, in order, are access to financing, inefficient government bureaucracy, inadequate labor force, and tax rates.

In terms of *international trade*, Catalonia accounts for an important fraction of Spanish exports (around 27% in 2008), and has in 2005 a non-negligible world export share that has increased up to 0.5%. Foreign trade has mainly an intra-industry character, and has, for the period 2002-2007, 70% of exports concentrated in the EU-15. Imports are concentrated as well, and the degree of openness to trade as measured by exports plus imports over value added reached 67% in 2007, 20 percentage points more than in Spain. In broad terms, Catalonia imports from EU and exports to Spain, and increasingly to EU, mostly products of middle-upper technology. Catalonia has tended to intensify its export flows to the EU-27 while diversifying its imports extending them to new EU members and Asia. We find that exports of low technological content are shrinking in relative terms (e.g. textiles) despite good behavior of some exports (e.g. food), and exports with a high technological content (e.g. electronics, pharmaceuticals) are increasing their share in total exports despite the extreme weaknesses in some high-tech areas (e.g. computing.) The bulk of exports, concentrated in traditional exports of goods of medium-high technological content, have split their behavior in good (e.g. chemicals) and not so good (e.g. vehicles, electrical, machinery).

With regard to *foreign direct investment* (FDI), Catalonia goes from a negative to positive net position in terms of FDI abroad (Catalan investment abroad minus foreign investment in Catalonia): from about -2% of GDP in 1988 to a balanced position in 1998 to an oscillating positive balance thereafter. Both Catalonia and Spain have decreased recently the share of received investment flow in manufacturing and increased the share of services (in particular wholesale trading and real estate). An exception in manufacturing is the chemical sector and knowledge intensive service sectors (banking and finance, telecommunications and corporate services) which both increase they share. In general Catalonia and Spain have reduced the share of received investment in knowledge intensive sectors.

FDI flows in Catalonia (million Euros)



DataInvex, MITYC.

Secondary Education

Recently, alarms have sounded on the declining quality of education in Catalonia (and Spain). This is the outcome of the PISA (*Programme for International Student Assessment)* comparative study conducted by the OECD. The PISA international education survey tests reading, mathematical and scientific literacy in terms of general competencies of 15-year-olds. There is the widespread perception that the education systems of Catalonia, as well of Spain, are underperforming. Their 2006 PISA average scores have been below the OECD average in the three subject areas (science, math, and reading skills), and did not improve with respect to the 2000 and 2003 reports. Furthermore, the number of students repeating a course and failures in graduating from secondary compulsory school ESO (up to 30%), are among the highest in Spain (with an average of 25%). Similarly, the percentage of students (from 18 to 24 years old) who abandon the education system without completed secondary studies beyond compulsory school is in the high end of Spanish regions and EU countries: 34% in 2005 (this doubles the figure for the Basque region, for example, and is higher than the Spanish average at 31%, which already doubles the EU-25 average). Catalonia is 15 points below the EU average in terms of the percentage of the population of 20-24 years that has gone beyond secondary post-compulsory school. An important factor in this outcome is the low graduation rate for professional training (*formación profesiona*l) and the influx of low skilled young immigrants.

The question is what factors are behind the underperformance of Catalan and Spanish students. Are environmental and background factors to blame, like the education of parents or the level of immigration, or rather the intrinsic quality of the education system?

Spain is in the bottom third in science and the bottom quartile in math; and only two countries do worse in reading. Ciccone and García Fontes find that *accounting for the low education levels of Spanish parents,* Spanish PISA performance is somewhat above average in science and math, and approximately average in reading. Spain does relatively worse when we consider teenagers with college educated parents or parents with upper secondary school, than when we consider teenagers with parents that have a lower secondary education. The children of college educated parents are at or below the average in both science and math. This indicates that the Spanish PISA performance in science and math need not automatically rise above average as parental education levels catch up to the European average.

With regard to Catalonia, and in contrast to Spain, *accounting for parental education levels does not change the comparative performance of Catalonia significantly*. Catalonia scores 12 points less than average in science and 14 less in math. Accounting for parental education levels, the same gaps are around 10 and 12 points respectively. For example, La Rioja and Castile and Leon outperform Catalonia in science and math by around 35 and 27 points respectively although they have quite similar parental education levels. However, in reading, Catalonia is only somewhat worse than average to start out with and improves slightly when parental education is taken into account.

Furthermore, *accounting for immigration makes little difference also*. In Catalonia the concentration of immigrants at some schools has been of concern. The authors show that while concentration of immigrant students is greater in Catalonia than in many other countries and regions, this is not an important factor behind the poor Catalan PISA performance. For example, the percentage of immigrant at a school can explain, at most, 5 points of the difference in scores between Catalonia and La Rioja.

Comparison of regions (Ciccone and García Fontes (2009))

	Unconditional average	Parental education	P. educ. + imm. control	P. educ + imm. control + >10% control
Difference between				
Science				
La Rioja-Catalonia	28,2	26,7	25,6	24,9
Castile and Leon-Catalonia	28,4	26,8	23,3	20,3
Math				
La Rioja-Catalonia	38,3	37,2	36,2	35,5
Castile and Leon-Catalonia	27,4	26,2	23	19,8
Reading				
La Rioja-Catalonia	14,4	12,9	9,6	10,8
Castile and Leon-Catalonia	1,3	-0,6	-6,1	-8,2

The conclusion, therefore, is that Catalonia has a differential problem since the dismal performance of Catalan students can not be accounted for by either parental background or the level of dispersion of immigration at schools. Another potential differential factor, bilingual situation where Catalan is the main school language, is not consistent with the fact that in reading skills, where supposedly the effect should be greatest, Catalonia is about average in the reference group and it improves when taking account parental background. This points at some *intrinsic qualities of the Catalan education system as the culprit*. The relatively low expenditure on education in relation to GDP or per student can be blamed either. First, Catalonia has a large private provision education system (up to 40% of students, with partial public financing) and, second, the results of the international studies find weak effects of educational expenditures on school performance.

The underperformance must be assigned to the lack of school autonomy associated with parental choice or the lack of a centralized meritocratic system. The cross-country evidence suggests that the combination of autonomy and meritocracy (e.g. a central nation-wide exam takes place at the end of high school) works best. The setting that is most conducive to school quality is *school autonomy subject to performance evaluation*.

Furthermore, substantial improvements can be obtained *fostering competition*, both among students to get into the good schools and among schools to attract the good students. Equal opportunity can be preserved if the financing of education remains public or if private financing is sustained by vouchers for a large enough amount.

The new law proposal on education under discussion in the Catalan Parliament is consistent with some of the reform ideas outlines above: modernization of managerial schools structures (with more professional school managers), giving more decision capacity to schools and to parents to choose school, and introducing incentives to differentiate and compete between schools. Recently the President of the Generalitat José Montilla has announced the implementation of an evaluation at the end of primary school in order to have an objective standard to measure the quality of the education system. A central agency will be created to monitor the performance of schools. The new law proposal also states that at least a third language, apart from Catalan and Spanish, should be learned and that some courses could be taught in this foreign language, supposedly English.

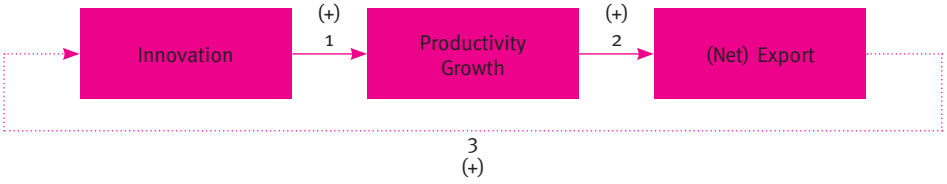
Productivity, innovation and trade

The long term growth prospects of an economy depend on the evolution of its productivity. The importance of productivity is increased by increasing cross-border integration: a domestic industry that is a productivity laggard might simply stagnate in a segmented world, whereas a more integrated world may threaten its very survival.

In the "Standard Model" innovation drives productivity growth (link 1), and success in international markets, usually measured by exports or net trade surpluses, is a key outcome (link 2).

According to a variant on the Standard Model, there is also a positive feedback effect from exports to innovation (link 3 in the figure), but the evidence in that regard is less clear.

Antecedents and Consequences of Productivity Growth: The Standard Model



Productivity growth has been demonstrably slow in Catalonia—lower than in the rest of the EU as well as in the United States. The significantly lower intensity of expenditures on innovation is an obvious suspect, with weak productivity growth in medium—or high-tech manufacturing sectors in Catalonia despite the presumably richer technological opportunities in there as well as the intuition that they represent the most likely sectors for a high-wage region like Catalonia to grow exports in. Indeed, exports of low technological content are shrinking in relative terms (textiles) despite good behavior of some exports (food), and that exports with a high technological content (electronics, pharmaceuticals) are increasing their share in total exports despite the extreme weaknesses in some high-tech areas (computing.) The bulk of exports, concentrated in traditional sectors of goods of medium-high technological content, have split performance, good in chemicals and not so good in vehicles and electrical, machinery.

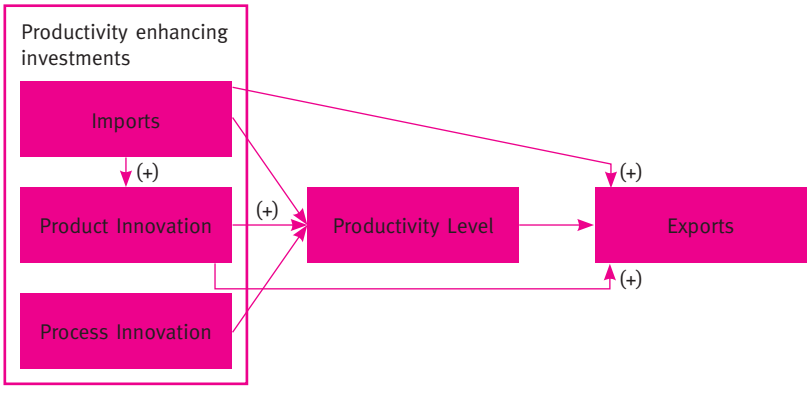
What has been the behavior of innovation activities?

R&D and innovation efforts have continuously increased in Catalonia and Spain since the mid 1990's in whatever way they are measured (in terms of inputs or outputs), but their levels remain clearly far away from the levels reached in comparable European countries and regions. Furthermore, when firms produce innovations there is a much lower propensity to patent them. Spanish (and Catalan) firms do not innovate much and when they do innovate, they innovate rather in process than in product. In addition, we find that R&D effort seems to be stagnant since about 2000, and the proportion of firms introducing process and product innovations has tended to decrease. We find also that innovation has also an important location component and that there are very large geographical differences in the productivity impact of innovation activities: the impact of innovation expenditure doubles if performed in Catalonia or in Madrid, and there is evidence of mutual spillovers from performing expenditures in the two places at the same time.

Unbundling both innovation and trade—the former into product and process innovation and the latter into exports and imports—the results from the Standard Model can be reassessed. This is

what Cassiman and Golovko do. It is found that there is indeed a feedback effect from international trade to innovation, but it seems to derive more from imports than from exports. In addition, there is evidence of two other kinds of links not in the figure: directly from imports to exports and from product innovation to exports without boosting productivity. The fact that a firm imports some of its inputs seems to positively affect productivity and, hence, exports. Furthermore, the fact that a firm has innovated in the previous year seems to positively affect productivity. Innovation—both product and process—has a positive significant relation with productivity. The following chart summarizes the findings and enriches the Standard Model. Firms that import and innovate improve their productivity and export, which turns into a persistent activity. Imports in particular induce product innovations which in turn make the firm start exporting. Process innovation then helps in getting volume and market share in the export market.

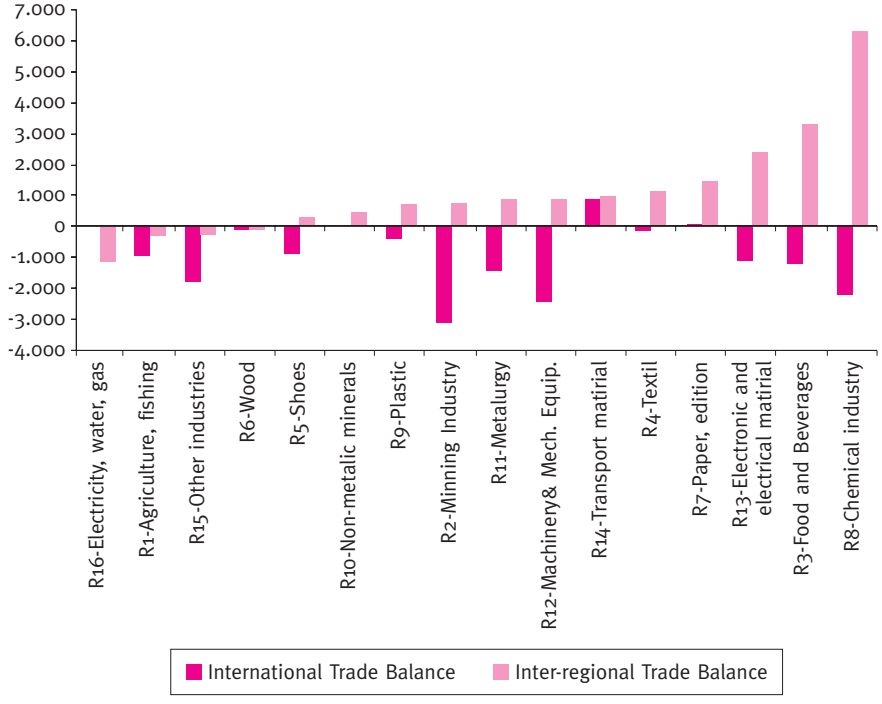
Innovation, productivity and trade



The work of Ghemawat, Llano and Requena reexamines link 2 in the Standard Model to look at interregional as well as international trade flows. Doing so shifts readings of Catalonia's external trade balance from very negative to positive, flags its role as an import hub for Spain and alters diagnoses of which sectors generate external surpluses and who its key trading partners are. Additional insights emerge from estimating border effects, including the insight that interregional trade may have a more important contribution to make to growth than it did between 1995 and 2005. More precisely: (1) Catalonia's estimated interregional trade in goods is slightly larger than its international trade. (2) Taking interregional flows into account helps identify Catalonia's role as a trading (particularly import) hub for Spain, and shifts readings of its external trade balance from chronically negative to positive. (3) It also changes diagnoses of which Catalan sectors are "competitive" in the sense of running external trade surpluses: thus, in chemicals, food and beverages and electronic and electrical material a large international trade deficit is offset by a much larger interregional trade surplus, yielding a large overall external surplus for Catalonia. (4) Add-

ing in interregional trade reveals a clear linkage between changes in Catalonia's external trade position and Catalan productivity growth, suggesting that Catalonia is specializing in sectors that offer it the highest productivity growth rates: a sensible pattern, but not one that is apparent if one looks at just Catalonia's international trade. (5) The addition also changes and expands the list of Catalonia's key external trading partners: Valencia, not France, turns out to be the largest—but a similar list of cultural, administrative, geographic and economic factors seems to determine who the key partners are at both the interregional and international levels. (6) Estimating border effects yields additional insights, including the surmise that interregional trade may have more of a contribution to make to Catalan growth in the future than it did between 1995 and 2005.

Catalan international and interregional trade balances by main sector



Trade balance in current prices. Million Euros. Average 1995-2006. All types of goods. Source: Ghemawat, Llano, Requena.

Ghemawat digs deeper into two key manufacturing sectors, food and beverages and transportation machinery (primarily autos) to take a closer look at link 1 in the Standard model, between innovation and productivity. Food and beverages is the better-performing sector of the two, in terms of not just productivity and productivity growth but also employment growth, profitabil-

ity, and—if one includes interregional trade—external trade performance. Higher productivity growth in food and beverages despite what can be presumed to be more limited innovation opportunities—it is generally considered a low-tech sector whereas autos is considered medium-tech—suggests that innovation is not the only mechanism, and perhaps not even always the most important one, for productivity growth. The sectoral studies shed light on other mechanisms for productivity enhancement—exploited to varying extents in the two sectors—that do not involve innovation per se and that Ghemawat groups under the rubric of *renovation:*

- Reaching efficient scale
- Rectifying (other) obvious internal deficiencies
- Replicating or imitating innovations, techniques etc. developed by others
- Replacement of inefficient incumbents by more efficient entrants
- Redeployment of resources across sectors

Some insights into the relative scope of innovation versus renovation opportunities can be developed by looking at the size distribution of firms within the two sectors. The food and beverages sector is extremely fragmented—not only in Catalonia or Spain but across Europe. In 2006, there were 2,876 Catalan food and beverage firms, of which three quarters had fewer than 20 employees and only 3% had more than 100 employees. The share of revenues accounted for the five largest firms is only 12%, up from 11% in 1993 and still substantially lower than the average of 15% across Catalan sectors. Autos is much more concentrated, but still features many very small firms, especially in auto parts and components: overall, two-thirds of auto establishments have fewer than 20 employees. This has important implications for innovation. The fact that the typical establishment has less than 20 employees affects the general usefulness to innovate since that typically requires slack resources and is subject to increasing returns to scale. Innovation and pushing the technological frontier make (comparatively) more sense for large, world-class firms, but it is also important to consider the large mass of other firms because otherwise, one would be focusing on just the tip of the iceberg.

In the two sectors considered there is a lot of variation among different firms: average productivity increases significantly with firm size, at least up to a threshold scale of 100-200 employees (achieved by well under 10% of the establishments in each sector). The implication is that the potential gains from bolstering the left tail of the productivity/size distribution would seem to be enormous. Consider the impact of raising the mean labor productivity of the firms in a sector to the mean for the firms whose value added is more than the median value, i.e., bringing the mean labor productivity of the bottom half of firms up to the mean for the top half. Cassiman and Golovko calculate that for their sample, doing so would translate into an average productivity gain of 65% in the food and beverage sector and 38% in autos!

From a policy perspective, the conclusion is that it is very important to recognize not just innovation but also renovation-related mechanisms as routes to productivity growth. The point is not to give up broadly on innovation, but to recognize that there are other policy levers that can and in fact need to be pulled on as well.

The science and innovation system and business

Innovation is thought to be one of the main engines of growth. Science affects economic growth by influencing technology adoption and innovation. Indeed, all major technological changes (railroads, electricity, cars, information technology) start with scientific discoveries. Science is developed by universities and research centers and then scientific findings are translated into applied technologies. We can distinguish between direct links connecting science and business at the frontier of science and indirect links where scientific knowledge is translated into applied technologies. Scientific findings are disseminated by academic publications and researcher (Ph.D) mobility between the university and industry, as well as research contracts between university and industry, patents and licenses, and university spinoffs.

Expenditure on R&D in Catalonia (1.48% of GDP in 2007) is far behind leading countries or regions as well the EU average (EU-27 at 1.83% in 2007, Madrid is at 1.92%). This is so despite the fact that the annual average growth in recent years has been high (12.6% in the period 2000-2007 against 10% for Madrid). The new Spanish R&D&I Plan 2008-2011 proposes to increase annual investment by 32%. The Catalan PNRI (Pacte Nacional per la Recerca i la Innovació) proposes to increase expenditure on R&D to 2% of GDP by 2010, and to 3% in 2017.

Spain and Catalonia share a fiscal system that tries to incentivate innovation, especially after the reform introduced at the end of the 1990's, with a set of subsidies available to firms through different state and regional agencies. The evidence available on the impact of R&D subsidies in Spain shows that (i) R&D expenditures of a fraction of small firms are actually dependent on subsidies, in the sense that these firms would stop performing R&D in the absence of subsidies; (ii) there is no "crowding out", or substitution of public funds for private funds, and even a (modest) increase in the private expenses that the firm would had dedicated to the investment in the absence of subsidies. However, according to the evidence, a high proportion of subsidies go to firms that would have performed the innovative activities anyway. In terms of potential effects, it is estimated that almost half of the large non performing firms could be induced to perform by financing less than 10% of their likely expenses, and the same goes for small non performing by financing a higher fraction of their needed expenses. A striking fact is that a significant part of the firms say to "ignore" and/or do not apply the possible fiscal deductions for their innovative activity. A possible reason is that small and medium firms are likely to be deterred by the costs of formalizing the accounting needed to access the support, including the necessary matches between engineers and accountants to define the innovative expenses, barriers to be added to the start up and fixed costs of innovative activities. In summary, both tax deductions and subsidies seem to have played a role even if modest in the stimulation of R&D invest-

ments. The reasons for the weak results seem to lie in their cost of implementation in the case of fiscal deductions and their conservative application in the case of subsidies.

The Catalan science and innovation system basically consists of universities, public research centers of the Government of Catalonia, hospitals, technological centers, the research centers of the Spanish government (belonging to the Consejo Superior de Investigaciones Científicas—CSIC), and R&D&I departments in the private sector. The Government of Catalonia can only implement directives under the legislation established by the Spanish Government. This leads to an overlapping of powers, with no systematic co-ordination between the Governments of Spain and Catalonia in terms of the governance and development of a strategic and operational policy for science, technology and innovation. Furthermore, in the Catalan system efforts seem rather dispersed (as compared to the Finnish case for example) and fragmented over different policy makers, institutions and agents. On top the total expenditure on R&D in Catalonia is low (for example, in 2006 it was 2.614 M€ while Nokia alone spent 3.712 M€).

Cassiman and Mas examine three challenges for Catalonia to improve the connection between science and business: sufficient supply of high quality science, sufficient demand for it, and an appropriate connection between the two. With respect to the first, the science landscape at Catalan (and Spanish) scientific institutions has improved considerably in the last decade. With respect to the second, as Catalan firms innovate little, their demand for science is very weak. The present structure of the Catalan economy, tilted towards medium and low technological intensity firms, does not lend itself to a high level of innovation and therefore to interactions with the science and university system. With respect to the third, the level of connection is very low: only 1% of publications in Catalonia include a private firm and there still exists very little mobility between industry and university by trained PhDs.

Núria Mas examines the case of biotechnology. Biotechnology is science-based and is rapidly gaining priority in many political and industrial agendas as more and more countries and regions focus on it as a key engine of long-term economic growth. This is the case, for example, of the Lisbon Agenda and of the EU Sustainable Development Strategy, of Spanish Plan Nacional de R&D&I 2008-2011; and indeed Catalonia's PNRI. As a result, biotech seems to have attracted the largest share of any area of activity of public expenditures by Catalonia on R&D. Catalonia is the leading region for biotech within Spain: it accounts for an estimated 24% of Spanish firms with activities related to biotechnology. The number and the size of Catalan biotech firms seem to be growing relatively more rapidly than in leading European regions, although biotech activities in Catalonia are still substantially smaller on both those dimensions than in the leading European regions, let alone the global leaders in the United States. And in terms of research, the Catalan publishing effort has been improving steadily and, in biochemistry has even overtaken some of the other European biotechnology regions, although it lags far behind in originating patents and licensing agreements. Despite this overall positive picture there are some concerns since profit prospects for the biotech sector worldwide, at least in human health (red biotech), seem poor. The likelihood of poor average performance ratchets up the importance of relative

viability of the Catalan sector. On the other hand, Catalonia's underweighting, compared to the European averages, of green biotech for agrofood and white biotech for chemicals raises questions given the strength of both the food and chemicals sectors in the region. (Catalonia dominates Spanish production of fine chemicals/pharmaceuticals to an even greater degree, but such measures of Catalan dominance based on counts of firms or their revenues ignore the fact that the level of expenditure on pharma R&D, in Catalonia as well as in Spain, is quite limited: local firms spend relatively on R&D and while multinationals operate production sites in Catalonia, very few have significant R&D facilities.) In addition, white and (segments of) green biotech offer the prospects of a somewhat better relative position based on biochemistry research and shorter investment horizons and lower requirements for funding (which tends to be a key constraint in Catalonia and in Spain).

Company Strategies

Factor endowments, demand conditions and governmental policy all influence competitiveness, but do not entirely determine it: companies' strategies mediate between these influences and actual outcomes—and their evolution over time. After the full integration of the Spanish and Catalan economies into the EU, firms had to adapt their strategies to compete in a highly open and competitive environment. The need for change was reinforced by the crisis of 1993, although the devaluations in 1993 and 1995 did provide firms with some breathing room. A room which will not enjoy in the present crisis. In the 1990s costs and investments in human capital, product differentiation and the adoption of new technologies all seem to follow paths consistent with improved productivity and enhanced competitiveness. However, R&D-intensity has stagnated since about 2000, while the proportion of firms introducing process and product innovations has actually decreased! Catalan firms are engaging in too little innovation because the large segment of small firms are too constrained to engage in much strategizing or innovation. For such firms, renovation rather than innovation is likely to be the key to productivity improvement. Furthermore, for other firms the slack offered by declining unit and labor costs, may have limited the pressures on firms to upgrade. This comes from the decline in interest rates in the euro area and wage moderation due, at least in part, to the large influx of immigrants.

The traditional Catalan "business model", or strategy that developed in the course of early industrialization in response to an environment which can be characterized by the availability of imported technology that increased the scale thresholds for efficient operation; inflows of low cost labor, especially from other parts of Spain; and a Spanish market protected from foreign competition that grew rapidly (enough) during the postwar decades of autarchic development. This lead to a virtuous cycle linking low cost, volume and economies of scale (Ricart i Costa and Casadesús-Masanell). The problem is that despite the drastic changes in circumstances due to market integration in Europe and world globalization very few Catalan firms have managed more than incremental strategic changes. Indeed, there are some exceptions to this rule: a handful of companies that have managed to transform their business models or

strategies, mostly through effective pursuit of internationalization. The problem is that the process of strategy development described above is guaranteed to lead only to a local peak: a set of policy choices that is internally consistent in the sense that any one-policy-at-a-time change would be dysfunctional. However, local peaks come with no warranties as to their global or absolute desirability. In fact, it may be that the local peak that a firm or a group of firms is clinging to happens to be submerging because of environmental changes, aggravated in the context of the present crisis. This implies that if larger Catalan firms that appear to enjoy more degrees of strategic freedom are indeed stuck, breaking out of that state is likely to require changes in strategies that cut across functional areas, i.e., overall strategic innovation rather than just engagement in more R&D.

Agenda for action

The context

Catalonia is in a contest with other developed regions in the world to attract economic activity and business decision centers. Regions compete in terms of location, variety of resources and in terms of offering a style of life and "culture", in the general sense as well as in the business sense. Regions also compete, in terms of the quality of the nucleus of services and infrastructure, as objective elements of the quality of life that they offer. For example, if taxes are equal companies choose regions with more quality in infrastructures and services. The implications of this latter type of competition are important, as investments in quality have the character of fixed expenditure and the entry of new competitor regions with high quality can displace regions with lower quality that, until that moment, competed successfully on the international market. Therefore, for example, a country that maintains low quality tourist services (poor infrastructure) can be displaced by the entry of countries with better quality services. We have seen how globalization pressures bring up these questions in the automobile industry, and with dramatic force in a crisis situation. The only response for regions with labor costs that are not competitive with the new entrants is to enhance productivity with a coherent strategy which opens the economy to global sourcing, renovation, and broad-based innovation. This would allow firms to compete, for example, in terms of product innovation, going up the quality ladder. This strategy needs an active policy on the matter of infrastructure, competitive environment and the creation of the necessary critical mass in crucial factors. Without this policy the region can become sandwiched between those offering superior quality, on the one hand, and those that are more cost efficient, on the other.

The success of a region in terms of economic growth is affected by a set of *complementary factors* such as the degree of competition in the markets, the stock of human capital, the capacity to generate new knowledge, the quality of the service infrastructures (transport, communications, etc.), the availability of sufficient business finance, an efficient and fair fiscal system, a cohesive society, and the level of the quality of life. The public sector is crucial in the provision of these factors.

Strengths and weaknesses

Catalonia has some assets to start with: a diversified industrial base, a high degree of openness of the economy (both in terms of trade and capital flows), a commodity hub for Spain and with important logistic potential in the Mediterranean, a tradition of entrepreneurship with a segment of dynamic internationally oriented firms—a few with international dimension, a high quality life (helped by location advantage and mild climate), a reasonable level of human capital, and some leading research and teaching centers. At the same time infrastructure (port, airport, railways, local transportation) lags behind; the overall level of innovation in the economy is low; the size distribution of firms is tilted towards small firms with low productivity, lack of tradition of cooperation, as well as absence of locally rooted large multinationals and important dependence of multinationals with far remote headquarters; the process of entry and exit in industry shows in practice many rigidities, outcome, in part, of a rigid labor relations system; the service sector lacks competition; the education system is failing with dismal performance of primary and secondary education and inadequacy of professional education; the University and science system is bureaucratic-driven and there are no incentives for excellence; constraints to mobility are important and the knowledge of the English language still low; R&D policy has tended more to dispersion than to consolidate critical mass in key areas; and the administration is heavy handed in terms of regulatory measures with the ratio between institutional complexity and command budget high.

Catalonia shares with Spain many other problems. In Spain, Justice is slow and inefficiently organized, inflicting high costs on the operation of firms. Administrative procedures are cumbersome and the cost of doing business is high. Sectoral regulators still have a long way to attain the desired independence and technical capability. Spain has a very high index of protection of labor leading to a dual labor market (with a segment of protected jobs and another of temporary laborers), low levels of part time work and a welfare system that does not incentivate work. Collective bargaining is at an intermediate degree of centralization, very far from the decentralized extreme and not close to the centralized one (both with good properties). This system does not allow neither to fine tune salary conditions to the productivity at the firm level, nor to internalize general economic conditions when setting wages. The rental housing market is very narrow because the property rights of owners are not firmly established. The pension system must be reformed in order to guarantee its viability. Competition in services is weak and this discourages the use of information technology. Particularly severe competition issues arise in the energy and commercial (retail) sectors. In energy, on top, a general policy on the future of the technology generation mix should be defined having in mind the extremely high dependence on imports.

Catalonia, and Spain, have the opportunity to converge in the long term not with average EU-27 or EU-15 but with the best performers in the EU if structural adjustments are made. A couple of factors may help: (1) Spain (and Catalonia in particular) have a relative weight of the public sector in the economy more aligned with the UK level than with France and Germany, and (2) society, despite all weaknesses, is still more flexible and adaptable than the more entrenched middle Europe. The current crisis should be a rallying point for action. The risk of not taken action is a

protracted period of low economic activity and bleak prospects. No devaluation will save the Catalan industry as in the early 1990s. In the last two decades Catalan firms have made efforts to become more competitive. This follows from looking at efforts to reduce costs, investments in human capital, product differentiation and the adoption of new technologies. Innovation effort has lagged behind, mostly because of the constraints faced by small firms. However, the drastic reduction of financing costs, as well as the immigration influx, that the entry in the euro has brought may have limited the pressures of firms to upgrade. There are indications than there has not been yet a clear break with the traditional Catalan business model derived from the autarchic period with cheap labor, imported technology and a protected market. Obviously, there are a few exceptions to this rule since a handful of companies *have* managed to transform their business models, mostly through effective pursuit of internationalization. We think that the present crisis will end forever the traditional business model for a simple reason: it will not survive.

The need for a coherent set of policies

A coherent set of policies are needed to leverage the strengths of Catalonia's economy (diversification, industrial base, climate, quality of life...) to move the industrial and service sectors towards products and services further up in the quality ladder, to improve the productivity of the vast segment of small firms which are far away from the technological frontier, and compete effectively in the world market. The present crisis is an opportunity to restructure industry and services to induce a sustained productivity increase.

The present crisis will serve to reduce costs, in fact, it will put tremendous pressure to cut costs and move operations to locations where it is more advantageous to produce. Productivity, broad-based renovation and innovation and internationalization, together with removing artificial obstacles to capital reallocation, are the name of the game. The cluster development initiatives that have formed one of the principal platforms of industrial policy in Catalonia for more than a decade have been useful. Now they have to be rethought because the need to have complete clusters of activities locally has been superseded by the international fragmentation of the value chain and the idea that innovation is *the only* route to productivity growth may miss the broad perspective on productivity enhancement. Indeed, traditional indicators of market shares and market growth may need to be replaced by indicators of productive growth in absolute and relative terms to competitors. A distinction must be made also between those firms and segments which are at the technological frontier, and for which the pressure to innovate is formidable, and those which are well inside the frontier, for which renovation and replication is crucial in order to advance towards the frontier. This calls for an approach which integrates fostering innovation and renovation in the broader context of fostering growth and placing industrial activity and advanced services at the center stage. This means exploiting opportunities to reach efficient scale (especially important given the fragmented structure of the Catalan industry system with predominance of small firms), to replicate and reach the technological frontier where it has not been reached yet, to allow the less efficient to be replaced by the more efficient, and not to block redeployment of resources from declining to uprising activities. This broad strategy needs a vibrant

market with effective rivalry and low barriers to entry and to exit. In a recessive conjuncture care has to be taken not to block the process of exit of inefficient firms while at the same time helping efficient producers which are innocent bystanders of the collapse of credit markets. Small firms are certainly the most vulnerable to the contraction in bank credit, and many may need help to survive the crisis, but such help will represent an efficient deployment of resources (rather than a failure to redeploy) only if there is some way to turn small firms which are inefficient into ones which are efficient. Consolidation will be needed, it is not farfetched to surmise that the industrial landscape of Catalonia after the crisis will look quite different that the one we see today.

The stated policy of the Government of Catalonia (Generalitat) tries to address many of the weaknesses highlighted in this report and summarized above. For example, in June 2008 a revision of the "Acord estratègic per a la internacionalització, la qualitat de l'ocupació i la competitivitat de l'economia catalana 2008-2011" was published. The document together with the PNRI and the "Pla de política industrial (2009-2013)" will become reference points for policy action. We provide below some recommendations which go beyond and/or may complement the plans of the administration. The present crisis should serve as catalyzer for action in areas that need reform.

In terms of agenda for public action it should be noted that quite a few of the long term policies related to perceived weaknesses are in the hands of the Spanish government. Indeed, Spain needs reforms in institutions in the area of justice, labor market, rental housing market, pensions, and competition in services, to name some leading problems. In all those cases reform has to come from laws enacted at the Spanish level, although there is some leeway for intervention of the regions. In some other cases, like education, the regions have more of a say. In our recommendations we will concentrate mostly on issues for which the Catalan government has some relevant levers of action.[1]

Key ingredients for a coherent strategy

- Back to basics. Catalonia needs
  - To build on its industrial tradition as engine of productivity to pull the economy:
    - Special care has to be given to the segment of dynamic firms active in the international market.
    - Medium and low tech sectors should not be forgotten but rather the internationally competitive segments upgraded. The strategy of replication, replacement and redeployment of productive assets together with innovation should be followed.

1. Most recommendatios are derived directly from our analysis while a few come out of the consensus of experts in topics not dealt with in the present study, and since they are consistent we the gist of our report are included for completeness.

- Public policy will need to acknowledge and anticipate heterogeneity in industry contexts and firms' strategies. While small firms may need help and encouragement in reaching the minimal efficient scale, larger ones may need to have obstacles to full insertion in the international division of labor removed.

- Sectoral development initiatives and cluster development should be refocused with a broad perspective centered in productivity growth and international linkages.

- Professional training should be fostered.

- The financial sector must be deepened to provide credit to small and medium firms and to innovators.

– To have a regional strategy:

- Not forgetting inter-regional trade and integration.

- Developing transport and communications infrastructure with Valencia and the South of France. The Euroregion should go from the drawing table to investment reality.

- Having Barcelona as backbone of the competitive strategy of Catalonia.

• Foster human capital formation, openness, and internationalization

– In education and R&D what is key is a change in organization and incentives rather than more public spending.

– Require excellence and international standards in new projects.

• Look ahead, do not look back.

– Eliminate barriers to capital reallocation, do not protect declining sectors but help transitions.

– Barriers to reallocation of resources have to be lowered at the same time that those in trouble receive transition help.

– The crisis must serve as rallying point for reform and restructuring. For quite a few productive segments this may be the last opportunity to get in shape to face the international market.

- Increase competition
  - In services (implementing the EU services directive) to lower costs and induce adoption of information technology. This may be particularly important in a sector such as commerce retail where the Catalan Goverment has traditionally had a restrictive stance on the issue.
  - In education to improve quality.
  - In funding R&D&I projects and research centers with competitive bidding to promote excellence.
  - In the labor market eliminating rigidities and turning the protection of unemployment into the protection of work.
  - Enforcing competition policy in product and service markets.
- Make government intervention simple and incentive-responsive
  - Government should provide the basic structure for the functioning of the market economy rather than micro manage.
  - Simplify regulation and the structure of government agencies.
  - Increase transparency in government action.
  - Change organization and incentives in public entities (and civil service) towards service and excellence.

Some specific recommendations for the public sector:

- Create a government for the Barcelona area (with real transfers from local governments). This would help in consolidating Barcelona and Catalonia as commodity hub for Spain with a better coordination of infrastructure port, airport, local transport.

Education

- Schools should have more autonomy to compete for students and professors.
- More transparency on the performance of schools (e.g. with the publication of rankings of results) so that parents can make informed choices.

- A central exam for students and school evaluation programs should be implemented.
- The authority of school professors should be firmly reestablished.
- A culture of excellence, independence of thought, and effort should be promoted.
- The use of English as vehicular language at school should be implemented with a credible timetable.
- Professional training should be put at the center stage to improve productivity.
- In higher education, the universities should have autonomy to select professors and students with public financing according to results, charge fees closer to the real costs of education and a system of fellowships should be developed so that deserving students are not left out.

Innovation and internationalization

- There is room to improve procedures for R&D subsidies and fiscal allowances: simplify drastically for SMEs, end the restrictive attitude of fiscal authorities to assess what qualifies as innovation, do not use subsidies to delay restructuring, and encourage agencies to take risks.
- Do not discourage firms from locating R&D centers where they are most productive (since to have multiple R&D centers, e.g. Madrid and Barcelona, is good.)
- Focus policies more broadly on helping firms access international markets rather than developing policies narrowly and solely focused on getting firms to export. There is currently no attention to the import side of the internationalization process despite that access to international (technology) markets directly affects and enhance the export decision.
- Stimulate the product innovators in higher tech markets to improve the health and resilience of the Catalan economy.
- The integration of CIDEM and COPCA decided in 2007 is a step in the right direction but will need to mesh successfully the culture of two different organizations. Furthermore, a more explicit connection between innovation and internationalization of activities is necessary. This implies adding requirements for exports when giving innovation subsidies or putting in requirements for (product) innovation when giving export subsidies. A question mark is whether the Invest in Catalonia agency within the new ACC1Ó will have the adequate profile and clout to do its mission.

Science and business

- Both supply and demand should be increased, policy should, not get obsessed with links but with fostering excellence. In particular do not try to adapt frontier research groups to the needs of a low-tech industrial base.

- Reform the structure of the science and innovation system:

  – The University system should move from the bureaucratic mode to an excellence-oriented one which responds to the needs of society. The governance of the University should depend on Councils with strong representation of external members. Meanwhile the University should not be a privileged channel to implement scientific policy.

  – The ratio of structure/complexity in public support to R&D investment has to be lowered dramatically.

  – The PNRI points in the right direction with the merger COPCA-CIDEM, and coordination of the agencies (AGAUR, ICREA, FCR), but could go further (under the principles administrative simplicity, with each agency with a clear mission). A possible model is to have one Research Agency plus another for Innovation/Technology/Internationalization (like Finland's two agencies: Academia and Tekes). This would merge CERCA with AGAUR/ICREA/FCR.

  – Centralize information on science performance and relations science-business in order to evaluate the Catalan science and innovation system.

  – Provide correct incentives for the players in the system, in terms of excellence, evaluation and autonomy of centers:

    - Competitive (transparent) bidding for projects/new centers.

    - Establish a competitive fund for industrial research finance.

    - Support international standards (Ph. D. programs, research).

  – Improve the coordination with institutions of the rest of Spain.

- Foster mobility and understanding; promoting

  – A program of Ph.D.'s in firms.

  – Business training of scientists.

- For the case of biotechnology:

  – More attention should be given to green and white biotech given better prospects of relative position in terms of biochemistry research, and shorter investment horizons and funding requirements.

  – The limitations (managerial, technical, finance) of the Catalan cluster should be overcome fostering international linkages (among other things by lessening geographic, administrative and linguistic barriers).

The improvement imperative for the private sector

The agenda for action for the private sector flows from the likely need for significant changes to "business as usual" at many companies in Catalonia—even after the crisis is "past." While there is much discussion about how long that will take, we think that the point that is underplayed is the post-crisis world is likely to differ significantly from the pre-crisis one.

While the contours of the post-crisis world are still murky in many respects, it seems clear that *the acceleration of productivity growth will be an overarching target*, both because of the general pressure to improve (the majority of competitive advantages do not last five, let alone ten years) but also because of some specific features of the Catalan case:

- The pre-crisis productivity gap.
- The low level of innovation and technological capital accumulated.
- Constraints on simply continuing to import cheap capital (and labor) to bridge the gap.
- Additional pressure from a higher inflation rate than the average for the Eurozone.
- Lack of currency devaluation as a tool for correcting external imbalances.
- The possibility of a longer-run decline in average industry profitability if there is chronic excess capacity (i.e., if the recovery is slow).

Another clear implication seems to be that *job creation in industry will be key* because of

- An unemployment rate that has already swollen to uncomfortable levels.
- Poor prospects for growth in construction and in some service sectors (e.g., finance, insurance and real estate, and possibly tourism).
- The likelihood of further restructuring and job losses within the industrial sector itself.

The twin objectives of accelerated productivity growth and net job creation cannot be met just by restructuring so as to reduce personnel or personnel costs, however necessary such moves may be in the short run. Instead, *firms will actually need to focus on productivity and productivity growth as performance metrics*, and to engage in benchmarking with local competitors, competitors from other Spanish regions, and internationally. Creative thinking along a multiplicity of dimensions will be necessary. For firms at the technological frontier, innovation (both science-based and general) will be crucial to remain at the forefront of developments and be competitive. More in general, however, achievement of escalated productivity targets will require firms to broaden their view of the possible mechanisms for productivity growth, beyond the focus on science-based innovation, in two ways.

First, process, service, and strategic innovations need to be taken into account. The requirements for strategic innovation, in particular, can be summarized as involving broadening the options considered and the scope of the external scanning effort, systematically trying to look at one's business from different perspectives, and harnessing the creative powers of the whole organization (for example, by cultivating open-mindedness and tolerance of divergent thinking; encouraging risk-taking and a commitment to learning).

Second, innovation, even broadly defined, is far from the only mechanism for productivity improvement. Especially for the very large mass of very small firms in Catalonia, renovation, involving mechanisms such as reaching efficient scale, rectifying (other) obvious internal deficiencies and replicating or imitating innovations and techniques developed by others, seems to us likely to offer a more important immediate set of productivity levers than innovation (without dismissing it).

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1. Introduction

Catalonia is ending an extraordinary period of growth since 1996 which has been based on low interest rates, a large immigration inflow, wage moderation, and very substantial employment creation. This pattern of growth has been sustained with an important contribution from the construction and real estate sectors (as well as tourism) and not with increases in productivity. This model is not sustainable and even when the present crisis is overcome it will not come back. At the same time Catalonia has maintained a core of medium sized firms which are very dynamic in exporting (mostly in medium technology sectors). This has contributed to a diversified industrial base which together with a high quality of life provides two key assets for the future.

Several trends accompany the globalization process driven by the advancement of information and communication technology, and the lowering of transport and trade costs. A common driver is the effective expansion of market size which leads to increased specialization and return to excellence. This explains the geographical fragmentation of the value chain and the increased importance of investment in intangibles and human capital. Looming in the horizon there is a move to an economy with lower carbon intensity. Technological change and globalization pressures imply that restructuring is needed and that losers may need to be compensated.

Catalonia is competing with other advanced regions of the world, in order to do so effectively it needs to have a first class infrastructure, skilled human capital and a vibrant competitive environment. Productivity, human capital, renovation and innovation, and internationalization are the name of the game. The exit from the present crisis will need a changed pattern of growth.

Globalization has posed many questions that now, in a crisis context, are becoming urgent. The increase in competition that the globalization process has fostered, coupled with the crisis, puts on the line several key sectors of the Catalan economy. The crisis will add tremendous pressure to cut costs. Will the automotive sector shrink as the textile sector has? Or we need to go back to sector specific industrial policies to save declining sectors?

Certainly, the industrial sector is crucial for a country like Catalonia and this not only because of tradition. First, industry is the engine of productivity growth with manufacturing firms being very active in R&D and innovation activities. This is so, among other thing because of the in-

tense competitive pressure that the sector is subject to after the lowering of trade barriers with European integration and world competition. Second, productivity improvements in industry have important external effects in technology adoption in the rest of the economy and lower prices of inputs. Finally, industry has important forward and backward links with the rest of the Catalan economy.[1]

In this report we deal with some *selected* key issues related to the competitiveness of Catalonia. We start with a review of recent macroeconomic performance and assessment of some competitive endowments of Catalonia. We move on then to analyze performance and prospects in three key areas: education, the links between productivity, innovation, trade and competitiveness, and the relations between the science and innovation system and business. In so doing we draw the lessons from the analysis of a low tech sector (food and drink), a medium tech sector (automotive), and a high tech sector (biotechnology). Finally, we analyze company strategy. We end by setting an agenda for action.

In this report we summarize the findings of an extensive research on the topics at hand. They contain a number of fresh and even controversial implications for policymakers that will be dealt with as we proceed. We should add that the treatment here is our own, drawing on but not entirely coincident with the contributions of the authors of the book chapters for this report. So while we are circling back to the respective authors for comments on this section of the report, they may not agree with all the views expressed herein.

Chapter 2 was prepared with a contribution of Joaquín Trigo and material gathered by Jordi Ollé under the supervision of Xavier Vives. Chapter 3 deals with secondary education and is based on the contribution of Antonio Ciccone and Walter García-Fontes. Chapter 4 deals with productivity, innovation and trade and summarizes the findings of the contributions of Jordi Jaumandreu, Bruno Cassiman and Elena Golovko, and Pankaj Ghemawat, Carlos Llano and Francisco Requena. Chapter 5 deals with two sectoral studies, drawing on Ghemawat, and draws some policy implications. Chapter 6 studies the relations of the science and innovation system and draws on the work of Cassiman and Jordi Mas, as well as Núria Mas. Chapter 7 is based on the work of Ramon Casadesús-Masanell and Joan Enric Ricart. Ghemawat undertook primary responsibility for assembling Chapters 4, 5 and 7 in this report out of these source materials, and Vives for Chapters 1, 2, 3, 6 and 8. We are grateful to Angel López, Flavia Roldán and Salvador Estapé of the SP-SP center and to Joaquin Trigo and Joan Pujol of Foment del Treball for helpful comments on the manuscript and Jordi Ollé, with the assistance of Jorge Paz, for excellent research assistance. We are grateful also to Montserrat Palet of the Government of Catalonia for her help.

1. See, for example, González and Manresa (2007).

+

2. Macroeconomic performance and endowments

Catalonia has been immersed in the globalization process driven by technological change, liberalization, and market integration. The application of information technology has transformed production and trade of goods and services with the end result of a decrease in the trade and transport costs of goods, capital, people and, indeed, information. Several consequences have followed: market enlargement, increase in competition and the entry of emerging economics like the BRICs (Brazil, Russia, India and China). The process has forced a capital reallocation and corporate restructuring. This has included several waves of mergers and acquisitions. Underlying these changes it is the consideration that size matters in many industries, at least up to the efficient scale of operation, in particular those facing an effectively enlarged market.

How has Catalonia (and Spain) fared in the globalization process? We will survey first the macroeconomic performance of Spain and Catalonia. We will deal next with the endowments of Catalonia in its competition with other economic regions in Europe and in the world, and with the outcomes of such competition in terms of trade performance and investment flows. This chapter draws from the contribution of Trigo (2009) and from an effort to collect relevant economic data for Catalonia.

2.1. Macroeconomic performance

The macroeconomic performance of Spain and Catalonia has been conditioned by two major events after the industrial crisis suffered in the late 1970s and early 1980s. The first is the integration in the European Community in 1986 and the second the adoption of the euro in 1999. The effects and these events have been intertwined with the impact of globalization in the world economy.

The joining by Spain of the common market in 1986 opens the economy and makes both imports and exports increase (in particular with the EU[2]), strengthens the tendency for the indus-

2. In 1985 exports to the EEC were a proportion of 52% of the total, imports from the EEC accounted for 37%; three years later, in 1988 the proportions were, respectively, 71% and 64%.

trial sector to decrease its weight in terms of value added and employment and of services to increase it, and increases considerably the flows of foreign direct investment and, more recently, of direct investment abroad.

Spain has caught up with the EU (since 1996 it has grown consistently above the mean of EU-15, Spanish real growth rate being at least 0.7 points higher than EU-15 until 2007). In this period growth has been driven by a strong increase in internal demand accompanied by intense job creation, wage moderation, and fuelled by low and decreasing interest rates and a marked increase in immigrations flows. The result has been a stagnation of productivity.

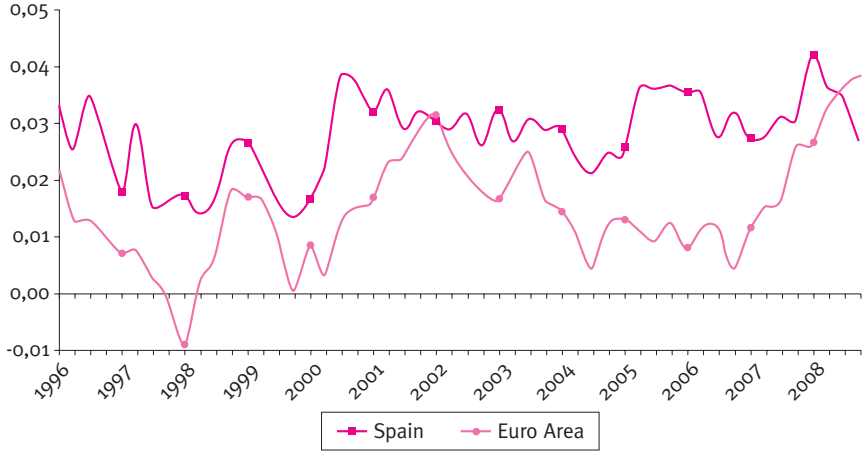
The catching up process has not been smooth, with a crisis post 1992 which was dealt with competitive devaluations between 1992 and 1994. Income per capita (PPS[3] corrected) goes from about 80% of EU-15 in the mid nineties to more than 90% in 2007.

Since joining the euro competitive devaluations are no longer possible and this may be problematic since the weight of Spain in the formulation of monetary policy for the euro area is small. This has implied that interest rates have been very low, even negative in real terms (in the period 2002-2005), and have contributed to a huge boom in construction and real estate accompanied with the expansion of financial intermediation. Labor force for this construction boom has been found mostly abroad with a very important increase in immigration (foreigners were 2.2% of total population in 2000 while 10% in 2007, and almost 11.5% in 2008). By 2007 the weight of construction in employment was 13%, compared with a mean of around 8% in the EU. In total 4.850.100 jobs have been created in the period 2000-2007 in Spain (representing a staggering 31% of EU-15 new employment). Employment has grown an average of 3.5% in 2000-2007 (1.2% in the EU-15).

Spain has traditionally had a more pronounced economic cycle than the EU. A first reason has been its sectoral composition with larger weight of agriculture (although declining), low and medium technology products, and tourism. Since the mid 1990s Spain, fuelled by low interest rate and the construction boom, has managed to do better than the EU-15 even in periods of economic deceleration. This will probably reverse in the present recession. A second reason has been a more procyclical economic policy at least until 1994, when a phase of more orthodox macro-management has been implemented. Spain has had a consistent positive inflation differential with the Euro area, up to the recent recession, and for 2006-2008 the differential has been 1.4 (2006), 0.7 (2007) and 0.8 (2008).

3. Purchasing Power Standards.

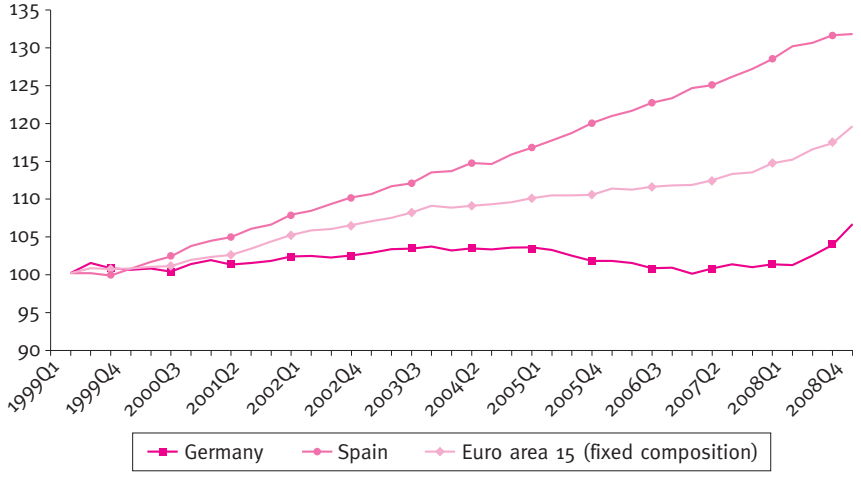
Figure 2.1: Unit Labor Cost[4] (year to year) growth rate. 1996-2008



Source: Bank of Spain (from the European Central Bank).

In the past years Spain has lost competitiveness with respect to EU-15 as measured by the evolution of unit labor costs (see Figure 2.1 and 2.2). With respect to Germany for about 30% since 1999 (see Figure 2.2a). Since 1995 Spain has displayed a similar loss of competitiveness as Italy (see Figure 2.2b).

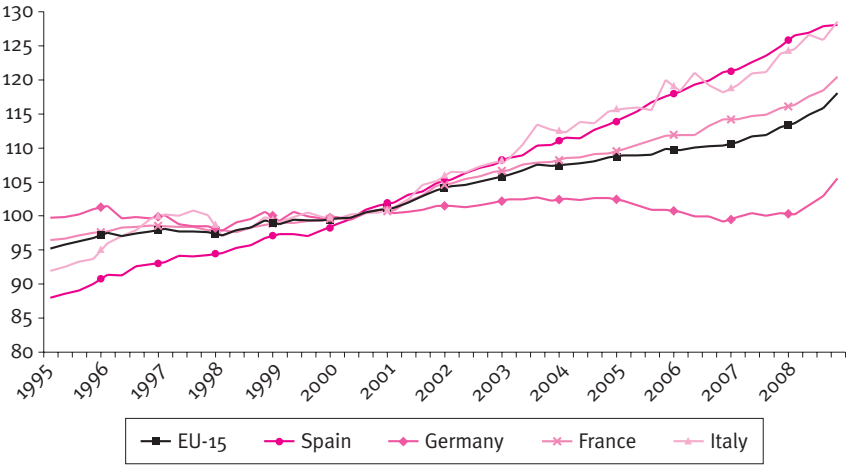
Figure 2.2a: Unit Labor Costs growth. Index: 1999I = 100. Seasonally adjusted



Source: European Central Bank.

4. As defined by the ECB, this is a measure of total labor costs per unit of output calculated as the ratio of compensation per employee to labor productivity (defined as GDP per person employed).

Figure 2.2b: Unit Labor Costs growth. Index: 2000 = 100. Seasonally adjusted



Source: European Central Bank.

How has *Catalonia* performed in this context?

Growth and productivity

Catalonia has had a positive growth trend and has indeed caught up with Europe. In GDP per capita (PPS corrected) it has gone from 84% of EU-15 in 1986 to 106.4% in 2004, while Spain has gone from 72.5% in 1986 to 89% in 2004. Also, Catalonia has gone from the level of 96.3% of the Euro Area (111.6% of UE-27) in 1995 to 111.7% (122.6%) in 2007. According to Eurostat, in 2005 Catalonia in the EU-15 would have a GDP per capita (PPS corrected) between the 6th country position (Sweden) and the 7th (Belgium) while Spain would be 13th just below Italy.

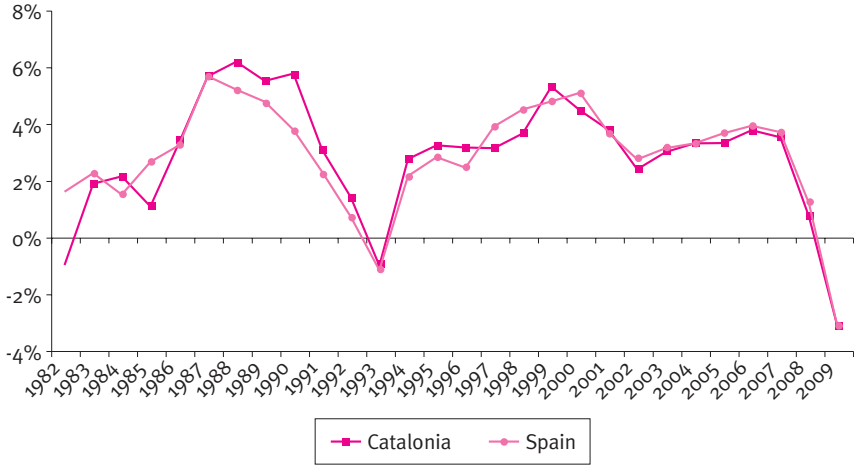
It is worth to compare this data with some European regions of industrial tradition like Catalonia. In 1986 Baden-Württemberg, Bavaria Rhône-Alpes and Lombardy were between 112% and 136% of the EU-15 level while Catalonia was at 84%; in 2006 the range has shrunk, to between 101% and 121,7%, while Catalonia is at 110,9%.

Catalonia has had traditionally more oscillations in the economic cycle than Spain, probably because of the industrial specialization (with less public employment[5]) with predominance of SMEs, and therefore more exposed to international competition and credit constraints. Re-

5. For example, in the first quarter of 2008 public sector wage earners were 17.4% of the total in Spain while less than 10% in Catalonia (while close to 30% in Extremadura).

cently the cycles have tended to converge, most likely because of the similar residual role of agriculture in both Spain and Catalonia as well as a higher weight of services in the Catalan economy. (See Figure 2.3).

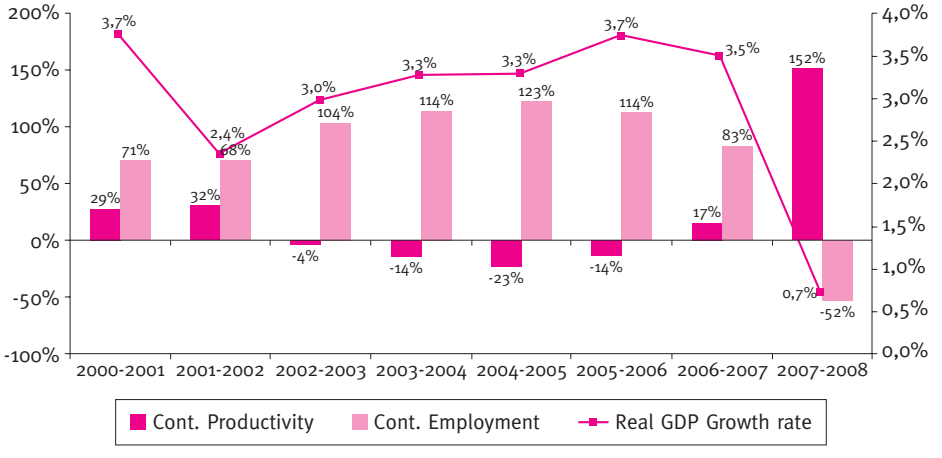
Figure 2.3: GDP Evolution. Real annual growth rate, in percentage



Note: 2009 is forecast from Departament d'Economia i Finances, March 2009. For Spain, European Commission, Economic Forecast Spring 2009.
Period 1981-1995, homogeneous series base 1986. Period 1996-2008, homogeneous series base 2000.
Source: INE.

Recent growth per capita in Catalonia (and Spain) has been due to job creation (employment over population) and not productivity increases. See Figure 2.4 which shows the percentage growth of real GDP in Catalonia in the period 2000-2006 and splits the growth of real GDP between productivity and employment in a 100 scale. From 2000 to 2006 Catalonia's real GDP has grown 3.1% annually on average cumulative rate while population has grown at 2.2% delivering a GPD per capita annual cumulative growth of 0.8%. The rate of growth of real GDP was 3.5% in 2007 while it declined to 0.7% in 2008. It is worth noting that the negative contribution of productivity of 2003-2006 is reversed in 2007 and, dramatically so, in 2008. The reason is that job destruction has been much more marked that the output fall.

Figure 2.4: Real GDP growth in Catalonia (right scale) and contribution of employment and productivity to it(left scale)[6] 2000-2008



Source: Spanish Regional Accounts (INE).

Growth has been driven by domestic demand. (See Figure 2.5 which reports up to 2006). And there are estimates that internal demand has grown more than potential output generating inflation above the Spanish (and Euro area) averages. In fact, Catalonia has typically had a positive inflation differential with Spain of up to 0.5% in recent years.[7]

Since mid 1990's European labor productivity growth is lower than the growth of productivity in the United States[8], both in the whole economy and in manufacturing and services, and the one in Catalonia and Spain has been clearly lower than the average growth in the European countries. Table 2.1 documents this fact with numbers for the period 1995-2003. (See also Figure 2.6)[9]

6. Real productivity is measured as the ratio of real GDP to employment. Then:

$$\Delta\% \text{ Real productivity} = \Delta\%\text{Real GDP} - \Delta\%\text{Employment}$$

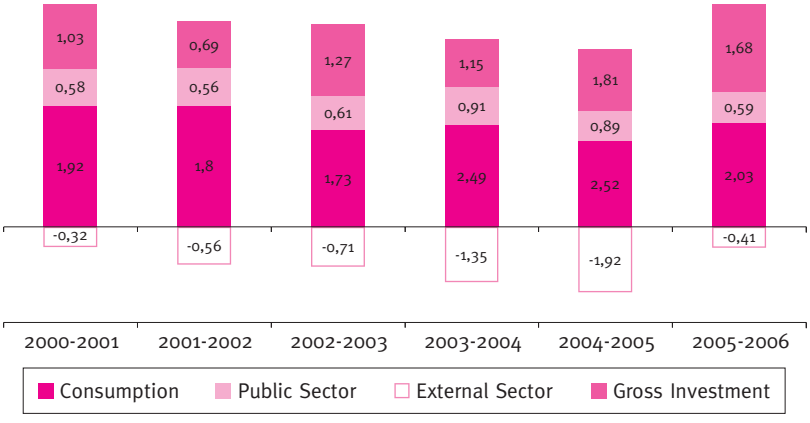
and

$$\frac{\Delta\%\text{Real GDP}}{\Delta\%\text{Real GDP}} = \frac{\Delta\%\text{ Real productivity}}{\Delta\%\text{Real GDP}} + \frac{\Delta\%\text{Employment}}{\Delta\%\text{Real GDP}}$$

The right hand side summands are the contribution of real productivity and occupation to real GDP growth.

7. However, between April and November 2008 the differential reversed, recuperating its typical behavior from then on again.
8. See Alesina and Giavazzi (2006) for a statement of the reasons why productivity has been lagging in Europe in relation to the US.
9. Note that different sources used in this report calculate "labor productivity" using at times different definitions. Those are shown in a note below each table/figure.

Figure 2.5: Contribution of the components of demand to Real GDP growth in Catalonia, 2000-2006



Source: Competitivitat de l'economia catalana 2000-2006, CTESC (2008).

Table 2.1: Labor productivity growth in Spain, European Union and United States 1995-2003 (average rates in %)

	1995-2000			2000-2003		
	Spain	**EU-15**	**US**	**Spain**	**EU-15**	**US**
Manufacturing	1.0	2.6	2.8	1.8	3.6	7.1
Services	-0.3	1.3	2.4	0.1	1.2	3.1
Economy	0.4	1.9	2.2	0.9	1.9	3.5

Productivity computed as GDP per hour of work.
Source: Jaumandreu (2009).

The average labor productivity of the (until recently) 25 EU members has been growing at a slightly higher pace than the productivity of the 15 former members. The difference in the level of productivity between these two groups had been reduced up to only 6.5% by 2005. Catalonia maintained in the mid 1990's a small advantage on the EU-15 average. This advantage has been lost and by 2005 its productivity is in between the levels of the two aggregates. Spain, which initially maintained only a weak advantage with respect to the EU-25 aggregate, showed by 2005 a level of labor productivity slightly lower. (See Table 2.2).

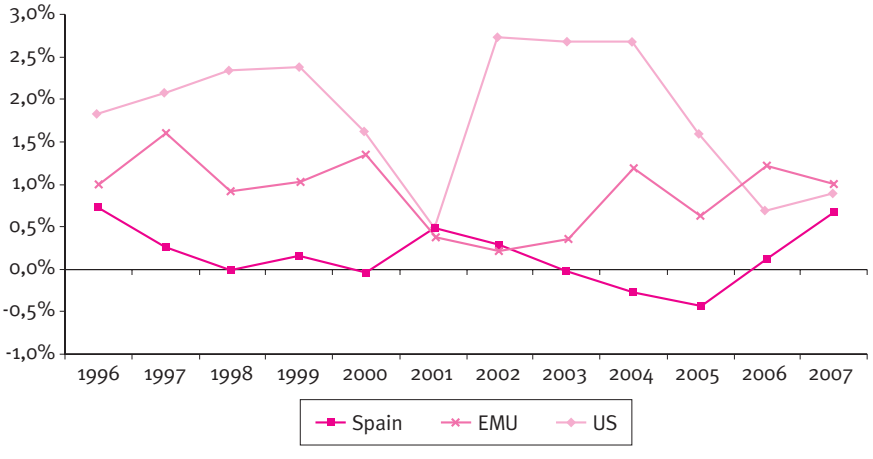
Table 2.2: Labor productivity in the EU

	Level with respect EU-25		
	1995	2000	2005
EU-25	100.0	100.0	100.0
EU-15	109.3	108.3	106.5
Spain	103.7	97.9	97.3
Catalonia	111.7	102.0	104.6

Source: Jaumandreu (2009). Productivity is computed as GDP (PPS) per person employed.

GDP per worker (in PPS) in relation to EU-25 (= 100) has gone from 112 in 1995 to about 105 in 2005 (in Spain it goes from 104 to 97). This is below the EU-15 level which is 106.5 in 2005. If the reference is EU-15 Catalonia has gone from being above at 102 (the result of dividing the Catalonia level in 1995 by the EU-15 level in the same year) in 1995 to being below at 98 in 2005 while Spain has gone from 95 (by dividing the level of Spain in 1995 by the EU-15 level in the same year) to 91,4.

Figure 2.6: Labor productivity annual growth rates



Source: Bank of Spain, AMECO[10].

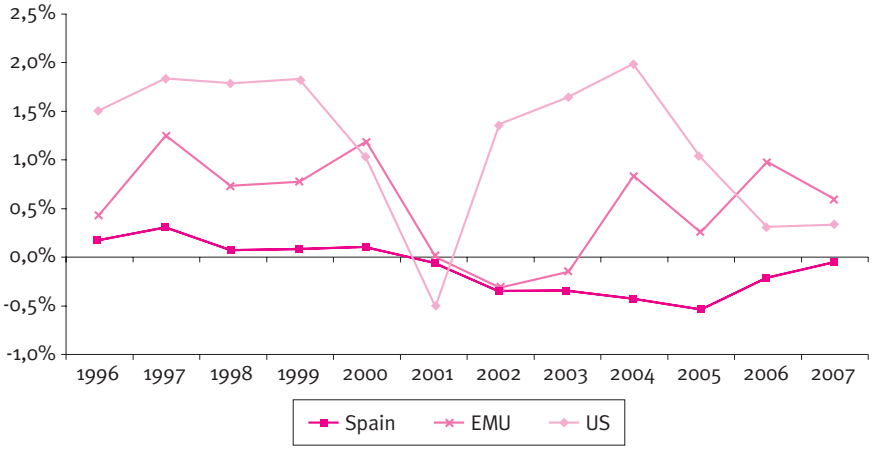
With regard to *total factor productivity* (TFP), from the 1990s Catalonia has had lower TFP growth than the Spanish average (with negative growth in 1996-2000 while Spain had barely

10. Bank of Spain (Spain and EMU): Productivity is calculated as GDP at constant prices and PPS of 2005 divided by the number of persons employed (full time equivalent) according to the National Accounts. AMECO (USA): Gross domestic product at 2000 market prices per person employed.

positive growth, see Figure 2.7 for Spain).[11] For example, for large firms (more than 250 workers) Catalan firms in the period 1994-2004 had a TFP growth smaller than in the rest of Spain. Interestingly, Catalan firms which trade abroad have a larger TFP growth (something we will return to later on), as well as new entrants. The trade effect is not present for firms of the rest of Spain.[12]

In Spain labor productivity growth has been near zero between 1998 and 2000, with positive rates the next two years, turning negative later on up to 2006. In 2007 labor productivity has an increase of 0.6%. On the other hand, TFP has negative growth rates from 2001 until 2007, achieving -0.5% in 2005. Labor productivity growth in the EMU area has been well above Spanish rates through the whole period (only below in 2001 and 2002) while increases in TFP have been consistently larger in the EMU area, although negative between 2001 and 2003. (See Figure 2.6 and Figure 2.7)

Figure 2.7: Total factor productivity annual growth rates



Source: Banco de España, AMECO[13].

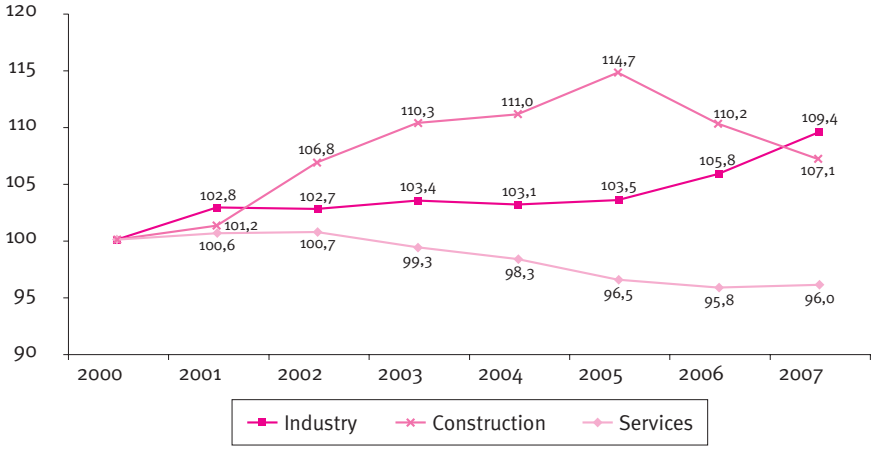
Population, immigration, and employment

Catalonia and Spain have created employment at significant rhythms. The employment rate in Catalonia was in 2007 almost 4 points above the EU-15 average (57.8% vs. 54%) and unemployment was 0.5% point under this same reference average (6.5% vs. 7%). The difference with

11. See Gual, Jódar, and Ruiz (2006).
12. See Segarra and Teruel (2007). An interesting observation is that firms with external trade activity enjoy large margins in upswings than other firms (and margins converge in downturns).
13. The growth rate of this variable is proxied by the differential between the growth of real output (GDP) and the growth of primary inputs (capital and labor) weighted by their share of total income. This indicator is expressed in the form of an index with 1995 = 100.

respect to what happened to employment in the average of the rest of European countries is so important than some have suggested a relationship between the slowdown in the growth of productivity and the creation of jobs in low productivity sectors, particularly construction and services. However, in the period 2001-2004 estimates of productivity growth for the construction sector are above those of industry. This is reversed in 2006 and 2007 (see Figure 2.8). During the construction boom a lot of employment was created in the construction sector but the appreciation of real estate was such that productivity increased. When the boom shows signs of lessening then the value appreciation is moderated. We see in the figure also that the productivity of services declines steadily since 2000.

Figure 2.8: Productivity across sectors in Catalonia, 2000-2007 (2000 = 100) [14]

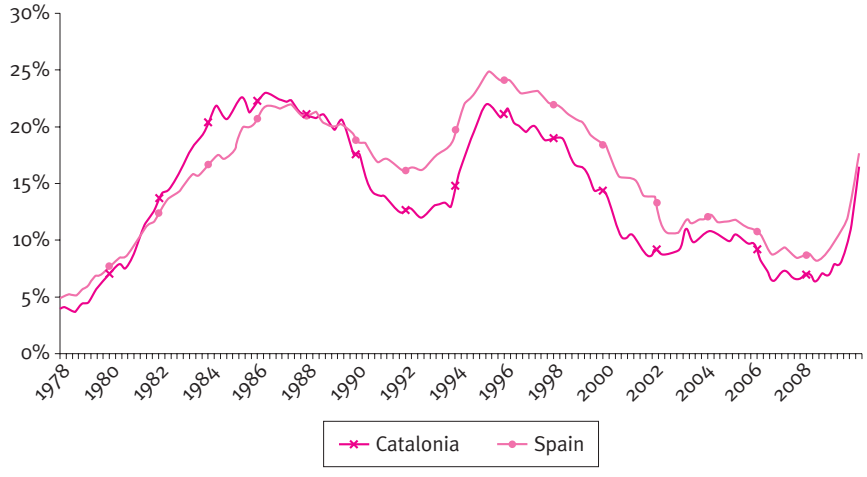


Source: Spanish Regional Accounts (INE).

However, the crisis has implied a dramatic change with unemployment rates for 2008 of more than 11% in Spain and of 9% in Catalonia. The projected unemployment rate for Spain in 2009 is up to 20% for the end of the year. Recently, Catalonia has tended to have an unemployment rate below the average in Spain although in crisis periods tends to catch up or even overshoot (as in the industrial crisis of the early to mid eighties). In the first quarter of 2009 unemployment is at 16.2% in Catalonia and 17.4% in Spain. (See Figure 2.9). Furthermore, Catalonia has a high share of temporal contracts –up to 25%– which has remained quite stable over time with some decline in 2008. This is similar to Spain with a share for temporal contracts typically of more than 30% but contrasts with EU-27 with average shares in the 12-14% range. (See Figure 2.10).

14. Sector real productivity is measured as the ratio of gross value added to employment (jobs).

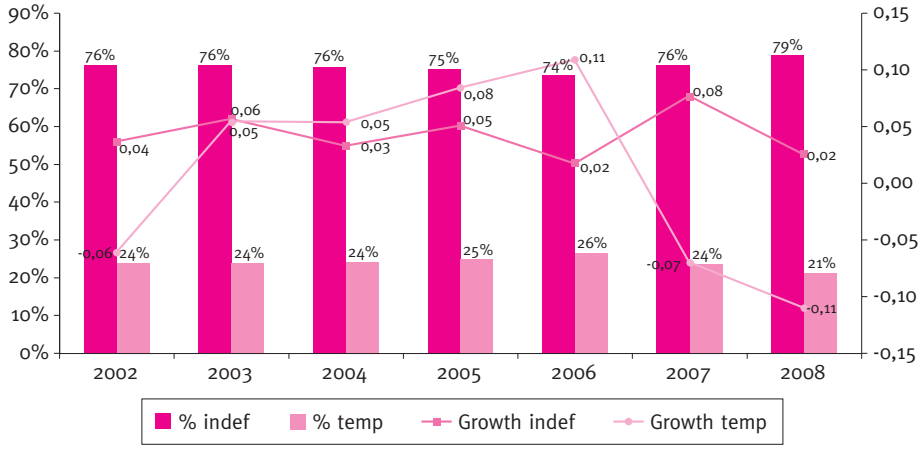
Figure 2.9: Unemployment rate evolution, 1976-2009I (quarterly average)



Source: INE.

Catalonia has been very dynamic in population growth, reaching an annual average of 0.45% between 1995 and 2000 and around 2% between 2000 and 2007. In 2007 (2008) population was around 7.2 (7.4) million and a 13.5% (15%) of them were foreign (while only 2.8% in 1999), who in a high percentage are at the low end of the skill spectrum.

Figure 2.10: Duality in the Catalan labor market.
Left axe: percentage of indefinite/temporal contracts. Right axe: annual increase



Source: Idescat.

In *summary*, *increases in employment explain increase in GDP per capita and not increases in productivity*, which are now between the lower EU-25 level and higher EU-15 level. This creation of employment has been accompanied by an important *demographic dynamism with big increases in population due to immigration.*

Economic structure

The sectoral structure is converging with EU-15 (Eurostat 2005) with larger weight in gross value added (GVA) of industry (23% in relation to 20%), construction (10% vs. 6%) and tourism (7% vs. 3%). (Spain has less weight in GVA in industry, 17.7%, and more in construction, 12.2%). It is worth noting that the weight of construction in GVA in Catalonia almost doubled from 1985 to 2005. The weight of industry is in between Rhône-Alpes and Lombardy (and way below Baden-Württemberg 34%).[15] The weights in terms of industrial employment are similar: 22% for Catalonia, in between Rhône-Alpes and Lombardy (and way below Baden-W 32%). Catalonia is below the weight of other industrial regions like Piedmont, Emilia-Romagna or Bavaria). *Catalonia is an industrial region more diversified than other industrial regions of reference* (with the exception of Rhône-Alpes). The tendency has been for the weight of industry to decrease overtime (for example, in 2000 it represented 25.8% of GVA while in 2008 this is down to 19.2%). Catalan industrial GVA as share of total Spanish industrial GVA is above 25% (with a mild decreasing tendency from above 27% in 1995). It is interesting to note that the weight of the public sector in GVA at 17.4% is below Spain (21%), above Lombardy and Ireland, close to Baden-Württemberg and below Denmark at 27%.

The size distribution of Catalan firms is biased towards SMEs, family-owned firms and industrial firms. It is worth noting that the percentage of firms with less than 20 workers is just above 97% (the figure for Spain is similar). For large firms (more than 250 workers) active Catalan firms in the period 1994-2004 are smaller on average than those of the rest of Spain. However, new firms are larger.[16] The distribution of headquarters among the 500 largest firms by sales in 2000 was 52.6% for Madrid, 21.8% for Catalonia (and 5.4% for the Basque Country). The corresponding selling volume distribution was 60.67% for Madrid, 16.60% for Catalonia and 7.38% for Basque Country.[17] In 2005 there were 29 Spanish companies in the Forbes ranking of the largest 2000 companies of the world. Among them only three had its headquarters in Catalonia.[18] Regarding the location of the Spanish subsidiaries of the 100 largest transnational companies in 2002, 50% of them were located in Madrid, whereas 31% were located in Catalonia (and the Basque Country accounted for 4%).[19]

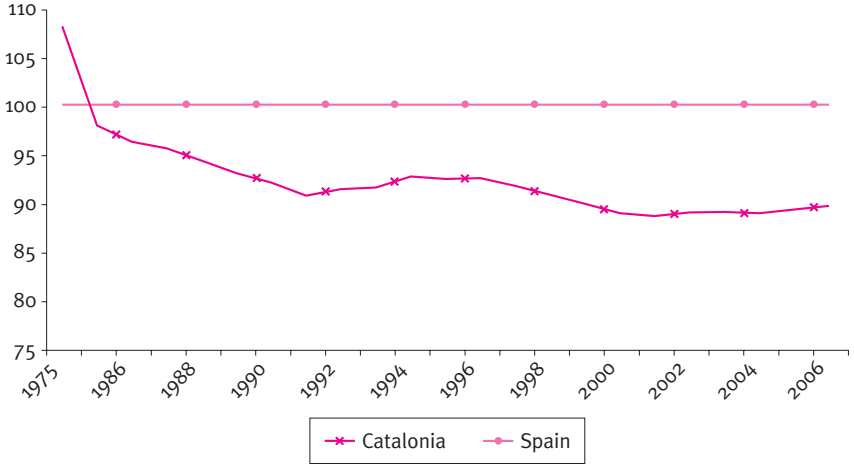
15. Obviously, if we were to take a broader perspective on what "industry" means its weight on GVA would be much higher (see Baró and Villafaña (2009)).
16. See Trigo (2009), and Segarra and Teruel (2007).
17. Vives (2002).
18. Gas Natural, Banco Sabadell and Abertis.
19. Solà and Miravitlles (2009).

2.2. Endowments and institutional environment

The endowments behind the economic performance of Spain and Catalonia are natural (geography and climate), capital (infrastructure, productive, technological, human, and social), and the legal and regulatory environment.[20] We will deal later with technological and human capital more at length. Here we summarize briefly some main indicators.

Catalonia has lagged behind in public infrastructure since 1975, with a per capita public infrastructure endowment from the 1990s which oscillates around 90% of the average Spanish region. (See Figure 2.11)[21]

Figure 2.11: Relative net capital stock in public infrastructure per inhabitant, Spanish average=100



Source: FBBVA, IVIE and own elaboration.

When dealing with the different types of transport infrastructures railroads is the only type in which Catalonia is above Spain's average in the period 1990-2006, airports and ports have also a relatively better position in 2006 than in 1990. (See Table 2.3).

20. This is to be understood in a broad sense. Indeed, not much can be done to change the climate while investment changes the different stocks of capital, and laws and the regulatory environment can also be changed, although there is a lot of inertia.
21. Public infrastructures include highways, water treatment, railroads, airports, ports, and urban infrastructure. It excludes toll roads. Regional data available until 2006. The definition of net capital stock is "the market value of an asset in a concrete year that must equal its present value discounted to the income this asset is expected to generate."

Table 2.3: Net capital stock in public infrastructure per inhabitant

	Highways		Airports		Railroads		Ports	
	1990	2006	1990	2006	1990	2006	1990	2006
Catalonia	93,3	81,5	88,5	96,3	132,2	134	96,8	105
Spain	100	100	100	100	100	100	100	100

Source: own elaboration from IVIE and INE databases.

Catalonia has received systematically public investment below its weight in Spanish GDP (at 18.7% in 2007). On average between 1991 and 2004 Catalonia has had about 19% of Spanish GDP, 15.5% of the population but 12% of public infrastructure investment. For example, since 2000 Catalonia has received between 11% and 16% of the total centrally regionally allocated public investment. Furthermore, in the period 1997-2007 only 66% of the budgeted investment was executed. (See Table 2.4).

Table 2.4: Budgeted versus realized investments by the State in Catalonia

Year	(Budgeted / Realized)
1997	83.8
1998	144.5
1999	61.8
2000	45.5
2001	67.2
2002	70.0
2003	64.6
2004	58.6
2005	61.7
2006	68.9
Total	66.1%

Source: Trigo (2009).

With respect to the level of education of the Catalan economically active population in 2007, 43% had studies up to secondary education (ISCED level 0-2), 25.7% up to high school and vocational training (ISCED 3-4), and 31.2% University education (ISCED 5-6). The corresponding percentages for 2000 were, respectively, 49.8%, 22.4% and 27.8%. This is not far from the corresponding percentages for Spain in 2007 of 44.6%, 23.6% and 31.8%, respectively.[22] The level of education in relation to the

22. Eurostat. The International Standard Classification of Education (ISCED) divides educational level attained in 6 levels, although it is commonly used by grouping them in three groups: 0-2 (from pre-primary education to lower secondary education), 3-4 (from upper se-

EU-27 is low and with a low proportion of high school and vocational training (25.7% in Catalonia versus 49.2% in EU-27) but, somewhat surprisingly, Catalonia and Spain show a higher proportion of University studies (31.2% in Catalonia versus 25.2% in EU-27). This education composition of the population looks potentially dysfunctional for an industrial region like Catalonia.

It must be added that Spain has a relatively low rate of students who are in vocational training in a higher secondary education framework in the OECD, and is last in the percentage of alternation between vocational training and general education (for 2006, 2.2% versus, for example, 44.2% in Germany or 11.6% in France). In Spain, and Catalonia, professional training has not been emphasized and lacks social consideration and integration with the general education system. The result is a stagnation or even decline in the number vocational training students.[23] Finally, although Spain doubles the percentage of population in EU-27 between 18 and 24 that has not completed secondary education and is not doing any other type of study or training (31% in Spain for 14.8% in EU-27 in 2005), it is remarkable that 10.4% of people between 25 and 64 participate in education and training in 2007 in Spain for 9.7% in EU-27.[24]

The University system has improved in its research capabilities (we will see this in chapter 6) but it shows a poor performance in terms of high rates of students quitting –between 30 and 50% depending on the field – and the average years required to finish (6.3 years for a 4-5-year degree). The causes of this state of affairs, according to experts, have to be found in the bureaucratization of the system and the lack of autonomy and problems in the governance and financing of Universities.[25]

Government spending on education was 3.4% of GPD in 2005 while it was 4.2% in Spain and around 5% in EU-15. The difference between Catalonia and Spain is explained in part by the higher supply of private education in the former. We will see in chapter 3 that structure and incentives in the system are more important for performance than money spent on secondary education.

In relation to technological capital, R&D spending as part of GDP has an increasing tendency, at 1.48% in 2007 (1.04% in 2001), above the Spanish average at 1.27% but below EU-15 at 1.91%. The private sector accounts in 2007 for 63% of R&D total spending (68.4% in 2000), an equivalent participation as in the EU-15, at around 65%. Employment in R&D also tends to increase: in absolute terms the number of full time equivalent R&D personnel increases in Catalonia annually 9% between 2002 and 2007, achieving 43.000 R&D workers. In relative terms, in 2007 Catalonia has 1.23% of R&D personnel over total employment (0.91% in 2000) while 1.63% for the EU-15.

Corporate innovative effort in technology slows down from 2000 to 2004 as a percentage of GDP. We will return to this in chapter 4.

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condary education to post-secondary non tertiary education) and 5-6 (from first stage to second stage of tertiary education).

23. Data from OECD and the Spanish Ministry of Education. See Homs (2009).
24. Eurostat and LFS. See Homs (2009).
25. See Fundación CYD (2009).

Patents per capita are far from the EU-15 level (specially on information and communications technology ICT– and high-tech), however, the use of ICT is converging to the European level. Scientific citations are still far from EU-15 level (although scientific production per million inhabitants at 387 is not so far from OECD average at 468 in 2005). In the European Regional Innovation Scoreboard of 2006 Catalonia is in the position 82/208 (while, for example, Madrid is 31/208), and in the European Innovation Scoreboard of 2008 at national level Spain is 16 in the ranking of EU-27.

In terms of the burden that economic regulation and public administration impose on business Spain is doing poorly. According to the "Doing Business 2009" report by the World Bank Spain is 49/175 in ease of doing business, far from other European countries (Denmark is at 5/175 and Ireland 7/175, for example). Spain fares particularly poorly in terms of ease to start a business, employ workers, or paying taxes. Spain has heavier regulation than the average OECD country in terms of market, economic and administrative regulations which translate into higher barriers to entrepreneurial activities. (See Table 2.5). The rigidity in the Spanish labor market is also particularly noticeable in the OECD context (for example, in terms of employment protection). According to a World Economic Forum poll restrictive labor regulations are, by far, the most problematic factor to do business in Spain. Other factors, in order, are access to financing, inefficient government bureaucracy, inadequate labor force, and tax rates.

The EU, with the Lisbon agenda, Spain and Catalonia have started programs of administrative simplification in order to ease the regulatory burden. Their effectiveness remains to be seen.

Table 2.5: World Bank and World Economic Forum's rankings of Spain

World Bank Doing Business		**World Economic Forum**	
Numbers correspond to ranking position (181 countries)		**Most problematic factors to doing business**	
	Spain (49)	Spain	Percentage
Starting a business	140	1. Restrictive labor regulations	17.3%
Dealing with licenses	51	2. Access to financing	13.0%
Employing workers	160	3. Inefficient government bureaucracy	12.6%
Registering property	46	4. Inadequately educated workforce	11.6%
Getting credit	43	5. Tax rates	10.9%
Protecting investors	88	6. Inadequate supply of infrastructure	9.3%
Paying taxes	84	7. Inflation	9.1%
Trading across borders	52	8. Policy instability	6.4%
Enforcing contracts	54	9. Tax regulations	5.5%
Closing a business	19	10. Poor work ethic	2.2%

Source: World Bank (2009), WEF (2009).

2.3. International trade

Catalonia accounts for an important fraction of Spanish exports (around 27% in 2008), and has in 2005 a non-negligible world export share that has increased up to 0.5%. Foreign trade has mainly an intra-industry character, and has, for the period 2002-2007, 70% of exports concentrated in the EU-15 and 75% in Europe 27. Imports are concentrated as well, and the degree of openness to trade as measured by exports plus imports over value added reached 67% in 2007, 20 percentage points more than in Spain. The latest years covered by the trade data show some evidence of deterioration of the competitive position, apparent in examples like the inability to penetrate the rapidly increasing Asian market and the deterioration of the balance in consumer durables. Market shares of Catalan products in the world market grew until 2003. From then on export penetration tends to decrease in all areas. (See Table 2.6).

Table 2.6: Catalonia's export shares

	World	China	South and Central America	European Union (15)	European Union (27)
1995	0.46%	0.17%	0.68%	0.84%	n.a.
1999	0.52%	0.08%	1.01%	0.94%	0.91%
2003	0.56%	0.12%	1.10%	1.03%	0.99%
2004	0.53%	0.08%	1.00%	1.00%	0.96%
2008	0.46%	0.06%	0.65%	0.89%	0.84%

Source: Idescat, MITyC, WTO. n.a.: not available. Export shares of Catalonia are calculated as the ratio of Catalan exports to a specific country/region over total imports of that country/region.

If we focus attention on the evolution of both the structure of exports and the relative commercial advantage (computed as exports-imports over the sum of exports and imports) with products classified according to their technological content during the period that ranges from 1994 to 2005, we find that, in general, Catalonia imports from EU and exports to Spain, and increasingly to the EU, mostly products of middle-upper technology. Comparing the periods of 1995-2001 and 2002-2007 Catalonia has intensified its export flows to the EU-27 while diversifying its imports extending them to new EU members and Asia. Actually, imports from New Member States have doubled between the two periods and achieve 3% of total imports while imports from Asia have gone from 16.5% to 19% of the total.

Catalonia has a non-negligible portion of exports of products of high technological content, consisting mainly of electronics and pharmaceuticals. With the growth of exports of these products over time, their joint share in exports has increased up to 12% while the trade deficit has diminished. This is the most dynamic part of exports. It must also be said, however, that the trade deficit in electronics has remained virtually the same since the intermediate year 2000.

More than half of Catalan exports are goods of medium-high technological content. Most of these products are vehicles and chemicals, which together constitute almost 40% of total exports. The exports of chemicals have increased in relative terms continuously over time and the trade deficit has shrunk. As we will see in chapter 4 the trade deficit in chemicals turns into a surplus if we consider interregional flows. This is because Catalonia acts as import hub for rest of Spain. The share of vehicles has slightly decreased while a trade deficit has replaced what was almost the only surplus of the 1990's. The evidence on the export behavior of other goods in this technological category is also mixed. Significant shares of machinery and electrical goods have decreased over time while the deficit has increased. Precision instruments and other transport with small shares, present more positive evolutions.

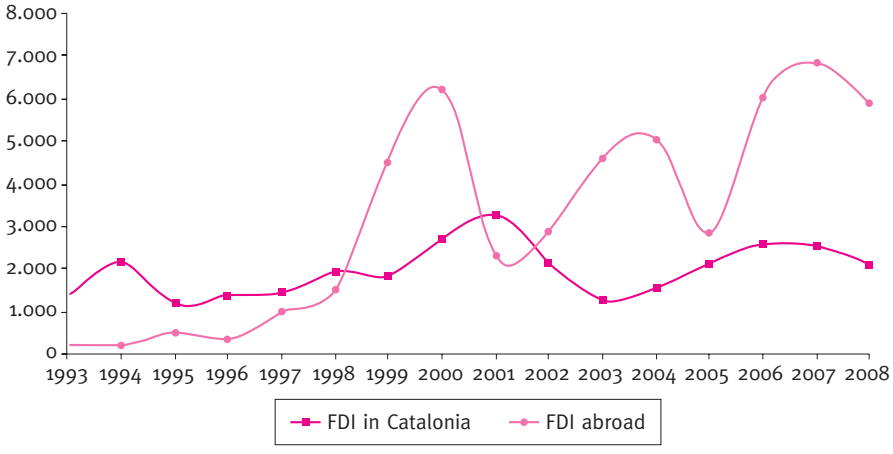
During the same period, exports of goods of low technological content decreased from a quarter to one fifth of total exports. The exports of textiles decreased in relative terms while the trade deficit grew. The exports of foods, instead, grew to 9% of total exports while the deficit in food products decreased, at least until 2000. The evidence on other goods of low technological content is mixed (for example, more positive on paper, more negative on wood).

In summary, exports of low technological content are shrinking in relative terms (e.g. textiles) despite good behavior of some exports (e.g. food), and exports with a high technological content (e.g. electronics, pharmaceuticals) are increasing their share in total exports despite the extreme weaknesses in some high-tech areas (e.g. computing). The bulk of exports, concentrated in traditional exports of goods of medium-high technological content, have split their behavior in good (e.g. chemicals) and not so good (e.g. vehicles, electrical, machinery).

2.4. Foreign direct investment

Catalonia goes from a negative to positive net position in terms of foreign direct investment (FDI) abroad (Catalan investment abroad minus foreign investment in Catalonia): from about -2% of GDP in 1988 to a balanced position in 1998 to an oscillating positive balance thereafter (with the exception of a negative position in 2001). (See Figure 2.12). Catalonia invests in EU-15 (about to 70% in the 2002-7 period), Latin America (about 13%) and North America (about 5.5%). In the period 2002-2007 FDI abroad has a strong manufacturing component (with food industries, chemistry and other manufacturing representing 50%) while about 40% goes to services (retail, finance, real estate). In 2007 major sectors of investment abroad were transport and communications, energy and water, and chemicals.

Figure 2.12: FDI flows in Catalonia (million Euros)



Source: DataInvex, Ministerio de Industria, Turismo y Comercio.

FDI in Catalonia has oscillated with a somewhat decreasing inflection from 2001. From 2002 and until 2007, according to Idescat and on average, received investment typically goes to real estate (up to 20%), chemicals (around 16%), retail (14%), manufacturing (9%) and food industries (close to 9% also). In 2007 Catalonia attracted real estate investment (26%), food and drinks (21%), and chemicals (24%). Comparing with the period 1995-2001, we can appreciate that in 2002-2007 there is an increase in the relative weight of chemicals, which gains close to 4 points, whereas there is a decrease of manufacturing and the transport sector (the latter falling from 9.5% to 5.9%). Food industries, textile and real estate maintain its share. In terms of new establishment FDI Catalonia has received 24,2% of the Spanish total for the period 2000-2007. As usual, participation of foreign capital is larger in larger firms (both in manufacturing and services). Around 95% of the investment received in Catalonia comes from countries of the OECD, and up to 70-80% from EU-15 countries.[26]

The end result is an accumulation of tangible fixed assets in companies with foreign capital for 22.6%, corresponding to 26.1% of employment, of the Spanish total in 2006. (See Table 2.7).

26. See Amarelo, Fernández and Saló (2008).

Table 2.7: Shares of tangible fixed assets and jobs generated by FDI in Spain (Dec. 2006)

Autonomous Comm.	Tangible fixed assets of companies with foreign capital	Employment in companies with foreign capital (jobs)	Total employment (jobs)
Madrid	25.5	27.8	15.2
Catalonia	22.6	26.1	17.3
Andalusia	9	8.4	15.8
Valencia	5.7	6.5	11
Basque Country	4.8	5.3	5
Other Aut. Comm.	32.4	36	36.4
Total Spain	100	100	100

Source: Invest in Catalonia[27].

Data of the Ministry of Industry, Trade and Tourism confirm also is also that the share of investment received by Catalonia and Spain from 1993-2001 to 2002-2006 has decreased in manufacturing and increased in services (in particular wholesale trading and real estate). An exception in manufacturing is the chemical sector and knowledge intensive service sectors (banking and finance, telecommunications and corporate services) which both increase their share. In general the share of investment received by Catalonia and Spain has decreased in knowledge intensive sectors. It is also interesting to note that part of FDI in Spain comes ultimately from Spanish companies operating from places such as the Netherlands. In the period 2002-2008 up to 6% of FDI in Spain has ultimately a Spanish origin.

There is evidence also for the period 2002-2006[28] that Catalonia has shown notable dynamism in receiving FDI: it attracts FDI projects from large firms only behind Ireland in EU-15. Catalonia attracts FDI from the established base of multinationals with continuity and expansion projects in traditional sectors like chemical, plastics, food and drinks, transport equipment, and also in emerging sectors like life sciences and pharmaceutical. It competes for the traditional sectors with Eastern Europe and also with central European regions like Flanders.

27. Data on Spain's FDI stock (or FDI position) drawn from the annual reports of the companies that receive capital from non resident investors corresponding to shares of at least 10% in the company.
28. A database of 411 multinationals and 10,525 FDI projects which are representative of those investing in Catalonia; the study considers regions of investment which are proper regions of a state or small countries (Torrens and Raluy (2008)).

3. Secondary education

It is not necessary to underscore the importance of human capital for productivity and growth. In fact, the modern economic strategy for a region to emphasize innovation and the development of the economy based on knowledge makes no sense without a very qualified and learned work force. More in general, we can say that a country is basically what the human capital of its people is. Recently, alarms have sounded on the declining quality of education in Catalonia (and Spain). In particular this is the outcome of the PISA (*Programme for International Student Assessment)* study conducted by the OECD, which has raised many comparative issues about the effectiveness of the different school systems in advanced countries.

The question is: What are the factors behind the underperformance of Catalan and Spanish students? Are environmental and background factors to blame, like the education of parents or the level of immigration, or rather the intrinsic quality of the education system?

Indeed, it has been suggested that the poor performance of Spain was partly due to the still relatively low education levels of Spanish parents and that, in fact, Spain was doing well once the family background was accounted for.[29] In Catalonia there is the perception that the large immigration flows between 1996 and 2006 could have affected the Catalan PISA performance. The Generalitat has proposed that schools with a high level of immigrant students integrate them first in separate groups and have a special adaptation regime.[30]

In this section we overview first the position of Catalonia in secondary education, we move then to the analysis of Ciccone and García Fontes who quantify how much of the Spanish and Catalan PISA scores can be attributed to the education levels of parents and to immigration levels, and what part must instead be explained by other factors. We end with some policy implications.

29. This is what Spain's Prime Minister Rodriguez Zapatero meant when stating, shortly after publication of the 2006 PISA results, that "the main determinant of the education of each generation is the education of the parents, together with the education received in the educational system". Spain's Minister of Education, Mercedes Cabrera, even argued that the Spanish education system was doing well once teenagers' family background was taken into account.
30. When commenting on the Catalan PISA results, the Catalan Secretary of Education, Ernest Maragall, argued "that Catalonia is a changing region due to the growth, mobility and diversity of its population".

3.1. The position of Catalonia

The PISA international education survey tests reading, mathematical and scientific literacy in terms of general competencies (i.e. how well students can apply the knowledge and skills they have learned at school to real-life challenges) of 15-year-olds. It is worth noting that Catalonia has increased to 98% (since 1994 about 7 points) the percentage of schooled 15 year olds. This has proved a challenge since there is the widespread perception that the education systems of Catalonia, as well of Spain (which has increased the schooling percentage in 4 points to 97.5%) are underperforming. Their 2006 PISA average scores have been below the OECD average in the three subject areas (science, math, and reading skills), and did not improve with respect to the 2000 and 2003 reports. Table 3.1 reports the scores for Catalonia and Spain in relation to some reference countries and EU averages.

Table 3.1: PISA results 2006

	Science	Math	Reading
Finland	563	548	547
Hong Kong	542	547	536
Germany	516	504	495
Ireland	508	501	517
EU-15	503	498	492
EU-25	503	498	490
Denmark	496	513	494
France	495	496	488
Catalonia	491	488	477
Spain	488	480	461
Italy	475	462	469

Source: OECD, PISA 2006.

To this data other negative performance measures, like the number of students repeating a course and failures in graduating from secondary compulsory school ESO (up to 30%), are among the highest in Spain (with an average of 25%). Similarly, the percentage of students (from 18 to 24 years old) who abandon the education system without completed secondary studies beyond compulsory school is in the high end of Spanish regions and EU countries: 34% in 2005 (this doubles the figure for the Basque region, for example, and is higher than the Spanish average at 31%, which already doubles the EU-25 average). An important factor in this outcome is the low graduation rate for professional training (*formación profesional*).

Altogether Catalonia is 15 points below the EU average in terms of the percentage of the population of 20-24 years that has gone beyond secondary post-compulsory school. This percentage has, in fact gone down since 2000, most likely due to the impact of the influx of low skilled young immigrants.

If we were to look at tertiary education Spain (and Catalonia) do much better (with a 28% of University degrees among the adult population, 4 points above the EU average). The picture is bleaker, however, if we consider advanced education in science and technology areas where the number of graduates has been stagnant since 2000.

3.2. Spain

The question to be answered is: How would the Spanish (and Catalan) PISA scores have compared with other regions and countries if all had the same parental education levels and immigration levels. If correcting for those factors we find no differential performance of Catalan and Spanish students then this means that the education system is not to blame for a relative poor performance. If, on the contrary, we find that correcting for those factors there is still a differential performance, then the education system is suspect. Apart from this, and obviously, in a country with a high stock of immigrants the educational system should be designed to accommodate –and remedy the effects of– heterogeneity.

We start with the Spanish case. The starting position in PISA 2006 is that Spain, in relation to Europe (with 23 European countries in the sample), performed 11 points below average in science, 14 points below average in math, and 24 points below average in reading. The gap in PISA scores between Spain and the top performer in Europe (Finland) is 76 points. *Spain is in the bottom third in science and the bottom quartile in math; in reading, only two countries do worse.*

Let us consider in turn the effect of controlling for parental background and for the level of immigration. Consider upper-level secondary education as a reference level of parental education. When regressing 2006 PISA student scores for, respectively, science, math and reading, Ciccone and García Fontes find the following effects of the educational background of parents:

Table 3.2: Parental education effect

	Science	Math	Reading
Father illiterate	-42.9	-41.9	-42.2
Father primary school	-26.4	-25.8	-25.7
Father basic secondary	-19.9	-15.3	-18.1
Father college	16	15.7	12
Mother illiterate	-62.6	-53.9	-61.5
Mother primary school	-40.2	-37.3	-43.4
Mother basic secondary	-25.4	-21.1	-28.5
Mother college	10.4	11.7	6.6

Source: Ciccone and García-Fontes (2009).

We see that the education levels of parents play a very important role for students' PISA performance in all European countries. For example, teenagers whose mothers have basic secondary schooling only, average more than 20 points less in science, math, and reading than teenagers whose mothers have upper secondary schooling. If both mother and father have basic secondary schooling instead of upper secondary schooling, the gap becomes more than 40 points. The question is: where would Catalonia and Spain stand in PISA if other countries and regions had the same parental education levels?

The situation of Spain changes when we consider students from a similar *family background*. For example, if we consider teenagers whose parents have left school with a lower secondary school degree and have been born in the country, Spain is 13.9 points above average in science, 13 points above average in math, and 7.7 points above average in reading. These comparisons cannot be generalized of course as they concern just one specific group of students. But they do indicate that the Spanish PISA score may be below average partly because of the low educational attainments of parents. In fact Ciccone and García Fontes find that *accounting for the low education levels of Spanish parents, Spanish PISA performance is somewhat above average in science and math, and average in reading approximately*.

We confirm therefore that the low education levels of Spanish parents influence Spain's poor PISA performance. However, compared to the European average, *Spain does relatively worse when we consider teenagers with college educated parents or parents with upper secondary school*, than when we consider teenagers with parents that have a lower secondary education. For example, Spanish teenagers with parents that have completed upper secondary school perform 5.2 points above average in science, and 7.6 points above average in math. The children of college educated parents are at or below the average in both science and math. This indicates that the *Spanish PISA performance in science and math need not automatically rise above average as parental education levels catch up to the European averag*e. In fact when we ask what Spain's PISA performance would be if parental education levels were equal to the European average, we find that more than half of the European countries in our sample would continue to do better than Spain in science and math.

The authors also examine to what extent PISA scores vary across countries and regions because of differences in *immigration* levels. The result is that for the comparison of Spain with other European countries, *accounting for immigration makes little difference*. Basically, this is because levels of immigration are similar in many European countries.

In summary, when correcting for parental background Spain improves considerably in PISA performance, although there is considerable room for improvement, and immigration does not make much of a difference. Do the same results apply to Catalonia?

3.3. Catalonia

For Catalonia the comparisons are with other Spanish regions that participated in PISA plus Lombardy, Flanders, and Denmark, which makes a group of 14 regions and coun-

tries. Catalonia does quite poorly in this group, either 3rd or 4th from the bottom depending on the subject tested.

In contrast to Spain, *accounting for parental education levels does not change the comparative performance of Catalonia significantly*. Catalonia scores 12 points less than average in science and 14 less in math. Accounting for parental education levels, the same gaps are around 10 and 12 points respectively. The comparison with some of the leading performers is especially interesting. For example, looking at the average of the math and science score, Catalonia does 47 points worse than Flanders. Controlling for parental education levels, this gap shrinks but is still 37 points. La Rioja's and Castile and Leon's math and science average score exceed Catalonia's average score by 33 and 28 points respectively, although they have quite similar parental education levels. However, in reading, Catalonia is only somewhat worse than average to start out with and improves slightly when parental education is taken into account.

With respect to immigration, the same result as for Spain holds for the comparison of Catalonia with the reference group: *accounting for immigration makes little difference*. In Catalonia the concentration of immigrants at some schools has been of concern. The authors show that *while concentration of immigrant students is greater in Catalonia than in many other countries and regions, this is not an important factor behind the poor Catalan PISA performance*. For example, the percentage of immigrant at a school can explain, at most, 5 points of the difference in scores between Catalonia and La Rioja. As we can observe as follows, controlling for immigration (column 3) and controlling for immigration and adding a dummy for students studying in a school with more than 10% immigrants students (column 4) does not suppose big change in differences in average results.

Table 3.3: Comparison of regions

	Unconditional average	Parental education	P. educ. + imm. control	P. educ + imm. control + >10% control
Difference between				
Science				
La Rioja-Catalonia	28.2	26.7	25.6	24.9
Castile and Leon-Catalonia	28.4	26.8	23.3	20.3
Math				
La Rioja-Catalonia	38.3	37.2	36.2	35.5
Castile and Leon-Catalonia	27.4	26.2	23	19.8
Reading				
La Rioja-Catalonia	14.4	12.9	9.6	10.8
Castile and Leon-Catalonia	1.3	-0.6	-6.1	-8.2

Source: Ciccone and García Fontes (2009).

In summary, *the performance of Catalan students does not change significantly when taking into account either parental background or the level of dispersion of immigration at schools*.

A difference between the Catalan system and others is that students are in a bilingual situation where Catalan is the main school language. Could this be the cause of the poor relative performance of Catalonia? This hypothesis is not consistent with the fact that in reading skills, where supposedly the effect should be greatest, Catalonia is about average in the reference group and it improves when taking account parental background. *This fact points at some intrinsic qualities of the Catalan education system as the culprit.* Here we can only speculate on the deep causes but we can dismiss some usually alleged factors.

To start with it has been pointed that Catalonia spends very little public money in non-University education in relation to GDP or per student. Two observations are necessary in this respect. First, Catalonia has a large private provision education system (up to 40% of students, with partial public financing). Second, the results of the international studies find weak effects of educational expenditures on school performance. The analysis of Ciccone and García Fontes yields similar results. Across Spanish regions participating in PISA, there is only a very weak (and statistically insignificant) effect of secondary school expenditures on PISA performance adjusted for parental education and immigration status. Across European countries there is a statistically significant but very small effect of secondary school expenditures on adjusted PISA scores. Similarly, there is no correlation between the ratio of student per teacher and PISA proficiency in mathematics or reading.[31]

Some studies about Catalonia[32] have pointed out that there is an important gap in performance between public and private schools, but this can be attributed to the different composition of students, and that the schools that separate students in groups according to performance do worse. With respect to the latter, it is possible that schools that have more students with weaker backgrounds will tend to separate them in groups and therefore it cannot no be inferred that group separation is bad. In fact, to the contrary, one may think that schools that manage to cater to the least performers and stimulate the best performers with separate treatments keeping an essential class unity will be the schools that will come ahead.

3.4. Conclusion

The academic literature suggests that school autonomy associated with parental choice has positive effects on the performance of the educational system, while centralized meritocratic systems also work well. Cross-country evidence based on PISA-type data correlates achievement measures with data on how the system is managed in each country (characteristics such as the degree of school autonomy, the prevalence of central exams, the importance of private vs. public financing, and man-

31. Calmfors et al. (2006).
32. Ferrer, Valiente and Castel (2008).

agement). The evidence suggests that the combination of autonomy and meritocracy works best. For example, these studies show that school autonomy typically works best in countries where a central nation-wide exam takes place at the end of high school, while it has insignificant effects in the absence of a central exam.[33] That is, the setting that according to the academic literature is most conducive to school quality is *school autonomy subject to performance evaluation*.

Furthermore, substantial improvements can be obtained *fostering competition*, both among students to get into the good schools and among schools to attract the good students. Equal opportunity can be preserved if the financing of education remains public or if private financing is sustained by vouchers for a large enough amount. Pure public financing favors equal opportunity, since students can in principle access the same educational resources regardless of their family background. But it gives little incentives to be cost-efficient. Pure private financing is not egalitarian (indeed, achievements are more likely to depend on family background, the lower the share of public financing), but it leaves more room for cost-efficiency and price competition. However, price competition does not seem to have managed to bring down the costs of private schools, in part because in most countries the poor, who are the ones who should care about costs, cannot afford private schools and send their children to public schools instead. This suggests that a generous voucher system, in which a large fraction of school costs is covered by vouchers, might be a good mechanism to reconcile price competition with equal opportunity.

A new law proposal on education is under discussion in the Catalan Parliament. The project is consistent with some of the reform ideas outlines above: modernization of managerial schools structures (with more professional school managers), giving more decision capacity to schools and to parents to choose school, and introducing incentives to differentiate and compete between schools. A touchy issue will be the establishment of immigrant per school quotas with the idea of avoiding concentration. Recently the President of the Generalitat José Montilla has announced the implementation of an evaluation at the end of primary school in order to have an objective standard to measure the quality of the education system. A central agency will be created to monitor the performance of schools. The new law proposal also states that at least a third language, apart from Catalan and Spanish, should be learned and that some courses could be taught in this foreign language, supposedly English.

In summary, to improve Catalan school performance schools should have more autonomy with a central exam for students, and school evaluation programs have to be implemented rigorously. Competition among schools should be fostered and for this autonomy and transparency are crucial. Autonomy to compete for students and professors, and transparency on the performance of schools (e.g. with the publication of rankings of results) so that parents can make informed choices. All this should be done in a frame where the authority of professors is firmly established and the culture of excellence and effort promoted. And last, but not least, the use of English as working language at school should be implemented decisively with a credible timetable. The proposals in the new law seem to go in the right direction but not far enough.

33. Calmfors et al. (2006)

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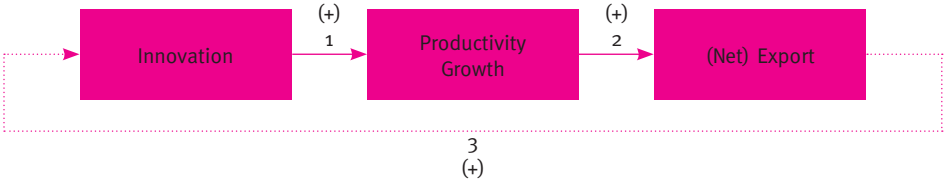
4. Productivity, innovation and trade

The long term growth prospects of an economy depend on the evolution of its productivity. The importance of productivity is increased by increasing cross-border integration: a domestic industry that is a productivity laggard might simply stagnate in a segmented world, whereas a more integrated world may threaten its very survival. And of course, the pressures on laggards peak during demand downturns, which lead to drop-offs in productivity because of sagging capacity utilization and labor hoarding if the industry survives, or mass unemployment otherwise.

Much attention has been paid, as a result, to not just measuring levels of and changes in productivity but also to understanding the antecedents of productivity growth, and to examining its consequences. While there is a vast literature on this topic, at a very basic level, most of it seem to conform to the "Standard Model" depicted in Figure 4.1: a representation in which innovation drives productivity growth (link 1), and success in international markets, usually measured by exports or net trade surpluses, is a key outcome (link 2). According to a variant on the Standard Model, there is also a positive feedback effect from exports to innovation (link 3 in the figure), but the evidence in that regard is less clear.

Figure 4.1: Antecedents and Consequences of Productivity Growth: the Standard Model



The foci of the Standard Model happen to dovetail with some of what are widely agreed to be problems with the Catalan (and Spanish) economy, as documented in the sections 4.1 and 4.2, reporting the work of Jaumandreu, which, among other things, makes use of some new, particularly extensive survey data. Productivity growth has been demonstrably slow in Catalonia –lower than in the rest of the EU as well as in the United States. The significantly lower intensity of expenditures on innovation is an obvious suspect, with some corroboration supplied by

Jaumandreu's observation of relatively weak productivity growth in medium –or high– tech manufacturing sectors in Catalonia despite the presumably richer technological opportunities in there as well as the intuition that they represent the most likely sectors for a high-wage region like Catalonia to grow exports in. And exports are a key concern because deficits on international trade have been very large. The productivity-depressing consequences of the current downturn (should) make this nexus of issues loom even larger in policymaking.

The remaining three sections in this chapter of the book can be read as looking in more detail, with new data, at each of the three links in the figure above. They have some fresh, even controversial implications that we will discuss later focus on digging deeper into the components of the Standard Model to provide, in conjunction with the data, some fresh insights into the productivity-innovation-trade nexus. Here, we provide the briefest of summaries of their focus and key findings.

The work of Cassiman and Golovko, reported in section 4.3, can be read as reexamining (possible) link 3 in figure 4.1 above. They unbundle both innovation and trade –the former into product and process innovation and the latter into exports and imports. On the basis of survey data, there is indeed a feedback effect from international trade to innovation, but it seems to derive more from imports than from exports. In addition, there is evidence of two other kinds of links not in the figure: directly from imports to exports (transshipment?) and from product innovation to exports without boosting productivity (product adaptation for international markets?)

The work of Ghemawat, Llano and Requena, reported in section 4.4, reexamines link 2 to look at interregional as well as international trade flows. Doing so shifts readings of Catalonia's external trade balance from very negative to positive, flags its role as an import hub for Spain and alters diagnoses of which sectors generate external surpluses and who its key trading partners are. Additional insights emerge from estimating border effects, including the insight that interregional trade may have a more important contribution to make to growth than it did between 1995 and 2005.

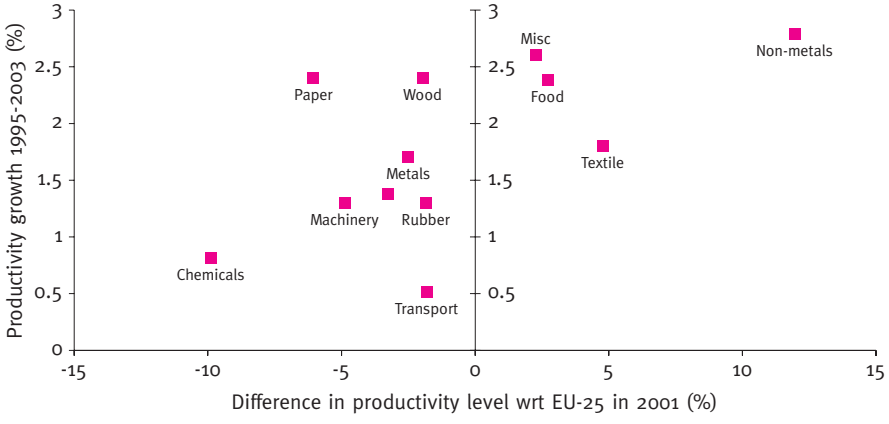
4.1. The evolution of productivity and international trade in manufacturing: a first look

We have seen in chapter 2 how labor productivity has slowed down in Catalonia, as in Spain. As a result, since the mid-1990s, Catalonia's relative position with respect to the average labor productivity in the European Union has deteriorated, although there are some signs of a (partial) recovery after 2000.

More specifically, comparisons of productivity in manufacturing show a small productivity disadvantage in 2001-2 for Catalonia versus the EU-25 countries as well as a slightly larger advantage relative to Spain. Around 1/3 of the difference between Catalonia and Spain can be attributed to differences in the mix of manufacturing sectors, but such differences explain very little of the difference with respect to Europe. The industries in which Catalonia shows a higher productivity relative to the EU-25 levels are, significantly enough, industries usually classified as low-technology sectors (nonmetals, textiles, food).

Another striking pattern shows up when one relates the productivity differences between Catalonia and the EU- 25 countries by sector in 2001-2002 with the average growth rates of productivity in these sectors for the whole period 1995-2005. Figure 4.2 depicts the relationship, which indicates that productivity growth is higher in the sectors in which Catalonia exhibited a productivity advantage and lower in most of the sectors in which it showed some disadvantage (namely chemicals, machinery, electrical goods, metals, transport equipment, and rubber and plastic). So with the exception of paper and wood, which exhibit productivity disadvantages but high productivity growth, the figure suggests a perpetuation of productivity differentials instead of convergence over time. Note that that all the sectors with fast productivity growth (some of them with high productivity advantages) are sectors usually classified as low technology sectors, while all sectors with the slow productivity growth (and some productivity disadvantages) are sectors usually classified as medium to high technology sectors. This potentially problematic pattern will be revisited later in this chapter and in the next one.

Figure 4.2: Catalonia productivity advantages with respect to EU-25 and productivity growth

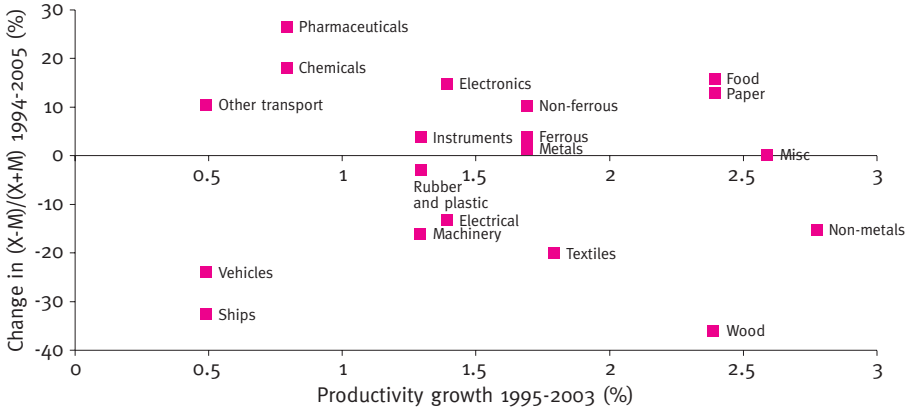


Source: Jaumandreu (2009).

Focusing on the dynamics of productivity for Catalan small and medium enterprises (SMEs) on a sectoral basis shows that comparing across the 1990-99 and 2000-06 periods, productivity levels have improved for all firms in *textiles, office machinery and computing, machinery and equipment, electronics and electronic equipment,* and *chemicals* sectors. In two other sectors, *food, tobacco and beverages* and *motor vehicles and other transport equipment*, we do not observe such generalized productivity improvements. In food, tobacco and beverages, the low productivity firms improved their productivity, while in motor vehicles and other transport there is no clear pattern. It is also interesting to note that some of the sectors that showed rapid productivity growth –e.g., textiles and food– experienced significant drops in the number of firms, suggesting a link between restructuring and productivity growth that will be examined in more detail in chapter 5.

The link between these productivity measures and trade –link 2 in the standard model– is summarized in Figure 4.3, which relates changes in revealed trade advantages (exports minus imports over the sum of exports and imports) against productivity growth. The patterns here are less clear-cut. Some sectors improved their position in international trade despite their poor record in productivity (pharmaceuticals, chemicals, electronics and other transport), and others saw their positions deteriorate despite their high productivity growth (non-metals, textiles, wood). Yet other sectors have their productivity gains and competitiveness more closely aligned (food and paper for good, vehicles for bad). This puzzle will be addressed further in section 4.4.

Figure 4.3: Catalonia's revealed international trade versus productivity growth



Source: Jaumandreu (2009).

To summarize this section, productivity growth in Catalonia has been relatively high in sectors of low technology content, many of them in which Catalonia has a productivity advantage, but more modest in the sectors of higher technological content.

4.2. Innovation activities

The intensity of R&D/innovation efforts has increased in Catalonia and Spain since the mid 1990s irrespective of whether they are measured in terms of inputs or outputs. However, but their levels remain far below those reached in comparable European countries and regions.

Table 4.1 summarizes the evolution of R&D expenditures in percentage of GDP, until the latest year for which there are comparable data for all the instances of interest. Innovation expenditures show a similar pattern. Catalonia spends more on R&D than the average for Spain,

and the gap between the two in terms of private R&D, in particular, has increased over time (although Spain seems to do better in terms of publicly-financed R&D, with this last component having a much larger weight in Madrid in particular).

Table 4.1: R&D Expenditures (% of GDP)

	Total				Private				Public			
	1995	2000	2004	2007	1995	2000	2004	2007	1995	2000	2004	2007
EU-27	1.8	1.85	1.82	1.83	1.14	1.21	1.18	1.19	0.67	0.63	0.64	0.65
EU-15	1.85	1.91	1.89	1.91	1.17	1.26	1.23	1.25	0.68	0.65	0.67	0.67
Spain	0.79	0.91	1.06	1.27	0.39	0.5	0.58	0.71	0.4	0.41	0.48	0.55
Madrid	1.61	1.57	1.65	1.92	0.84	0.88	0.93	1.14	0.76	0.7	0.71	0.79
Catalonia	0.89	1.06	1.33	1.48	0.55	0.72	0.88	0.93	0.33	0.34	0.44	0.55

Source: Eurostat, INE

Looking at the broader set of innovation indicators in Table 4.2, *Spanish (and Catalan) firms do not innovate much: actually, the percentage of firms describing themselves as innovators has actually decreased since 2000. And when local firms do innovate, they innovate in processes rather than in product and, relatedly, have much lower propensity to patent their innovations*. From these and other examples, firms from Catalonia seem to be comfortable in an equilibrium characterized by a mild technological content and a pattern of intraindustry specialization requiring only modest innovation. We will return to this point and will revisit possible explanations in the next chapter.

Focusing just on Catalonia, it clearly has some distinctive features. First, the proportion of firms with R&D activity is higher in Catalonia than elsewhere, and much higher in the case of small firms (in particular, comparing with Madrid). Second, the average R&D effort of Catalan firms is smaller than the effort of firms from Madrid in the case of the big firms and even than the effort of the firms of the rest of Spain in the case of the small firms. Third, Catalan firms have enjoyed until now an advantageous position, both in the number of firms performing innovative activities and in the introduction of process and product innovations, but in a context of weak general activity. However, this is accompanied by a much lower innovative effort in the firms that perform these activities in relation to Madrid. This may be partly related to the particular composition of activities in the two places. In any case, Catalonia doesn't escape the signs of lack of dynamism after 2000.

Jaumandreu, in his empirical analysis of Catalan and Spanish firms, confirms that innovation expenditures and activity strongly influence total factor productivity. Even controlling for detailed industry level productivity effects, the outputs of firms show a high elasticity with respect to the R&D expenditures embodied in the "knowledge capital of the firm" –similar to or even higher than the elasticity with respect to physical capital.

Table 4.2: R&D and Innovation at the firm level

	Small firms						Big firms					
	1991	1994	1997	2000	2003	2006	1991	1994	1997	2000	2003	2006
Catalonia												
Proportion of firms with R&D expenses	0.307	0.300	0.296	0.313	0.283	0.355	0.798	0.796	0.778	0.700	0.743	0.776
R&D expenses/ Sales*	2.6	2.3	2.1	2.1	1.4	2.3	1.6	1.9	1.7	1.7	1.7	1.6
Firms introducing process innovations	0.294	0.346	0.311	0.326	0.208	0.278	0.552	0.628	0.516	0.614	0.426	0.534
Firms introducing product innovations	0.235	0.255	0.245	0.246	0.191	0.204	0.423	0.482	0.389	0.543	0.416	0.371
Rest of Spain												
Proportion of firms with R&D expenses	0.148	0.159	0.182	0.173	0.165	0.186	0.644	0.690	0.681	0.691	0.660	0.670
R&D expenses/ Sales*	2.6	2.4	2.2	2.4	2.6	2.4	1.6	1.7	1.7	1.4	1.4	1.6
Firms introducing process innovations	0.257	0.246	0.289	0.268	0.168	0.203	0.527	0.499	0.543	0.564	0.365	0.393
Firms introducing product innovations	0.184	0.195	0.206	0.185	0.122	0.130	0.385	0.391	0.454	0.428	0.302	0.356
Madrid												
Proportion of firms with R&D expenses	0.159	0.208	0.231	0.177	0.156	0.196	0.701	0.758	0.787	0.655	0.711	0.511
R&D expenses/ Sales*	3.4	3.3	2.9	2.1	2.3	3.1	3.0	2.7	3.0	2.2	2.2	2.0
Firms introducing process innovations	0.210	0.198	0.347	0.298	0.176	0.196	0.517	0.484	0.557	0.466	0.400	0.378
Firms introducing product innovations	0.203	0.217	0.247	0.189	0.141	0.139	0.437	0.387	0.607	0.500	0.400	0.289

Source: Computed with ESEE data (Jaumandreu (2009)) * Defined as R&D expenses divided by sales and multiplied by 1.000.

His analysis also indicates that innovation has also an important location component. Location matters because of the tendency of innovation activities and the necessary human capital to cluster in specific metropolitan areas. Globalization by providing firms with a larger market enhances innovation incentives but certain regions may be favored over others as more desired

locations for R&D activities. The existence of a critical mass of human and technological capital and a suitable infrastructure are necessary conditions to reach a viable competitive position in the global market. The evidence from agglomerations such as information technology in Silicon Valley and biomedical activities in Boston suggests a tendency for technological advanced activities to cluster-although clustering is also evident in low tech sectors. The former clusters tend to obtain where there is a high concentration of human capital; presence of leading international education and research centers (like Stanford for Silicon Valley or MIT/Harvard for the Boston area); access to a thick and advanced market of suppliers and services; availability of venture capital financing; and good quality of life.

It is not surprising therefore to find that *the geographical location of the innovation activities matters for their effectiveness*. There are very large geographical differences in the productivity impact of innovation activities. In the Spanish context the *impact of innovation expenditure doubles if performed in Catalonia or in Madrid, and there is evidence of mutual spillovers from performing expenditures in the two places at the same time*. The important lesson is that R&D activities can have a very different impact in productivity according to its location, presumably due to spillovers, and that a firm strategic location decision to absorb spillovers may be important to enhance productivity.

Engaging in broader comparisons, the pattern of expenditure in Catalonia (breakdown in terms of business enterprises, government and higher education) is aligned with European regions like Baden-Württemberg or Rhône-Alpes or countries like Ireland or Denmark) but the level of expenditure still remains well below the indicators for the EU-15 and even the EU-25. In addition, the proportion of firms that undertake innovative activities is lower, the occasional performers are more numerous, the innovation efforts of firms that perform innovative activities and technological cooperation are low as well, and all this is not explained well by differences in the mix of manufacturing sectors.

4.3. Innovation and international trade[34]

How do process and product innovation relate to competitiveness as revealed through imports and exports? Cassiman and Golovko examine this broad set of issues, i.e., look in more detail at link 3 in the Standard Model presented in Figure 4.1.

The self-selection of Catalan firms into the export market turns out to follow a clear pattern: firms make productivity enhancing investments and as a result the more productive firms start an export activity, which might make these firms even more productive. Productivity and firm export status are strongly positively correlated and that exports are positively affected by productivity. The comparison of productivity distributions of exporting versus non-exporting firms shows that exporting firms outperform non-exporting ones in terms of productivity.

34. This section is based on the work by Jaumandreu (2009) and Cassiman and Golovko (2009).

Two types of productivity enhancing investments made by Catalan firms are evident: (1) The fact that a firm imports some of its inputs seems to positively affect productivity and, hence, exports. The results show that firm current import status is positively and significantly correlated with productivity. Importing firms are also highly related to higher productivity firms.[35] (2) The fact that a firm has innovated in the previous year seems to positively affect productivity. Innovation –both product and process– has a positive significant relation with productivity. Moreover, firms' previous innovation status plays an important role in explaining the productivity differences. Firms with innovation activities outperform non-innovating firms in their productivity levels. The results also show that firms with import and innovation activities also have the highest productivity level measured as value added per employee.

Product innovation seems important in the *decision* to start to export, but process innovation is important in the *share* of exports in total sales. Product innovation gets firms to export, while process innovation improves export performance. There also seems to be an important difference between the effects of product innovations versus process innovations: product innovations seem to matter more for the export decision of Catalan firms. Innovating in product in a current year increases the probability of becoming an exporter next year by 9%. On the other hand, process innovations have little or no effect on the decision to export. This is in line with the literature on the internationalization process of firms where firms enter into the export market after having developed new products for the domestic market.

In general, cost advantages, cost advantages related to innovation, and product innovations all explain significant portions of variance of exports across firms. It is found that successful product innovations are associated to simultaneous process innovations lowering the cost of products. The evidence points at "cost related" input improvements (e.g. through imports) which lead to (and help) product innovations that lead in turn to success on the export market. Importing increases the probability of exporting the next year by 9.5%. Those costs advantages linked to innovation have a bigger impact on exports than any other cost advantage.

Exports are also very persistent. Once a firm enters the export market it is very likely to remain in the export market for a while. The fact that a firm exported in a previous year increases the probability that the firm will be exporting in the current year by 66%. If a firm exported two years ago, the probability that the firm exports in a current year increases by 27%. This is consistent with the fact that there are sunk costs to enter export markets. Furthermore, Catalan exporters do seem to enhance their productivity even after having made these productivity enhancing investments. We observe the highest number of exporters (85%) in the subsample of firms that also perform import and innovation activities.

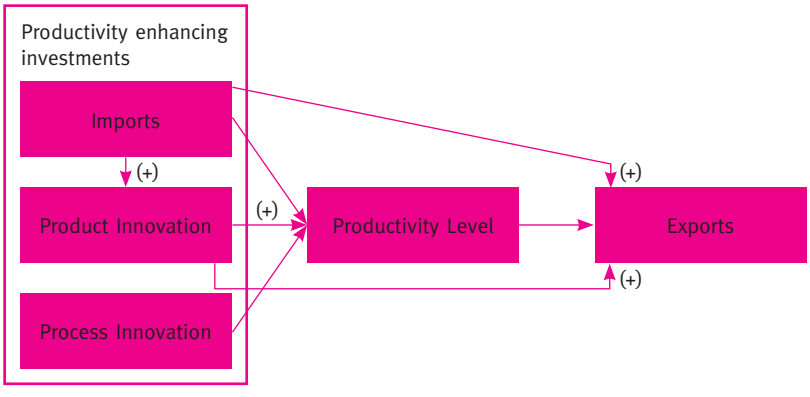
It is worth emphasizing that *innovation is directly affected by imports*. The evidence indicates the following succession of activities by the firm. Firms import and as a result generate better new products. Most product innovations are related to new designs and/or presentations of the product and less to new components, new materials or new intermediate products. Based on the data for importing firms,

35. Jones and Kierzkowski (2001) argue that geographical fragmentation of the value chain is behind productivity increases.

about 79% of their product innovations incorporate new design or presentations, while only about 50% deal with new materials, components, and functions. This suggests that Catalan importers provide some value adding transformations of the product. This in turn allows these firms to enter the export market. Once they start exporting firms are very likely to remain in the export market for a while.

Figure 4.4 summarizes the findings and enriches the Standard Model. *Firms that import and innovate improve their productivity and export, which turns into a persistent activity. Imports in particular induce product innovations which in turn make the firm start exporting. Process innovation then helps in getting volume and market share in the export market.*

Figure 4.4: Innovation, productivity and trade



4.4. Interregional and international trade: border effects

Ghemawat, Llano and Requena (2009) focus in on goods trade as well, but use interregional data to extend the usual definition of trade to include interregional (within Spain) as well as international trade in their analyses. This has numerous interesting implications. First of all, confirming the importance of the phenomenon, Catalonia's estimated interregional trade in goods is slightly larger than its international trade. Second, taking interregional flows into account helps identify Catalonia's role as a trading (particularly import) hub for Spain, and shifts readings of its external trade balance from chronically negative to positive. Third, it also changes diagnoses of which Catalan sectors are "competitive" in the sense of running external trade surpluses: thus, in food and beverages, a sector discussed in more detail in the next chapter, a large international trade deficit is offset by a much larger interregional trade surplus, yielding a large overall external surplus for Catalonia. Fourth adding in interregional trade reveals a clear linkage between changes in Catalonia's external trade position and Catalan productivity growth, suggesting that Catalonia is specializing in sectors that offer it the highest productivity growth rates: a sensible pattern, but not one that is apparent if one looks at just Catalonia's interna-

tional trade (as we have seen in section 4.1). Fifth, the addition also changes and expands the list of Catalonia's key external trading partners: Valencia, not France, turns out to be the largest –but a similar list of cultural, administrative, geographic and economic (CAGE) factors seems to determine who the key partners are at both the interregional and international levels. Finally, estimating border effects yields additional insights, including the surmise that interregional trade may have more of a contribution to make to Catalan growth in the future than it did between 1995 and 2005.

While these are all empirical attractions of looking at interregional as well as international trade, the original motivation for this line of analysis is conceptual, and is prompted by the observation that studies of (subnational) regional competitiveness mostly imitate studies of international competitiveness in focusing on international trade patterns as indicators of revealed advantage. In so doing, they gloss over the novel element exposed by digging down from the national to the regional level: the importance of economic interactions *across regions within the same nation* as well as across national boundaries. Given that gap, this analysis of Catalan trade in goods is aimed not just at those interested in the Catalan economy *per se*, but, more broadly, as an illustration of the importance of expanding the standard focus on international trade to also account for interregional trade.

Catalonia turns out to be a particularly striking illustration of the importance of accounting for interregional trade, for a number of reasons. First of all, such flows have tended to be larger than international trade flows. As Table 4.3 indicates, over the period between 1995 and 2006 –and actually for each year within that period– Catalonia traded much more with Spain (intra- plus interregional trade) than with the Rest of the World. Although Table 4.3 captures this relationship just for goods, it holds a fortiori when services (generally less tradable than goods) are also taken into account. The relationship applies to both exports and imports. It has not been static, however: its evolution suggests a slow but progressive increase in the openness ratio to foreign markets that will be discussed later in this subsection.

Table 4.3: Spatial distribution of the Catalan trade of goods

Average 1995-2006. All goods (agriculture and energy included). Million Euros and growth rates

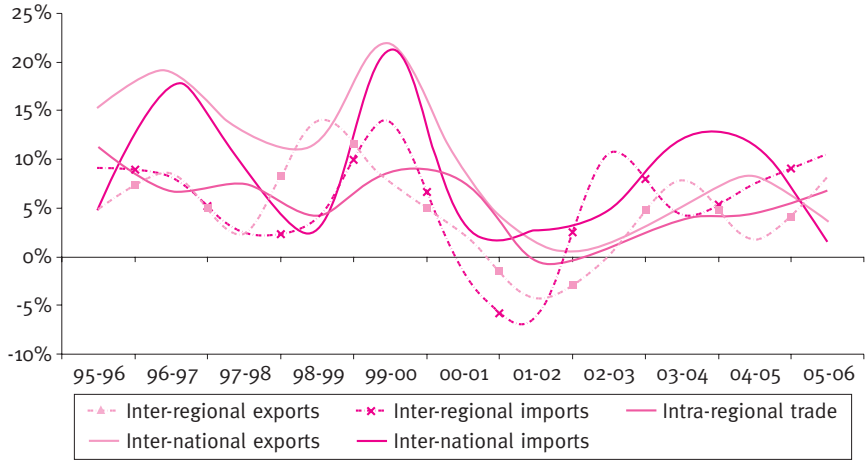
	Own region -1	Export to		Imports from		Balance		Openness Ratio (2+3+4+5) /(1+2+3)
		Spain -2	World -3	Spain -4	World -5	Spain (6)=(2-4)	World (7)=(3-5)	
Catalonia	40410	41835	32284	24025	46764	17810	-14479	126%
Rest of regions	106514	161513	85060	179324	113516	-17811	-28456	152%
Spain Total	146924	203347	117344	203347	160279	0	-42935	140%
1995-2006 (Growth rate)								
Catalonia	80%	64%	144%	79%	166%	44%	215%	12%
Rest of regions	106%	105%	121%	99%	181%	44%	502%	5%
Spain Total	99%	96%	127%	96%	177%	-	374%	6%

Source: Ghemawat, Llano and Requena (2009).

Second, interregional trade, in particular, is not only the largest single category of trade for Catalonia but taking it as well as international trade into account shifts readings of Catalonia's external trade balance from sharply negative to positive: from an average international trade balance over 1995-2006 of -€14.5 billion –a third of the total Spanish international deficit– to an average total external balance, interregional and international, of €3.3 billion. This shift reflects the fact that Catalonia exports much more to the rest of Spain than it imports from there. Coupled with Catalonia's international trade patterns –high volumes of imports, much lower exports– it suggests that the best single way of characterizing the external trading relationships in which Catalonia is embedded is that it functions as an international import hub for the rest of Spain. This is a finer-grained characterization than the usual conception of Catalonia as a bridge between Spain and the rest of the world –but exposing it requires information about interregional as well as international flows.

It is also clear from Table 4.3, however, and even clearer from Figure 4.5, that the relative importance of international trade has increased since the mid-1990s, and that of interregional trade decreased. This result, which also applies to other Spanish regions, contrasts with previous findings in the case of the US and Japan where as international integration proceeded, the fragmentation of the value chain led to strong spillovers across the boundaries of individual regions and so to rapid growth in interregional trade as well.[36]

Figure 4.5: The evolution of Catalan trade of goods by main markets (1995-2006)
Growth rates of trade in current prices. Million Euros. All types of goods.



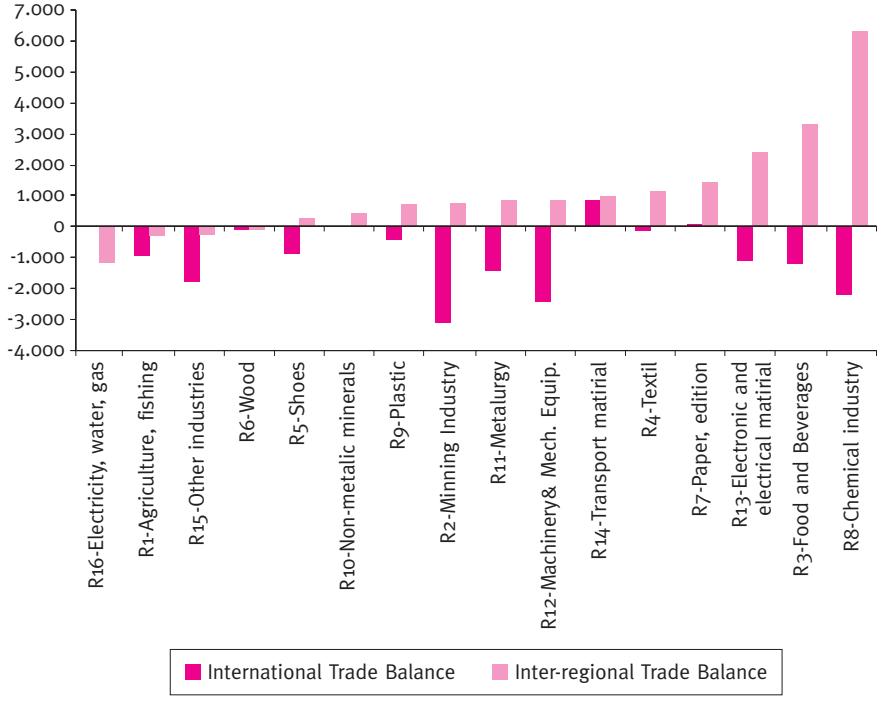
Source: Ghemawat, Llano and Requena (2009).

36. Jackson et al (2006), Feenstra (1998) and Jones and Kierzkowski (2005).

Sector-level patterns

Disaggregating overall trade data by sector and by trading partner further illustrates the difference that accounting for interregional trade can make because it shifts readings of Catalonia's external balances by sector. As Figure 4.6 illustrates, external competitiveness looks very limited when one focuses just on international trade, with the diagnosis being aggravated by the observation that transport machinery (looked at in detail in the next chapter), the one sector reported to yield a substantial international trade surplus over 1995-2006, actually experienced deteriorating competitiveness over the course of this period and was running substantial international trade deficits by its end. Accounting for interregional trade greatly expands the range of the Catalan goods sectors that are assessed to generate external surpluses and, even more interestingly, reveals that certain sectors that appear to generate large international trade deficits for Catalonia actually generate significant external surpluses when interregional trade is taken into account. Chemicals and food and beverages –the latter is studied in more detail in the next chapter– supply particularly dramatic illustrations.

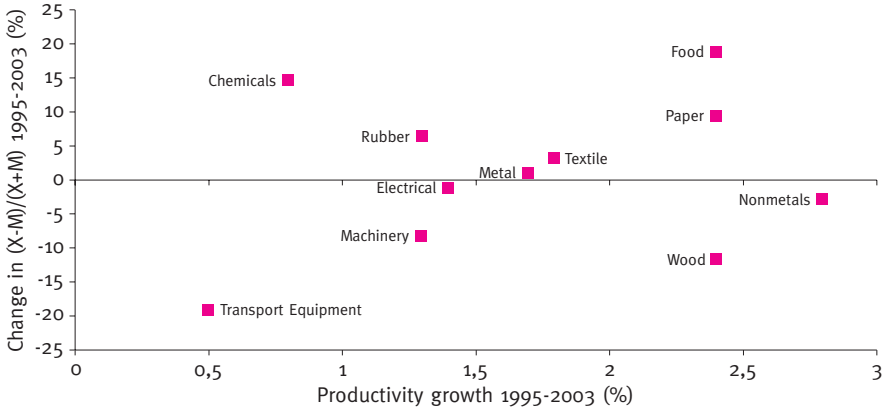
Figure 4.6: Catalan international and interregional trade balances by main sector
Trade balance in current prices. Million Euros. Average 1995-2006. All types of goods.



Source: Ghemawat, Llano, Requena (2009).

Furthermore, the pattern of surplus versus deficit appears quite logical –if one looks at interregional as well as international trade. Recall the conclusion in section 4.1 about the lack of a clear relationship between changes in revealed advantages in international trade and productivity growth. Or, as Jaumandreu puts it, "Some industries improve their position in international trade despite their poor record in productivity, and some others have seen their positions deteriorate despite their high productivity growth." Analysis by Ghemawat in the context of preparing chapter 5 indicates that replacing international trade with interregional plus international trade seems to take care of this puzzle.[37] Figures 4.7a and 4.7b relate the two types of trade measures to productivity growth. Note that the correlation between productivity growth and improved trade position triples when one takes interregional trade into account. The bottom line is that with productivity growth rates of less than 1.5% (close to the average for all of Catalan manufacturing), sectors' revealed advantages tended not to increase, whereas with growth rates greater than 1.5%, they tended not to decrease.

Figure 4.7a: Revealed international advantages vs. productivity growth



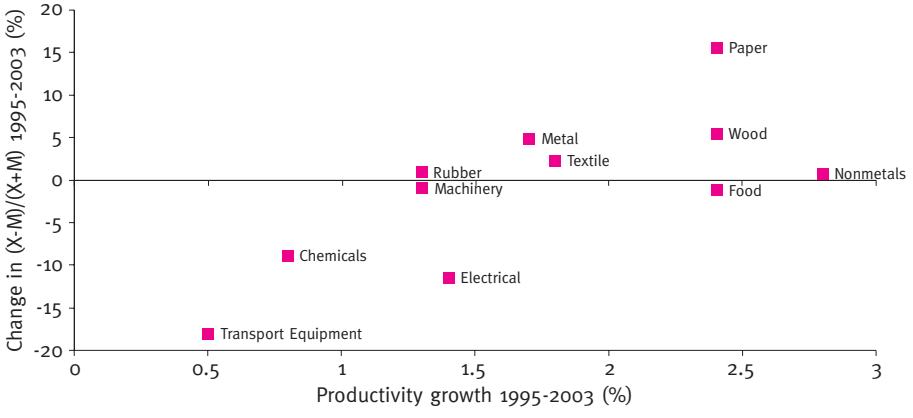
Source: Jaumandreu (2009).

Figure 4.7b is also of relevance to concerns that Catalonia is somehow focusing on the wrong sectors. The specific concern as articulated in the common wisdom (see section 4.1) is that Catalonia is gaining external advantage in low-tech rather than high-tech sectors. An alternate hypothesis is that the Catalan economy is simply specializing in sectors that

37. The degrees of freedom do get reduced, relative to Jaumandreu's chart of world trade advantages and productivity growth, because interregional trade data were available for this project only at an aggregated level. In addition, we have excluded miscellaneous manufacturing from this analysis.

offer it the highest productivity growth rates –as depicted in Figure 4.7b– and that the lack of coincidence between these sectors and R&D – intensity may reflect the limitations of (exclusively) R&D– and innovation-based views of productivity growth rather than some sort of basic failure by Catalan firms to exploit technologically rich opportunity sets. Detailed studies of two sectors –food and beverages and autos/transportation machinery– that are discussed in the next chapter drill deeper into mechanisms for productivity growth other than innovation, and also suggest some broader points about Catalonia's current manufacturing portfolio.

Figure 4.7b: Revealed international and interregional advantages vs. productivity growth

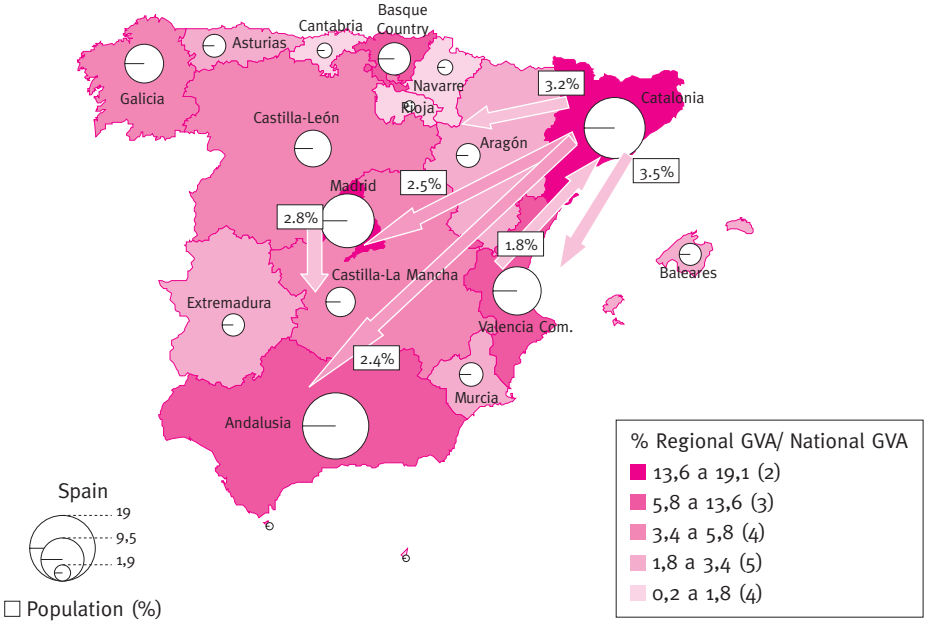


Source: Ghemawat (2009).

Key partners

Disaggregating by trading partner instead of sector, interregional trade data enable comparison of other Spanish regions with other countries to identify Catalonia's top trading partners. As discussed above, Catalonia's trade with the rest of Spain is greater than its trade with the rest of the world –or within Catalonia. Relative to other Spanish regions, Catalonia leads not only in terms of international trade volumes, but in terms of interregional trade volumes as well (although it should be noted that such absolute comparisons obviously are influenced by the fact that Catalonia is the biggest region within Spain economically). Thus, note from Figure 4.8 that Catalonia is involved (as origin or destination) in each of the five largest bilateral flows of goods between Spanish regions in 2006 –a pattern that has actually held up since 1995.

Figure 4.8: The strongest interregional flows in 2006.
All goods, R1-R16. % over total interregional trade in Million Euros.



Source: Ghemawat, Llano, Requena (2009).

From the list of Catalonia's top trading partners, whether international or interregional, in 1995, 2000 and 2006, it emerges that Valencia is the largest single trading partner in each of the years considered, and France has moved up to become the second largest, narrowly beating the Spanish region Aragon. In fact, each of the top five international partners has improved its ranking over time, reflecting the fact, noted above, that international trade grew faster than interregional trade over this period. But that said, Catalonia's trade with Spanish regions still dominates its trade with other countries in the sense that for each of the main international trading partners, one can find a (different) regional trading partner with which the volume of trade is larger.[38]

The CAGE framework

To supply some additional interpretation, it is worth noting that Catalonia's largest trading partners –regions as well as countries– tend to be particularly close to it along various dimensions –cultural, administrative and geographic, in particular– as well as relatively large eco-

38. See Table 2 in Ghemawat, Llano and Requena (2009).

nomically.[39] Consider applying this CAGE framework –an acronym for cultural, administrative, geographic and economic differences– first of all to Catalonia's two leading domestic trading partners, Valencia and Aragon. Culturally, Valencian and Catalan have the same root and are both considered co-official languages (apart from Castilian) for their respective regions. Administratively, the three regions fell under the Crown of Aragon for centuries –which probably created some additional cultural linkages as well– before being integrated under the Crown of Spain. Geographically, both Valencia and Aragon share common land borders with Catalonia. And economically, Valencia, in particular, is one of Spain's larger regions so it is natural, in a sense, that it be one of Catalonia's largest regional trading partners.

From this perspective, what is more surprising is how significant Aragon is as a trading partner for Catalonia since the Aragonese economy: it is only one-third as large as Valencia's. The greater intensity of Catalonia's trade with Aragon seems to rest, for the most part, on geographical factors. Although Aragon and Valencia are both adjacent to Catalonia, Zaragoza is only about one-third as far from Barcelona as is the city of Valencia, which, based on the effects of physical distance estimated in the paper as well as standard estimates, should offset the difference in Aragonese and Valencian GDPs. In addition, Aragon lacks direct access to the sea which, coupled with difficulties crossing the Pyrenees, means that Catalonia serves as its trading intermediary with the rest of the world in a way that Valencia simply doesn't require, which should further boost Catalan-Aragonese trade relative to Catalan-Valencian trade. So, based on the general results from the gravity literature, should the fact that Aragon is one of Spain's richer regions, with a per capita GDP nearly 20% higher than Valencia's.

More familiarly, such considerations can also be applied to Catalonia's international trade. Thus, there are a number of reasons why France should be a particularly large trading partner, even compared to other EU countries (which jointly dominate Catalonia's international trade since *they* are closer to it along those dimensions than non-EU countries). Culturally, Catalan is considered close to French, to the point where some even argue that it is closer to French than to Spanish; in addition, even more mutually intelligible languages (e.g., Catalan, Occitan) are spoken –to a limited extent– on the other side of the French border. Administratively, Spain was once ruled by France's Bourbon dynasty, which King Juan Carlos is descended from, and the Napoleon, in addition to invading Spain, contributed to the commonality of the two countries' legal systems. Geographically, France is the only foreign country –apart from tiny Andorra– to share a common land border with Catalonia, and the only route to Europe. Finally, economically, France is the world's six largest economy, and the second largest in the Eurozone. But again, economic size is only part of the story: France is less than 80% the size of Germany, the largest Eurozone economy and Catalonia's next largest international trading partner, but France trades 80% more with Catalonia.

39. For further discussion of cultural, administrative, geographic and economic differences under the rubric of the CAGE framework, see Ghemawat (2007), especially chapter 2.

So in other words, instead of simply bucketing other regions into the "Rest of Spain" and other countries into "International," it makes sense to think of countries and even regions as being embedded in space at varying distances from one another: France is much closer to Catalonia than the United States, and Aragon than Andalusia. Furthermore, this closeness has a geographic component, but there is more to it than that: the space that regions or countries are thought of as being embedded has to be multidimensional in encompassing cultural, administrative, geographic and economic attributes, acronymized as the CAGE framework.

Border effects

Ghemawat, Llano and Requena also estimate international border effects for Catalonia (and other Spanish regions), measured as the relative intensity of interregional-to-international trade after controlling for GDP (economic size) and distance, among other things.

Generally speaking, the concept of "border effect" is defined as how many times a region trades more with itself (or with another region of the same country) than with another country of the same size and accessibility. Several studies have measured the border effect at the regional level in a number of countries. [40]

There are a number of factors that may explain the downward impact of boundaries on the volume of trade. In general, these causes can be split into groups, depending on their exogenous/endogenous nature. Regarding the exogenous causes, the size of the border could be caused by tariffs, non-tariff barriers, information and transaction cost differences, etc. In parallel, border effects may arise endogenously either as a result of different tastes for local and foreign goods or as a consequence of an optimal location choices of producers and consumers (agglomeration). Obviously, the different reasons explaining the border effects have different welfare consequences and policy implications. If border effects reflect the existence of national or regional barriers to trade, there will be some room for increased market integration (reduction of this border effect) through the removal of these barriers. By contrast, if border effect is mainly induced by the agglomeration of intermediate and final goods producers in a specific nation or region, the nature of the effect is mainly "endogenous", and the possibility to reduce the border through policy is less clear.

Ghemawat, Llano and Requena quantify the external border effect of the Catalan economy during the period 1995-2005, both at the aggregate level and considering sector specific flows for 13 types of manufactures. This yields several additional insights.

First, international border effects, measured as the relative intensity of interregional-to-international trade after controlling for GDP (economic size), distance and other variables, vary significantly across sectors and by trading partner. More specifically, the results obtained show that

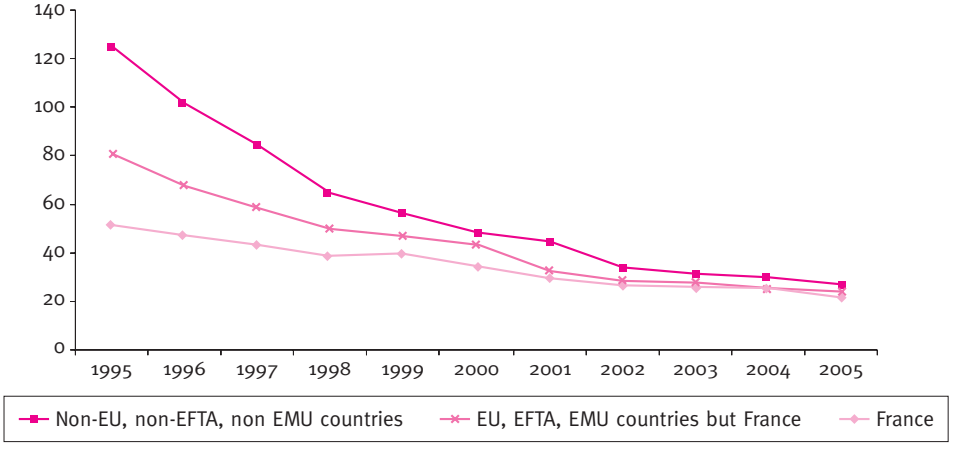
40. See the chapter by Ghemawat et al. (2009) for the results of the literature for other countries as well as Spain.

Catalan's trade with the rest of Spain is about 44 times its trade with any country. This Catalan's external border effect a medium-size border effect compare to other Spanish regions (Andalusia trades 98 times more and Madrid trades 6 times more). This is suggestive of the heterogeneity to be encountered –and somehow addressed rather than dismissed– in formulating policies to boost external competitiveness.

Second, the permeability of international borders also varies by the direction of the flow: Like in other previous analysis for the Basque Country, the results obtained confirm that Catalonia's exports exhibit higher border effects than its imports, consistent with its role as a trading hub for Spain being more weighted toward imports than exports.

Third, Catalan border effects do not seem to be the lowest even among large, multi-provincial Spanish regions, qualifying the common perception of Catalonia as particularly internationalized. Fourth, while the international border effect for Catalonia has declined drastically in recent decades, declines appear to be flattening out. This suggests that interregional trade may play a more important role in the growth of total trade than it did between the mid-1990s and the mid-2000s, when it ceded share.

Figure 4.9: Evolution of Catalonia's external border effect over time by country



Source: Ghemawat, Llano, Requena (2009).

Moreover, the use of disaggregated trade information allows quantification of the external border effect for sector-specific trade flows. In the case of Catalonia, the results obtained confirm that the border effect across industries is less dispersed in Catalonia than in the rest of Spanish regions. In addition the border effect of exports in sectors such as chemical, non-metallic mineral products, metal products and mechanical engineering is greater than the border effect of imports.

To sum up, in the case of Catalonia, looking at interregional trade turns out to have striking practical implications: it shifts readings of Catalonia's external trade balance from very negative to positive, flags its role as an import hub for Spain, and alters diagnoses of which sectors generate external surpluses and who its key trading partners are. It also suggests a clear link between productivity growth and improvements in external trade position (link 2 in the Standard Model) and permits estimation of border effects that yield additional insights, including the surmise that interregional trade may have more of a contribution to make to Catalan growth than it did over 1995-2005.

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5. Sectoral lessons, growth factors, and industrial policy

The work of Ghemawat, reported in this chapter, re-examines link 1 between innovation and productivity growth of the Standard Model (introduced in the last chapter) with microanalytic studies of two key Catalan manufacturing sectors, food and beverages and transportation machinery (primarily autos). The analysis indicates the need to expand the Standard Model beyond link 1 to consider other mechanisms for productivity enhancement that do not involve innovation per se and that he groups under the rubric of *renovation:*

- Reaching efficient scale
- Rectifying (other) obvious internal deficiencies
- Replicating or imitating innovations, techniques etc. developed by others
- Replacement of inefficient incumbents by more efficient entrants
- Redeployment of resources across sectors

In addition to these supply-side mechanisms, demand side influences on productivity growth also appear to be important. Ghemawat wraps these and other influences into a *House of Growth* of which innovation is a structural element, but only one of several. This helps situate the next chapter's focus on the innovation system. This chapter concludes by discussing the implications of renovation versus innovation and the House of Growth for sectoral portfolio planning and industrial policy.

5.1. The food and autos sectors sketched

Food and autos are both salient in terms of output and employment: they represent two out of the three sectors that individually account for more than 10% of Catalan industrial production (chemicals is the third). Given that and their links to other sectors, they are potentially important engines for pulling the Catalan economy out of the productivity doldrums in which

it was stuck well before the crisis struck. But otherwise, food and autos were selected based on differences in their performance rather than similarities.

In the Catalan food sector, labor productivity is slightly higher than the average for the EU-25 and has grown fairly fast, at about 2.4% per year over 1995-2003 –the second highest rate among 13 (2-digit) Catalan manufacturing sectors. The sector seems externally uncompetitive when one focuses just on international trade (i.e., it runs an international trade deficit) but, in line with its productivity performance, it emerges as the second largest contributor to Catalonia's total external surplus –after chemicals– if interregional trade is added in. In other words, Catalonia's interregional trade surplus in food and beverages is much larger than its international deficit. And sectoral profitability was stable for over a decade, before the crisis struck, and employment in it has actually increased modestly since the mid-1990s.

The second sector, autos, presents contrasts along all these performance dimensions. Labor productivity was a major concern in autos even before the crisis: Catalonia's is slightly lower than the average for the EU-25 and has grown only at about 0.5% per year –barely one-fifth as fast as in food and beverages. In line with this poor productivity performance, Catalonia's external trade balance in this sector has swung into the red. And even before the crisis, operating margins had decreased more or less steadily from about 10% in the late 1990s to 5% by 2007, and employment began to drop continuously at the beginning of this decade. See Table 5.1 for some relevant characteristics of the two sectors and their evolution based on the relevant firms within the Cassiman and Golovko sample discussed in chapter 4.

Table 5.1: Trade and innovation characteristics of companies in Food and Auto

Sector	Period averages	1990-1999	2000-2006
Food, tobacco and beverages	% of exporters	42.5	60.7
	% of importers	34.3	48.1
	% of product innovators	13.8	12.6
	% of process innovators	24.1	18.9
	Labor productivity (value added per employee), thousand Euros	32,138	56,089
Motor vehicles and other transport equipment	% of exporters	57.3	62.5
	% of importers	65.3	59.3
	% of product innovators	18.6	17.1
	% of process innovators	33.3	28.1
	Labor productivity (value added per employee), thousand Euros	35,683	38,771

Source: Cassiman and Golovko (2009).

Part of the reason for the poor performance of the auto sector in Catalonia has to do with factors that are, in a sense, external to Catalonia: the excess entry into and excess capacity within the auto industry worldwide and the emergence of low cost competition from East Europe (since Volkswagen/SEAT invested in Martorell in the early 1990s, all major new conventional vehicle assembly plants in Europe have been located in the east). These external factors have a big impact on the sector within Catalonia because competition is highly internationalized in autos and auto parts Catalonia's international trade in this sector is about twice as large as its interregional trade or, as Ghemawat, Llano and Requena estimate, its interregional-to-international border effect is 30: a high number in absolute terms, but the second lowest among 13 Catalan manufacturing sectors. In contrast, conditions internationally don't matter quite as much in food and beverages, where competition is more national than international: interregional trade flows in this sector are twice as large as its international trade flows and the estimated border effect is 144, the second highest in Catalan manufacturing.

It is worth adding that such international pressures can end up depressing measured productivity growth as well as profitability and employment. Note that competition from low-cost countries and, more generally, excess entry and capacity, put downward pressure on prices in the auto sector that is estimated by industry sources to be 2%-plus per year (comparable estimates for food are closer to 1%). This, in turn, depresses productivity measures such as output or value added per worker. So the rate of productivity improvement *net* of this downward pressure may be lower in autos than in food and beverages even if the *gross* rate of improvement is higher in autos because of richer technological opportunities. Clearly, the character of competitive interactions and how well positioned Catalonia-based operations are relative to the competition matter, not just the technological intensity of sectors *per se*.

Nevertheless, while international pressures may explain why Catalan auto manufacturing has fared so badly, this does not explain how food and beverages, a mature, low-tech sector, has achieved productivity growth rates of 2.4% –within the same Catalan context as autos and other lagging sectors. Innovation doesn't seem to be the answer, even though that is the focus of link 1 in the Standard Model described at the beginning of this chapter. The Catalan food and beverage sector has historically spent less than 1% of revenues on R&D (compared to more than 2% of revenues in the case of the Catalan auto sector). Detailed studies of the activities of public and private institutions in food and beverages suggest that apart from a few islands of innovation in multinational companies (e.g., Danone, Nestlé, Unilever) and large Catalan/Spanish companies (e.g., Agrolimen), the overall level of R&D-based innovation in Catalonia is very low. Attempts to "rectify" this state of affairs with public support are not regarded as having achieved the desired results. And the phenomenon seems to extend beyond R&D-based innovation to encompass other kinds of innovation.[41] Based on Cassiman and Golovko's data (see Table 5.1), only 13% of food and beverage firms reported being product innovators over 2000-6 and 19% process innovators, versus averages of 31% and 37% respectively for the sample as a whole (and 17% and 28% respectively for auto firms). Although the

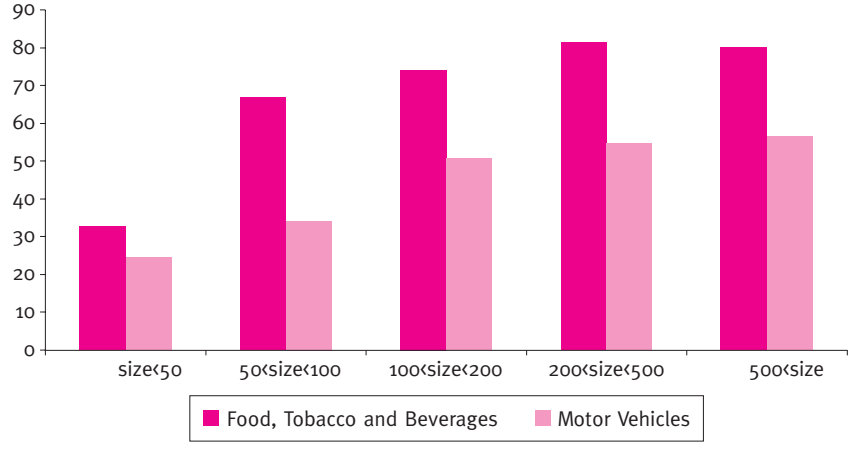
41. Many innovations, even product innovations, have very little fundamental science and technology content. This is obviously true of many incremental product innovations.

sample size is limited, it is worth adding that these percentages have actually decreased slightly since the 1990s, mirroring general cross-sector trends! So it would seem that the key to the Catalan food and beverage sector's productivity performance is not to be found in its innovation record.

Why does the reality of innovation fail to live up to all the rhetoric about it? One part of the answer is suggested by the observation that the food and beverages sector is extremely fragmented –not only in Catalonia or Spain but across Europe. In 2006, there were 2,876 Catalan food and beverage firms, of which three quarters had fewer than 20 employees and only 3% had more than 100 employees. The share of revenues accounted for the five largest firms is only 12%, up from 11% in 1993 and still substantially lower than the average of 15% across Catalan sectors. (Autos is much more concentrated, but still features many very small firms, especially in auto parts and components: overall, two-thirds of auto establishments have fewer than 20 employees).

The fact that the typical establishment has less than 20 employees would seem to affect the general usefulness of injunctions to innovate since that typically requires slack resources and is subject to increasing returns to scale. Put differently, it is useful to distinguish between class and mass: innovation and pushing the envelope make (comparatively) more sense for large, world-class firms, but it is also important to consider the large mass of other firms because otherwise, one would focus just on the tip of the iceberg.

Figure 5.1: Value Added per employee (thousand Euros)



Source: Ghemawat (2009).

Looking systematically across the population of establishments yields a number of other insights that are illustrated here on the basis of Cassiman and Golovko's data (see Figure 5.1) but consistent with evidence from other sources (including Jaumandreu) as well. First, average value added

per employee is significantly lower in autos than in food and beverages –in all size classes. Second, there are even larger variations in productivity within each sector. Third, some (but by no means all) of the variation is accounted for by differences in establishment sizes: average productivity increases significantly with size, at least up to a threshold scale of 100-200 employees (achieved by well under 10% of the establishments in each sector). Fourth, the potential gains from bolstering the left tail of the productivity/size distribution would seem to be enormous.

To calibrate such improvement potential, consider the impact of raising the mean labor productivity of the firms in a sector to the mean for the firms whose value added is more than the median value, i.e., bringing the mean labor productivity of the bottom half of firms up to the mean for the top half. Cassiman and Golovko calculate that for their sample, doing so would translate into an average productivity gain of 65% in the food and beverage sector and 38% in autos! By way of comparison, these figures are significantly larger than the actual productivity gains registered by this sample of firms between 1990-99 and 2000-06: 37% in the case of food and beverages and 19% in autos.

Data on historical gains also suggest that differences in the extent to which small/inefficient firms were able to tap such improvement potential between 1990-99 and 2000-06 actually account for an important part of the difference in productivity performance across food and beverages and autos. According to Cassiman and Golovko's data, firms with fewer than 200 employees grew their productivity between 1990-99 and 2000-06 by 38% in the food and beverage sector versus -8% in autos! Jaumandreu, working with a different dataset and stratifying by productivity rather than size, picks up on a similar difference between clear improvement by low performers in food but not in autos. The next section goes into more detail in the non-innovation based *remediation* mechanisms that may underlie such improvements.

Remediation isn't the only plausible alternative to innovation, however –and is important to reach beyond because it is not clear how capable some of the laggards actually are of improving their performance. *Replacement* of inefficient incumbents by more efficient entrants is an obvious alternative that also appears to have worked better in food and beverages than in autos. Thus, Cassiman and Golovko's inspection of their sample suggests a significant incidence of drop-outs, probably partly reflecting replacement processes, in food and beverages but not in autos (despite the particularly parlous performance of laggards in the latter sector). Corroboration is supplied by data suggesting that continuing plants in the Catalan food and beverages sector exhibit the second highest gross job creation and job destruction/replacement rates among 14 industrial sectors –or combining the measures, the highest job reallocation rate overall. Continuing plants in the Catalan auto sector ranked below those in food and beverages along all these dimensions.

Finally, situations where the performance improvement challenge simply *cannot* be met by either existing firms or potential entrants require reaching beyond replacement to talk about *redeployment* of resources, including human resources. Redeployment of resources from one sector to

another focuses attention on allocative efficiency across sectors rather than technical efficiency within them. The possibilities or rather, exigencies, in this regard are more obvious in autos. If one believes that significant slimming is indicated for the Catalan automotive sector, as argued in the sectoral study, then the extent to which the Catalan government obstructs its restructuring instead of facilitating it may be the single biggest influence on the sector's contribution to overall economic performance.

The next section puts these different mechanisms for improving productivity into broader context.

5.2. Renovation and innovation

Much of the point of the sector studies was to broaden discussion of productivity growth beyond the narrow techno-fetishism of science-based innovation and the inferred optimality of R&D subsidies of various types. While various approaches to broadening have already been mentioned in the context of the two sectoral studies, they are worth discussing somewhat more systematically and generally. Consider, first, the varieties of innovation:

- Many innovations, even at the level of specific *products*, have very little science and technology content. This is obviously true of many incremental product innovations. A transformative example of this sort is supplied by Freixenet's famous black bottle and labeling for its cava.

- *Process* innovations tend to involve comparatively more development and comparatively less research than product innovations –and generally seem to be subject to less appropriability by innovators.

- Then there are *service innovations*, which often rely heavily on information technology. Thus, innovation in autos is not confined to better (or cheaper) cars: onboard GPS has sparked a surge of service applications ranging from traffic management –of interest to highway operator Abertis as well as automakers– to customized pricing of insurance by route and time.

- It is possible to envision an even broader class of innovations than the provision of a better product or service. Mango, for instance, has prospered in clothing by developing an information and logistics system that might be classified as a service innovation but that seems so far-reaching in its implications as to warrant separate categorization, as a *business model* or *strategic* innovation.

Even more than these innovation categories, however, the two sectoral studies, and particularly the one on the low –R&D food and beverage sector, focused our attention on renovation– based mechanisms for productivity growth: mechanisms that do not (need to) involve innovation in the sense of anything new to the world.

- *Reaching efficient scale*, eliminating bottlenecks and effecting other *rectifications* often afford opportunities that are so obvious that no new information is required to spot them; rather,

what is required is managerial action. The long tail of small firms with low productivity levels in Catalonia supplies an obvious example.

- *Replication* does involve looking outside the firm but, like the other efforts at remediation already listed, it focuses on moving firms that operate within the production possibility frontier closer to that frontier. Its importance is flagged by findings ranging from imitation being cheaper and quicker than innovation to the observed dominance of the gains from major innovation by their diffusion. Its importance is indicated by the fact that the most commonly cited reason for currently low innovation rates in food and beverages is the rapid erosion of profit margins on product innovations by the quick introduction of "me too" products and white labels in the event of success, i.e., a lack of appropriability of returns to innovation by the innovator.

- *Replacement* of the less efficient by the more efficient is highlighted by studies of plant-level entry and exit which suggest that especially in the U.S., this mechanism accounts for more productivity gains than upgrading by existing establishments. The importance of replacement seems lower in Europe, but many authors argue that that is a large part of the problem –and that policies that ease entry and exit are sorely needed.[42]

- *Redeployment* of factor inputs from one sector to another focuses attention on allocative efficiency across sectors rather than technical efficiency within them. Policies are not all equally effective at resource redeployments, which can therefore make a significant difference. For example, given the size of the Catalan auto sector, whether the government obstructs or eases its restructuring is likely to have a discernible impact on overall economic performance.

In other words, if one start with the basic accounting identity linking output to productivity,

Total Output = Factor Inputs * Total Factor Productivity,

all of the points bulleted above should be thought of as mechanisms for raising total factor productivity.

The other term included on the right-hand side of the equation reminds us that output growth reflects factor accumulation as well as productivity growth. Factor accumulation is, within economics, an old story: the modern productivity literature can be read as aiming to demonstrate that factor accumulation is less important –and productivity growth more important– in explaining output growth than people used to think. It also has a well-established place in Catalan/Spanish policy debates: the key long-run concern is that pre-crisis growth may have been driven more by factor accumulation (particularly the import of cheap labor and capital) and less by productivity growth than other advanced economies, particularly the United States.

42. Pisani-Ferry, J. et al. (2008).

Finally, the discussion so far –of factor accumulation as well as various mechanisms for productivity growth– has focused on the supply side. But there is a long and distinguished body of evidence, on the important demand –side as well as supply– side influences on innovation, in particular.[43] Recent microeconometric studies, pointing to the importance of idiosyncratic demand shocks in driving productivity growth point towards the demand side as well.

In the Catalan context, Cassiman's work on the problematic links between science and business (see next chapter) and, with Golovko, on the importance of imports, also signal, albeit in different ways, the importance of the demand side or consumption. Yet it remains invisible in many policy discussions of how to encourage productivity growth, for reasons that ranging from a failure of expenditure-based measures to pick up on buyer surplus to a neomercantilist preference for production over consumption. These aren't good reasons, however, to ignore how demand interacts with factor stocks and institutional arrangements to influence innovation, imitation, replacement and redeployment.

5.3. The role of government and the House of Growth

The diverse mechanisms and influences highlighted above can be assembled into a House of Growth, as in Figure 5.2. This depiction reminds us of the range of approaches to growing economic output –and puts specific policy levers into perspective, as will be discussed next.

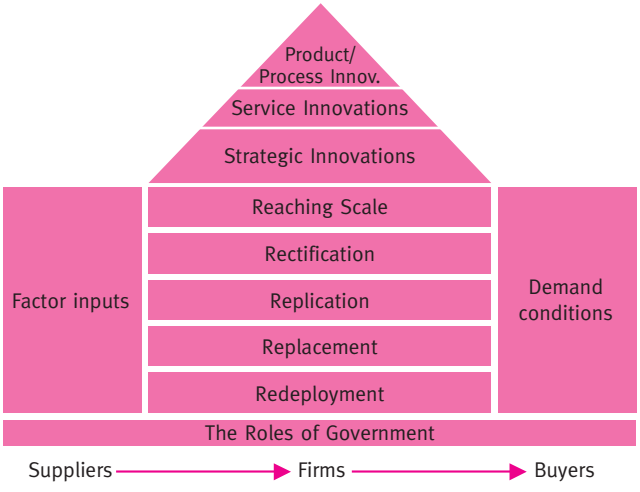
In addition to calling attention to the broad array of conditions and mechanisms that determine productivity growth, the house of growth helps structure a discussion of how governments can influence their operation –in terms of the relationships between the base of the house, involving the government, and its other parts. In addition, the discussion in this section suggests a new, productivity-based perspective on Catalonia's portfolio of manufacturing industries.

It is useful to begin by distinguishing between two roles that governments can play in influencing outcomes: as *players* or *transactors* in the marketplace –as suppliers of inputs or other essential complements, as competitors (or joint venture partners) in offering products or services, or as buyers– and as *rule makers*. As players, governments tend to have recourse to the same kinds of market instruments as private firms –but with differences in terms of scale (typically much larger if consolidated), incentives, power and, frankly, management depth. Rulemaking is a higher-level influence: governments determine the rules that govern the operations of markets, including those in which they are not present as transactors. Rules are myriad, and greatly expand and complicate the government's strategy space: they include taxes, subsidies, price/profit restrictions, disclosure requirements and other financial regulation, product/process regulation, local content requirements, trade/industrial policy, govern-

43. Griliches and Schmookler's classic works on the subject were published more than half-a-century ago. More recent contributions, to focus on a few just in management, include Eric von Hippel's work on lead-user innovation, C. K. Prahalad's insistence on the co-creation of value with customers, and Amar Bhide's research on venturesome consumption and in particular, iterated development with buyers by a sample of start-ups funded by venture capitalists.

mental ownership by statute, local ownership/partnership requirements, competition policy, restrictions on entry/expansion, patent law, intellectual property right recognition and enforcement, technology transfer policies, and so forth. And then there is the apparatus for adjudicating and enforcing them.

Figure 5.2: The House of Growth



Discussing each of such a large number of categories is beyond the scope of this chapter. Rather, this subsection will focus on registering some productivity-related points about the appropriate scope and content of governmental policy that are organized in terms of the House of Growth.

In terms of ensuring a supply of factor inputs, governments bring a variety of influences to bear ranging from overall macroeconomic and financial management to earmarks for specific sectors or types of firms. The role of the government in actually being involved in the provision of inputs, especially specialized ones, as opposed to influencing their provision, is more controversial. It is certainly possible to think of cases where public involvement proved beneficial even in the context of great specialization, e.g., the Idiada auto testing facility. On the other hand, simply to draw up a list of industry pleadings about inputs that the government might improve the quantity/quality of would be to risk succumbing to the simple logic that it is preferable to spend money out of public funds than one's own purse.

Since the public funds –and bandwidth– available for this purpose are limited, a sensible test of when to use them up is the one provided by market failures: would private provision be subject to one of the standard categories of such failures associated with increasing returns to scale (e.g., infrastructure and information), public goods/non-excludability (e.g., healthcare and education),

and uncertainty/missing markets (e.g., social safety nets)? And as public institutions aren't always better managed than private institutions, it is worth adding a second test: is public provision actually likely to lead to a better outcome than provided by second-best (regulated) private provision? In other words, it is important to make sure that the proposed solution (public provision) isn't even worse than the problem (private provision that falls short of the first-best).

The demand side has attracted less attention in the framing of governmental policies than the supply side but again, some focus areas can be identified. Macroeonomic management is important here as well, with countercyclical/stabilizing policies meriting special mention. The stop-go character of many publicly financed initiatives is problematic in this regard and suggests another heuristic about when to start an initiative that requires ongoing commitments of resources: only when it can be sustained through cyclical downturns. Additionally, governments can influence the sophistication of demand, both as transactors (government accounts for 10-20% of final consumption demand in most countries) and as rule makers (through tax policies, standards, et cetera). And they can even try to influence buyer venturesomeness in both those roles. The point is that demand matters even if one takes an innovation-centric view of productivity growth potential.

The rest of the House of Growth, which plays out at the firm level and bridges between suppliers and buyers, involves innovation and renovation. Regarding the former, the key point is that the traditional science→ research→ innovation sequence touches only the product and process innovations at the tip of the house of growth, and that too only a subset of them. The other observation to be made about this category is that the results of basic investments in science are often not appropriable –such knowledge tends, among other things, to be relatively mobile geographically– so the case for taking advantage of knowledge developed elsewhere, and husbanding scarce resources for investment in other ways, has to be taken seriously. Turning to service innovations, these often have an information technology component, need their own kind of attention, given the EU's generally poorer track record in this respect than the United States. And strategic innovations really fall squarely into the firm domain: it is hard to see what government can provide in this regard beyond general encouragement. But of course, there is no way to avoid figuring out how specifically to exploit this or other productivity enhancement mechanisms –rather than just influencing their conditions of operation– if the government is a transactor as well as the rule maker (e.g., education, healthcare).

The untapped potential for governmental rulemaking to improve productivity really seems to be concentrated under the heading of renovation. In particular, the existence of a long tail of small firms with very low productivity levels suggest that a major avenue for productivity growth and job creation is to figure out how to improve the productivity of very small firms with, say, fewer than 20 employees. (According to some early data, chosen for comparability with the table below, plants with fewer than 20 employees account for 38% of employment and 52% of gross job creation in Catalan industry and firms with fewer than 50 employees for 55% and 68% respectively). This also tends to be the most dynamic size category in terms of job reallocation across continuing plants (see Table 5.2).

Table 5.2: Gross Job Flows by Plant Size (Annualized, as Fraction of Employment)

Plant size	Job Creation	Job Destruction	Job Reallocation
1 1-10	0.0975	0.0251	0.1227
2 11-19	0.0647	0.0349	0.0997
3 20-49	0.0539	0.0326	0.0865
4 50-99	0.0446	0.0409	0.0855
5 100-249	0.0500	0.0343	0.0843
6 250+	0.0385	0.0394	0.0779
Wt. Average	0.061	0.034	0.095

Source: Josep-Maria Camacho-Cabiscol, Ramon Alemany-Leira and Joan Baró-Llinàs, "Job Flows in Catalonia," Paper presented at the 40th European Congress of the European Regional Science Association, Barcelona, 30th August-2nd September 2000.

The job reallocation rates in the last column in the table offer evidence of great heterogeneity in employment growth experiences across firms within very narrowly defined size classes, and hint at the potential for remediation. Note that the kind of remediation required to improve the productivity of firms with fewer than 20 employees is likely to depend less on innovation and more on rescaling, rectifying obvious deficiencies and replicating the better practices of better-performing organizations. Making progress along these dimensions will require the identification and relaxation of key constraints, the sharing of best practices across firms and perhaps even the provision of basic extension/consulting services –ideally, given the number of firms involved, with a degree of scalability across firms. It is worth adding that since small firms are also probably the most vulnerable to the contraction in bank credit, many may need help to survive the crisis, but such help will represent an efficient deployment of resources (rather than a failure to redeploy) only if there is some way to turn small firms that have persistently destroyed economic value into enterprises that actually add to it.

While the job flow data above illustrate the extent of displacement of inefficient incumbents by more efficient ones, their replacement by more efficient entrants is generally thought to pack even more productivity enhancement potential in most contexts. Again, such birth-and-death processes tend to be concentrated among the smallest firms. Maximizing their potential requires governments to ease barriers to entry, expansion/contraction and exit, rather than to protect firms in a particular size class, whether the smallest or some other. Particularly deleterious in this regard are size class preferences that discourage growth from one size class to the next. Also note the implication that preferences allotted to incumbent firms in a particular sector should, in principle, be made available to entrants as well.

Finally, efficient redeployment requires recognition that not all jobs, not even in the most cherished sectors, can or should be protected. Consider the case of auto final assembly, in which international comparisons did not redound to Catalonia's advantage. If that is an accurate diagnosis, trapping resources within this segment is costly and wasteful. It probably also delays the development of alternate, more sensible plans for how to proceed. And since the attempt to protect all the jobs is unlikely to succeed, it also carries a cost in terms of governmental

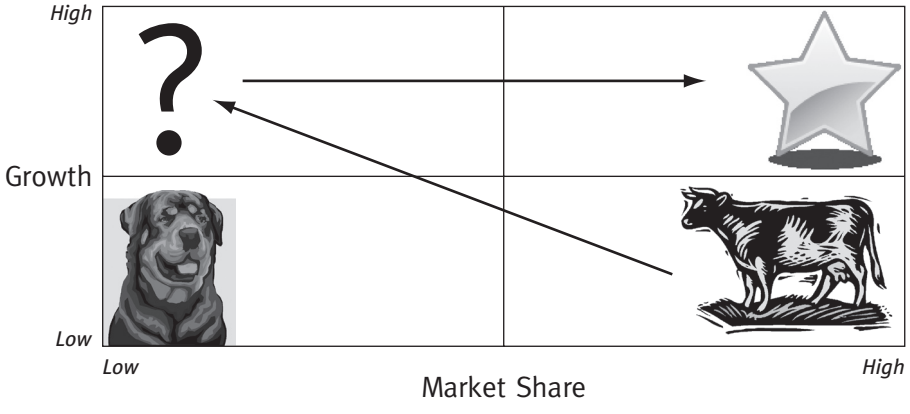
credibility. The clear policy implication for now is recognize when resources need to be redeployed. A different matter may be the internationally competitive segment of auto-parts suppliers.

5.4. Competitiveness, industry portfolios and industrial policy

The redeployment of resources, e.g., from sunset to sunrise sectors, is considered so important that some describe it as the key function of *industrial policy*. It is not within the scope of this chapter to specify the appropriate degree of governmental activism in reoptimizing industry portfolios. But one does not have to take a particular perspective on that issue to take an interest in developing a more *systematic basis for thinking about the broad portfolio of industries,* which is the focus of the treatment here.

Industry portfolio analysis for governments still often embodies the portfolio planning techniques consulting firms developed 40 years ago to help large corporations assess the relative potential of their businesses for investment. Broadly speaking, these techniques involve positioning of diverse businesses on a grid, with some proxy for competitive position on one dimension of the grid and some proxy for market potential on the other. The earliest example is provided by the Boston Consulting Group's share/growth matrix (see Figure 5.3). BCG focused on relative market share as its proxy for competitive position –in the belief that costs go down forever with scale/experience– and historic market growth as its proxy for market potential and investment-intensity. Its basic strategy recommendation was to maintain a balance between "cash cows" (that is, mature businesses) and "stars," while allocating some resources to fund "question marks" (that is, possible stars given the potential to increase share in high-growth arenas) and selling off "dogs."

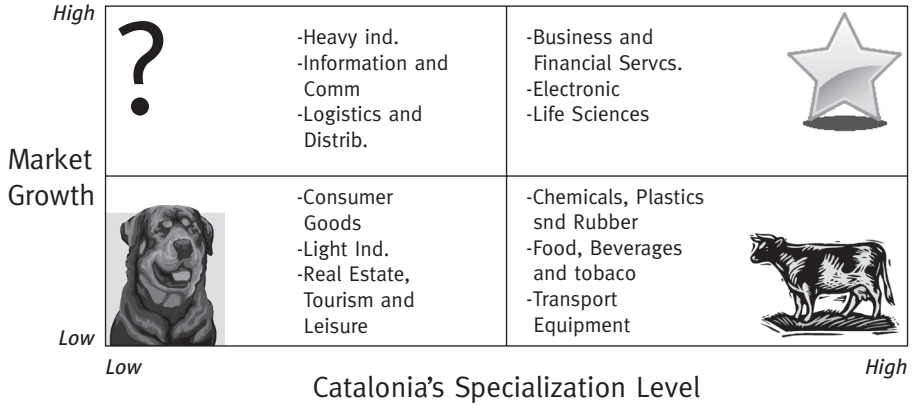
Figure 5.3: The BCG Matrix



Source: Ghemawat (2009).

A recent application to Catalonia's industrial portfolio is provided by Torrens and Raluy (2008), who change the horizontal dimension of BCG's 2x2 matrix from relative market share to Catalan specialization levels, and come up with the classifications –and implied investment recommendations– in the figure. Note that the two sectors discussed in this chapter are classified in the same way in their matrix, as high-specialization, low-growth sectors that Catalonia should treat as cash cows and milk.

Figure 5.4: Catalan sectors in the BCG Matrix



Source: Ghemawat (2009).

This putative similarity in positions is hard to reconcile with the relatively optimistic prospects for Catalonia in food and beverages and pessimistic ones in autos. A reconceptualization that refocuses the grid on productivity-related considerations fits better with the central thrust of this chapter as well as with the different diagnoses of the two sectors. An obvious productivity-based measure of *relative position is provided by Catalonia's labor productivity relative to the EU and of potential by productivity growth rates* (see Box below for further discussion).

Operationalizing a Productivity-Oriented Portfolio

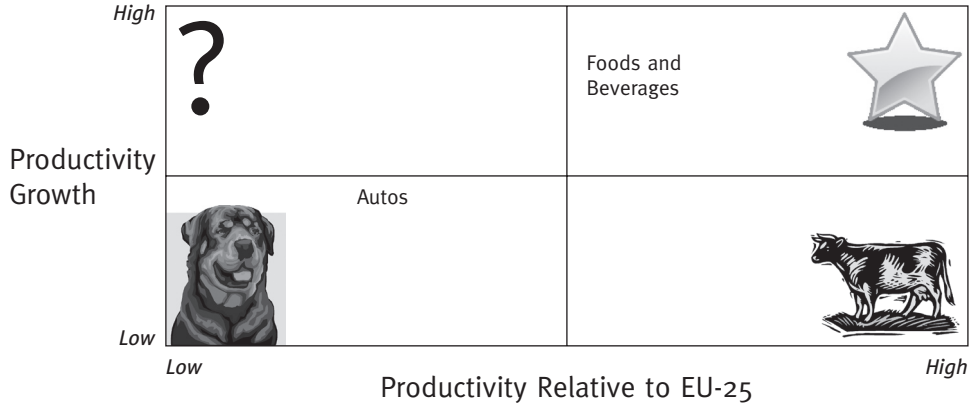
Relative position in a productivity sense is measured on the horizontal axis in terms of Catalonia's labor productivity relative to the EU averages. The EU was selected as the reference group because of its dominance of Catalonia's international trade. While the productivity differential is measured here as a percentage of EU averages, one might also look at the differentials in absolute terms, or on some other basis that at least partially picks up on the idea that, for example, the level of value added per worker in wood is, because of low capital-intensity et cetera, less than one-third that in chemicals.

Potential in productivity terms is measured on the vertical axis in terms of Catalonia's labor productivity growth rates. While one should ideally assess (and act upon) future productivity growth potential, BCG's use of historical growth as a proxy for future growth rates suggests the short-cut of using historical productivity growth rates in mapping Catalan industries. Historical growth rates are effectively compared across Catalan sectors rather than with some external reference group because there may be significant differences in productivity growth between Catalonia and other EU countries –as there have been, mostly in the form of Catalan shortfalls, in most recent years– yet Catalonia will likely end up having some industrial activity for a long time. Ranking Catalan industries relative to each other helps predict the likely mix.

Using Jaumandreu's data (see section 4.1) and redrawing the grid in these terms yields to the representation in the next figure. What is perhaps most striking is the divergence in the positions of the automotive sector and food and beverages –in contrast to Torrens and Raluy's diagnosis of similarity. More broadly, significant international competitiveness problems seem to afflict all machinery and equipment sectors, not just automotive. Lighter manufacturing sectors have generally done better in terms of productivity growth, although Catalan productivity relative to EU averages varies. And some traditional sectors –e.g., textiles and food and beverages– have done well in terms of both relative productivity and productivity growth. In other words, high tech industries aren't intrinsically good and lower tech industries aren't intrinsically bad. And simply focusing on sectors with high technology content is not necessarily a recipe for maximizing productivity growth.

Corroboration of the usefulness of this way of positioning sector/industry portfolios is that they actually fit with revealed measures of external competitiveness. Interestingly, whether Catalonia has a productivity advantage over the rest of Spain turns out to be the best single predictor of its total external trade balance –the data for interregional and international trade balances reported in chapter 4– since interregional trade tends to be larger than international trade, as discussed earlier in this section.

Figure 5.5: A productivity-Oriented Portfolio for Catalonia



Source: Ghemawat (2009).

5.5. Some policy implications

To summarize, what is needed is not a mentality of producing at home to sell worldwide but rather, an approach that is open in a more general sense: an approach that looks outside the home base for inputs, markets and ideas. The advantages in terms of cheaper/better inputs and expanded markets are obvious. In the specific context of ideas, considerable attention has been captured recently by open innovation. Openness also helps with the other productivity enhancement mechanisms discussed above, particularly replication, replacement and redeployment. And furthermore, it also has deep roots in Catalan history. For all these reasons, it comes close to being a touchstone for all policy decisions about internationalization. And government probably also has a transactional role to play in encouraging cross-border interactions at levels ranging from the corporate or (other) institutional down to individual connectivity and networking. Here inter-regional flows should not be forgotten, with particular emphasis on close-by regions (Valencia, Aragon, South of France). In fact, the Pyrenees-Mediterranean Euroregion has been constituted with a closely related set of players (Aragon, Balearic Islands, Catalonia, Languedoc-Roussillon and Midi-Pyrénées). Valencia has not accepted so far the invitation to join. The centrality of Barcelona may help, as long as the communication infrastructure is sufficiently developed, and synergies across the different regions may be realized. One example of potential synergy is the strong innovation pole developing in Toulouse with the activities in the Barcelona metropolitan area. Another is the headquarter capacity of Barcelona, in terms of providing services to firms' headquarters as well as centrality, in relation to the other regions.[44]

44. See Vives and Torrens (2009).

At the same time, when designing industrial policy measures, care has to be taken to understand the drivers of competitiveness which, as argued, may depend more on the prospects of productivity growth, and Catalonia's relative inter-regional position, than on prospects of market growth and market shares. This helps understand potential problems in sectors such as autos and the success of food and beverage, independently of their perceived technological content. In this respect, one may want to refocus sectoral development initiatives. The cluster development initiatives that have formed one of the principal planks of industrial policy in Catalonia for more than a decade have had their uses. But they need to be rethought because with the need to have complete clusters of activities locally has been superseded by the international fragmentation of the value chain and the idea that innovation is *the only* route to productivity growth misses the broad perspective. Public policy will need to acknowledge and anticipate heterogeneity in industry contexts and firms' strategies.

This calls for an approach which integrates fostering innovation in the broader context of the house of growth and placing industrial activity –together with its associated advanced services– in the center stage. This means renovation, exploiting opportunities to reach efficient scale (specially important given the fragmented structure of the Catalan industry system with predominance of small firms), to replicate and reach the technological frontier where it has not been reached yet, to allow the less efficient to be replaced by the more efficient, and not to block redeployment of resources from declining to uprising activities. This broad strategy needs a vibrant market with effective rivalry and low barriers to entry and to exit. At a time of recession, particular care has to be taken not to block the process of exit of inefficient firms while at the same time helping efficient producers which are innocent bystanders of the collapse of credit markets.

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6. The science and innovation system, business and policy

In developed countries governments adopt an active role stimulating innovation with tax/subsidy schemes and substantial amounts of money. This is justified by the externalities that R&D generates in the economy which are not appropriated by the innovators. Innovation is thought to be one of the main engines of growth. Furthermore, by now it is clear that science affects economic growth by influencing technology adoption and innovation. Science is at the base of fundamental innovations. Indeed, all major technological changes (railroads, electricity, cars, information technology) have scientific discoveries to start with. Science is developed by universities and research centers and then scientific findings are translated into applied technologies. We can distinguish between direct links connecting science and business at the frontier of science and indirect links where scientific knowledge is translated into applied technologies. Scientific findings are disseminated by academic publications and researcher (PhD) mobility between the university and industry, as well as research contracts between university and industry, patents and licenses, and, university spinoffs.

This chapter draws on Cassiman and Mas (2009) (and also Jaumandreu (2009) in section 6.2). It starts by describing the Catalan science and innovation system, looks at the evidence on the impact of innovation policy, presents facts and challenges to connect science and business in Catalonia, and studies more in detail the case of biotechnology (in section 6.4 drawing from Mas (2009)). The section concludes with some remarks on regional policy and policy implications.

6.1. The Catalan science and innovation system

The Catalan science and innovation system basically consists of universities, public research centers of the Government of Catalonia, hospitals, technological centers, the research centers of the Spanish government (belonging to the Consejo Superior de Investigaciones Científicas- CSIC), and R&D&I departments in the private sector. The Catalan government has established ex-novo research centers (to be coordinated in the agency CERCA) to foster frontier research. The number of centers has grown from 12 in 2000 to 29 centers by 2007, employing about 3000 researchers, PhDs and technical personnel. The Catalan government has invested also in research infrastructure such as the Barcelona Supercomputing center or the new synchrotron in

Cerdanyola del Vallés which might attract new researchers, labs and organizations. Expenditure on R&D in Catalonia (1.48% of GDP in 2007) is far behind leading countries or regions as well the EU average (EU-27 at 1.83% in 2007, Madrid is at 1.92%). This is so despite the fact that the annual average growth in recent years has been high (12.6% in the period 2000-2007 against 10% for Madrid). The new Spanish R&D&I Plan 2008-2011 proposes to increase annual investment by 32%. The Catalan PNRI (Pacte Nacional per la Recerca i la Innovació) proposes to increase expenditure on R&D to 2% of GDP by 2010, and to 3% in 2017.

The Spanish Ministry of Science and Innovation is responsible for the CSIC research centers (Consejo Superior de Investigaciones Científicas, Spanish National Research Council), the Carlos III Institute, the CDTI –the Centre for Industrial Technological Development produces policies and programs that are available on a competitive basis, and, is also in charge of the development of the national R&D&I plans. The CDTI provides an important contribution to linking science and industry through its programs (e.g. large scale projects or enhancing mobility of PhDs to industry).

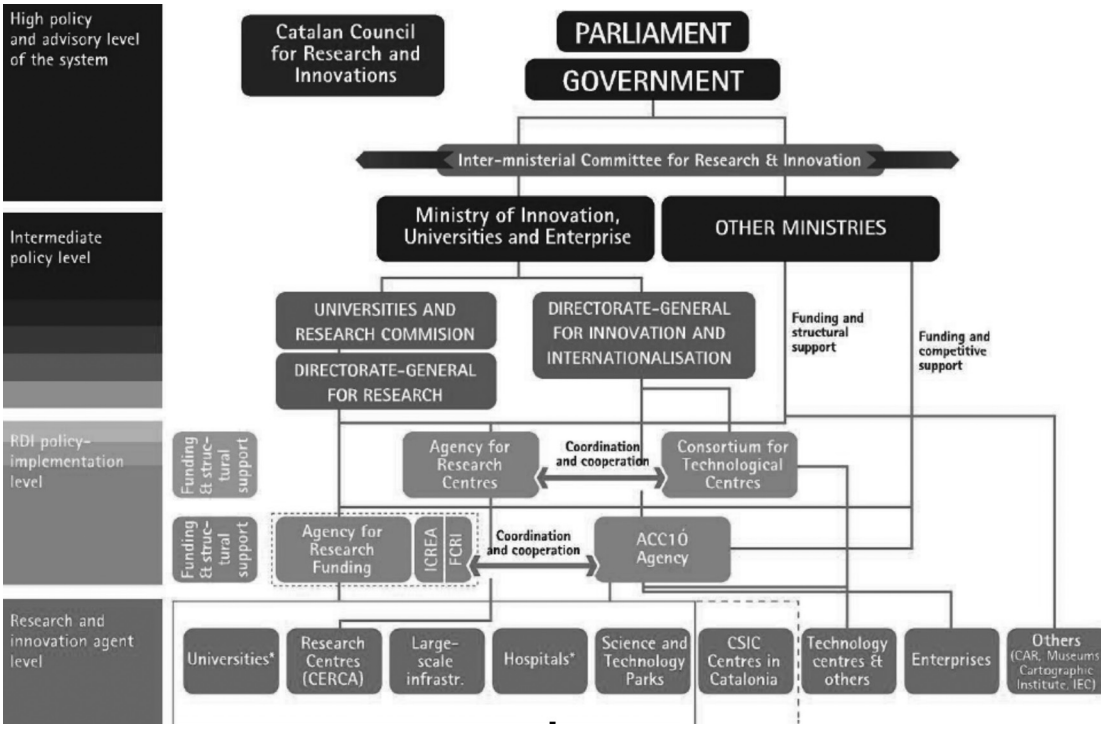
The Statute of Catalonia states that the Government of Catalonia has exclusive powers in research while the Spanish government has exclusive powers in the promotion and general coordination of scientific and technical research, in a typical compromise of the "State of the Autonomies". The Spanish Government has full powers in the realm of taxation and inspection of R&D and innovation activities, and in intellectual property. The Government of Catalonia can only implement directives under the legislation established by the Spanish Government. This leads to an overlapping of powers, with *no systematic co-ordination between the Governments of Spain and Catalonia in terms of the governance and development of a strategic and operational policy for science, technology and innovation*. The role that the research and innovation policies of the Government of Catalonia have historically played compared to the policy of the Spanish Government are in strengthening programs that have not received enough support from the Spanish policies.

The Ministry of Innovation, Universities and Enterprise of the Generalitat has responsibilities in the main areas related to research and innovation (and other ministries such as Health and Agriculture also contribute). An inter-ministerial Council (CIRIT) co-ordinates the policies on science, technology and innovation on an operational but not at a strategic level. There are several agencies in the Catalan research and innovation system. There is a support agency for innovation and enterprise, mainly in the industrial sector, the CIDEM, and an internationalization agency with 40 offices all over the world, COPCA that also includes a market and outlook observatory. CIDEM is a public agency with civil servants which has a cluster approach. COPCA is a public-private consortium which has sectoral approach. These agencies are currently being merged (into ACC1Ó). The Catalan Investment Agency (now called Invest in Catalonia) is placed inside the internationalization unit. The Agency for Management of University and Research Grants (AGAUR) operates in practice as an administrative and technical office of the Directorate General for Research and is to be converted into an agency for the financing of research to be coordinated with the program ICREA and the Foundation FCRI. Finally, there is

the University System of Catalonia Quality Agency which is an independent agency, responsible for assessing and improving the performance of universities. It is proposed also in the PNRI the creation of a consortium of technology centers. This has been done with the platform Tecnio.

In the Catalan system *efforts seem rather dispersed* (as compared to the Finnish case for example) *and fragmented over different policy makers and agents*. (Figure 6.1 is a schematic representation of the different players in the Catalan research and innovation system). If one considers the relatively limited amount of government spending on R&D and innovation, the number of administrations and agents involved seems indeed large. For example, the total expenditure on R&D in Catalonia in 2006 was 2.614 M€ while Nokia alone spent 3.712 M€; the projects of CIDEM in 2005 amounted to 47 M€, about one tenth of the Finnish equivalent TEKES. (Note that Finland has a GDP – PPS corrected– below that of Catalonia). On top of this help to projects is typically not awarded on a competitive basis and the public support system has a remarkable *lack of transparency*.

Figure 6.1: Projected organizational chart of the Catalan research and innovation system



Source: Cassiman and Mas (2009) from Generalitat of Catalonia.

6.2. Evidence on the impact of innovation policy

There are two main forms of public support to innovative activities: subsidies and fiscal allowances to innovating firms.

Spain and Catalonia share a fiscal system that tries to incentivate innovation, specially after the reform introduced at the end of the 1990's, with a set of subsidies available to firms through different state and regional agencies. Fiscal allowances (as well as subsidies) are costly policy instruments, and there are recurrent debates on their effectiveness and desirability. The Spanish economic authorities (the minister of finance Solbes) expressed their desire to reduce a large part of the current fiscal allowances by 2011, although finally the Government decided in March 2009 to maintain the fiscal incentives (at the somewhat reduced level). The main questions involved in the assessment of support to innovation are if firms are actually induced to undertake *additional* research projects, how important are these effects, and whether the policy instruments are adequately designed to reach the potential effects.

The evidence available on the impact of R&D subsidies in Spain shows that (i) R&D expenditures of a fraction of small firms are actually dependent on subsidies, in the sense that these firms would stop performing R&D in the absence of subsidies; (ii) there is no "crowding out", or substitution of public funds for private funds, and even a (modest) increase in the private expenses that the firm would had dedicated to the investment in the absence of subsidies. However, according to the evidence, a high proportion of subsidies go to firms that would have performed the innovative activities anyway. In terms of potential effects, it is estimated that almost half of the large non performing firms could be induced to perform by financing less than 10% of their likely expenses, and the same goes for small non performing by financing a higher fraction of their needed expenses.

A striking fact is that a significant part of the firms say to "ignore" and/or do not apply the possible fiscal deductions for their innovative activity. A possible reason is that small and medium firms are likely to be deterred by the costs of formalizing the accounting needed to access the support, including the necessary matches between engineers and accountants to define the innovative expenses, barriers to be added to the start up and fixed costs of innovative activities. On top of this we should add the restrictive attitude of fiscal authorities to grant what qualifies as an innovation.

Summarizing, both tax deductions and subsidies seem to have played a role even if modest in the stimulation of R&D investments. The reasons for the weak results seem to lie in their cost of implementation in the case of fiscal deductions and their conservative application in the case of subsidies.

6.3. Facts and challenges to connect science and business

Catalonia faces three *challenges* to improve the connection between science and business: sufficient supply of high quality science, sufficient demand for it, and an appropriate connection of

science and business. Catalonia shares the three challenges with many other regions in the world that want to improve their competitiveness based on scientific knowledge and directly competes with them on this in its attempt to develop a premier knowledge economy. Therefore, the successful development of a leading knowledge economy will depend on successfully tackling these three issues simultaneously.

First, there is a *need for a sufficient supply of high quality science*. Catalonia is already developing high quality scientific output for the innovation process and to attract companies that want to source such knowledge.

The science landscape at Catalan (and Spanish) scientific institutions has improved considerably in the last decade. For example, the publication share of Catalonia and Spain has increased at a rate of 2.7% per year over the 2000-2004 period to reach 3.3% of world publications. Catalonia has grown faster than most other regions in Spain. Catalonia accounts for about a quarter of scientific publications of Spain (0.85% of world scientific production in 2006). This progress has not been evenly distributed:

- New public research centers seem to be very active in publishing.
- Engineering and Computing come from a very low base and register important growth in the number of publications
- Biomedical publications in internal medicine, oncology and cardiovascular medicine generate a high number of publications.

Second, there is the *need for a sufficient demand for science by companies*. This is the second connected challenge. A vibrant innovative business sector is required to spur demand for scientific links. However, as Catalan firms innovate little, their demand for science is very weak. The present structure of the Catalan economy, tilted towards medium and low technological intensity firms, does not lend itself to a high level of innovation and therefore to interactions with the science and university system.

Despite this, anchor tenants, i.e. large firms with important applied R&D activities, seem to stimulate the science-business interaction in the local environment. Contract research leads to the development of new insights and technologies and these contracts create access to good researchers to hire for the firms. The three largest Catalan Universities (UB, UAB and UPC) cover about 80% of the limited contract research present in Catalonia and have very different field activity profiles. UB is more active in Pharmaceutical and the Chemical sector. UPC dominates telecom, environment and energy, and, production technologies and construction. UAB has important contracts with food and agriculture, informatics, and public administrations. Where firms put money down for interacting with Universities should provide a first approximation for pointing towards the quality of science-technology translation done.

Given the limited innovation activities of Catalan firms the relevant question becomes how to populate the economy with new, knowledge intensive firms. In consequence, *new start ups and university spin offs together with the links directly translating science into applied technology should be the focus of attention.*

Science-industry links can be measured in terms of contracts, spinoffs, patents and licensing revenues with information from technology transfer offices (TTO). On all this Catalonia has a weight similar to its contribution to Spanish GDP: the average score in the period 2003-6 is between 15% and 20%. For example, in 2006 Catalan TTOs took 19% of contract money (€71 million). Furthermore, not much of a trend can be gathered from the data except for the increase in contract research. Patent activity is very low and licensing revenues negligible (for both Catalan and Spanish institutions in general). For now, spinoff activity, patenting and licensing are only recent marginal activities of the university technology transfer offices. On average Catalonia has produced 10 spin offs a year during the past 5 years. Start ups and spinoffs from the university draw upon the local scientific knowledge base and encourage the development of local knowledge intensive firms.

Third related challenge, *science needs to* cross the "Valley of Death" and *connect with business*. In terms of the direct link between science and business we find that:

- Only 1% of publications in Catalonia include a private firm (while on average, 5% to 7% of publications are produced with one or more authors with a private business affiliation in the overall ISI-Thompson publication database).

- Most publishing – about 75% – by private firms and joint publishing actually happens in the area of pharmaceuticals. This is in line with the share of pharmaceutical publications in an international context by private firms.

- Other sectors such as water supply, health information management systems, and food are also active in publishing.

- There still exists very little mobility between industry and university by trained PhDs.

The latter point is an indicator of the low level of connections between science and business in Catalonia. PhDs understand how research is done at the university, what the incentives and interests are of the different university participants and which the potential is of the existing research and research staff. PhDs working for a private company understand (or should understand) the business needs of the company while being able to match this with the offer (or potential offer) from the different departments of the university.

It must be noted that industry and university use a variety of channels for knowledge interaction. A restriction of the analysis of industry-university links to only a few types of channels may

produce misleading results as there are significant differences in the orientation on certain types of interaction by industrial sectors and fields of science. For instance, while the pharmaceutical and chemical sector dominate the publication link, telecom, energy and the environment become much more prominent when analyzing contract research paid for by industrial partners.

Connecting science to business is far from automatic and requires coordinated efforts between the different players in the innovation system. Catalonia seems to be behind. For example, Catalonia accounts for only 6 out 67 "certified" technological centers in Spain and representing less than 10% of the innovation generated by them (according to Conseller Huguet of the Catalan Government). It must be stressed however that the institutional shells for links between science and industry (e.g. Networks, Technology Transfer Centers, Scientific Parks) by themselves are unlikely to have an important impact without policy measures that address the supply and demand issues.

Translation of scientific results into commercially viable products, processes and services is a challenge for all countries, companies and fields. As others are struggling to overcome this valley between science and business, can Catalonia improve on the first two challenges while leapfrogging others in this final challenge?

6.4. The case of biotechnology

The challenges of connecting science and business are illustrated and elaborated in the work by Mas on biotechnology in Catalonia. Biotechnology is clearly science-based and is rapidly gaining priority in many political and industrial agendas as more and more countries and regions focus on it as a key engine of long-term sustainable economic growth. This is the case, for example, of the Lisbon Agenda and of the EU Sustainable Development Strategy, of Spanish Plan Nacional de R&D&I 2008-2011; and indeed Catalonia's PNRI. As a result, biotech seems to have attracted the largest share of any area of activity of public expenditures by Catalonia on R&D.

The fact that biotech is a technology rather a sector helps underscore the importance of pushing analysis, whether of cross-cutting technologies, policies or anything else, down to the sectoral level (at least). It turns out that there are at least three very distinct kinds of biotech in terms of technologies, markets and competitors: "red" biotech for the pharma sector, "green" biotech for the food sector and "white" biotech for chemicals. Red biotech dominates in terms of revenues and expenditures on R&D and, as a result, much of the discussion of biotech focuses explicitly or implicitly on this sector. While the treatment here mostly aggregates across the three sectors because of space constraints, we *will* emphasize the distinctions among them in our recommendations.

Catalan biotech exhibits a number of positive features, as exhaustively compiled and analyzed by Mas. Catalonia is the leading region for biotech within Spain: it accounted in 2006 for an

estimated 24% of Spanish firms (15% for Madrid) with activities related to biotechnology.[45] Internationally, the number and the size of Catalan biotech firms seem to be growing relatively more rapidly than in leading European regions, although biotech activities in Catalonia are still substantially smaller on both those dimensions than in the leading European regions, let alone the global leaders in the United States. And in terms of research, the Catalan publishing effort has been improving steadily and, in biochemistry has even overtaken some of the other European biotechnology regions, although it lags far behind in originating patents and licensing agreements. (Again, the U.S. dominates overall).

Given these positives, the availability of the requisite scientific infrastructure in terms of researchers and institutions and reasonable infrastructure along other dimensions as well, biotech in Catalonia is an obvious base on which to build. But ideas about how to do so mostly focus on additional financial resources and other implicit or explicit forms of subsidy that the sector can be provided. There is little consideration of the competitive challenges confronting biotech in Catalonia, let alone possible responses. We therefore employ our observations to raise some concerns –and make some recommendations– about the future of Catalan biotech.

It is worth beginning by noting that *question can be raised about the overall profit prospects for the biotech sector worldwide, at least in human health (red biotech)*. The red biotech sector has clearly seen lots of entry: estimates of the number of efforts worldwide to set up biotech (mostly red-focused) clusters range as high as 200! The usual potential for excess as a result free entry into a trendy new industry is amplified by "paid-for entry," with national and regional governments around the world heavily subsidizing entry into biotech in a variety of direct and indirect ways. And fundamental ambiguity –not just about technologies but about viable business models– stirs up the problem of the winner's curse. For all these reasons, it seems clear that over some time frame, there will be a shakeout of biotech activities around the world. It seems less clear –unlikely in fact– that the shakeout will be as quick as the (themselves often quite protracted) shakeouts observed when motivations are purely commercial as opposed to political or social. This augurs poorly for the commercial health of marginal or even average players over a period of time extending beyond the short and perhaps even the medium run.

The likelihood of poor average performance amplifies the importance of relative viability and of improving competitive position. Here, the comparisons of Catalan biotech with leading European regions are not, overall, very reassuring. Many of the positives for Catalonia cited above had to do with changes –off levels that are still substantially lower than leading European regions (e.g., in regard to number and size of firms). But, as noted above, in terms of levels, Catalonia still lags the leading European regions. And the latter have found themselves challenged as well. Thus an INSEAD study of efforts by the German government to create biotechnology clusters is reported to have concluded that "Germany has essentially wasted $20 billion –and now Singapore is well on its way to doing the same." That last bit is a reminder that there are substantial if challenged efforts under way in Asia as well.

45. Asebio (2008).

To top this all off, even the performance of the biotech clusters that lead globally, in the United States, has been questioned. Gary Pisano shows that while the revenues of publicly held biotech companies in the United States have grown dramatically, if one excludes Amgen, the largest and most profitable firm, their combined profits have consistently been negative (with even greater losses if private companies were included in the data pool and, of course, if an opportunity cost were charged on the capital sunk into this industry over several decades). Pisano concludes that biotech has largely borrowed a structure from Silicon Valley that makes much less sense for businesses engaged in advancing basic science as a core activity and that it needs to work out a viable structure of its own. Likely elements, according to him, include more vertical integration, fewer but closer and longer-term collaborations, fewer independent biotech companies, quasi-public corporations as a possible alternative to small public companies, more emphasis by universities on opening up rather than closing off their research efforts, and more cross-disciplinary and translational research.[46]

These are broad, indeed global issues. They are raised here not with a view to spreading gloom and doom but to make the point –essential to any realistic discussion, we think– that if the absolute viability of even regions that are well ahead of Catalonia in biotech can be challenged, *the viability of biotech in Catalonia cannot be taken for granted*. Problems in terms of general (global as opposed to local) perceptions in this regard are suggested by the fact that Catalonia does not make the top decile of many rankings of biotech clusters: maps that list as many as 50 such clusters around the world fail to acknowledge Catalonia or Barcelona.

These challenges ratchet up the rate at which Catalonia must improve its relative position in biotech. Rather than simply calling for additional public monies to be earmarked for biotech, we wish to raise for consideration several ways of refocusing public support for biotech that can (also) aid the attainment of this objective:

More attention to green and white biotech. Catalonia's underweighting, compared to the European averages, of green biotech for agrofood and white biotech for chemicals raises questions given the strength of both the food and chemicals sectors in the region. Catalonia dominates Spanish production of fine chemicals/pharmaceuticals to an even greater degree, but such measures of Catalan dominance based on counts of firms or their revenues ignore the fact that the level of expenditure on pharma R&D, in Catalonia as well as in Spain, is quite limited: local firms spend relatively on R&D and while multinationals operate production sites in Catalonia, very few have significant R&D facilities. In addition, white and (segments of) green biotech offer the prospects of a somewhat better relative position based on Catalonia's specific strengths in biochemistry research and their lower and shorter requirements for funding (which tends to be a key constraint in Catalonia and in Spain). And finally, in green biotech, Spain was, for eight years, the only country in the European Union to permit commercial cultivation of genetically modified crops. Much of this activity, par-

46. Pisano (2006).

ticularly in corn, was concentrated in Catalonia and Aragon. It is plausible to think that an economically relevant lead, at least relative to Europe, has resulted.

Reconsideration of cluster completeness (and roles). Cluster development initiatives often target[47] the local development of the complete set of the requisites for a cluster to succeed in international competition. But it was clear in the case of the discussion of the auto sector, and is also clear in the case of pharma/red biotech, that the *Catalan clusters are likely to be fundamentally incomplete*: that international success is likely to require working with technological and decision hubs located at some considerable distance –500 to 1000 kilometers from Barcelona, for instance, in the case of the biotech hubs in Biovalley. Given this reality, a more appropriate model than the Biovalley hubs, let alone San Francisco or Boston, might be provided by other *"secondary" clusters* that, faced with limitations of local managerial and technical knowledge pools as well as venture financing, *have relied heavily on international linkages to offset their weaknesses*. The three biotech hubs in Austria –in Vienna, the Tyrol and Styria– provide interesting examples in this regard: they each rely on international knowledge links comprising market links, formal networks, knowledge spillovers and informal relations at least as much if not more than local (within each Austrian region) links.[48] And despite Austria's very small size (it has only one-fifth the population of Spain) links across Austrian regions are also significant, especially for the two less well established Austrian hubs (Tyrol and especially Styria). Government policies aimed at facilitating openness on the requisite dimensions have played a key role in this regard, although most of the relevant measures seem to have been enacted at the Austrian national rather than regional level. Without suggesting that nothing has been done along these lines in Catalonia, we do think that much more could be done, as specified under the next point.

Public policies that more coherently address distance. The last point reinforces the emphasis in the industry studies on openness: on looking outside the home base for inputs, markets and ideas. But that point can be taken one step farther. Openness isn't automatic and increasing it often requires, among other things, appropriate governmental policies and even public investment in areas such as cross-border connectivity. To allocate scarce governmental attention and resources appropriately, surely it is worth recognizing that the effects of distance along various dimensions –cultural, administrative, geographic, and economic– on cross-border flows vary by type of flow, and that particularly distance-sensitive flows may be the ones that merit the most attention from a public policy perspective.

While that point might sound abstract, it was prompted by the observation that the Catalan government earmarks most of its resources for biotech to subsidizing basic research, which is much more geographically mobile, i.e., less distance-sensitive, than cross-border flows of skilled people and even capital, which receive much less attention. Mas highlights problems with people flows in particular. One suspects that *ameliorating some of the cultural (especially linguistic),*

47. The original discussion is in Porter (1990).
48. Trippl and Tödtling (2007).

administrative and geographic connectivity barriers (particularly in terms of international air connections) to international (in)flows of scientific and managerial talent might have more of an effect, at the margin, on the biotech sector than simply earmarking additional money for basic R&D. And some of the same points also apply to the explicit encouragement of interchange with other Spanish regions. Such a strategy would also leverage one of the key assets of the biotech sector in Catalonia: the city of Barcelona, which was recently ranked as the business city with best quality of life in Europe. Barcelona's desirability helps both in terms of recruiting talent from elsewhere as well as retaining otherwise mobile researchers.

Complementing scientific knowledge with business knowledge. Perspectives on how to succeed in biotech are, in Catalonia as in many other parts of the world, supply-driven and revolve around scientific research and knowledge development. But while local excellence in science may be necessary for science-based businesses to become regional or world leaders, it is not sufficient. In particular, even if a scientist-entrepreneur does get to the point of starting-up a small firm, it is hard to believe that some business knowledge would not be a useful complement to his/her scientific knowledge and innate entrepreneurialism. And incubators geared to supplying infrastructure are not always focused on facilitating such information or knowledge flows.

Thinking through the whole venture cycle instead of just seeding start-ups. Biotech policy in Catalonia seems, in some respects, overly focused on the number of start-ups. But as mentioned above and discussed in some detail by Mas, Catalan biotech firms have significant size-related disadvantages to overcome relative to their counterparts in leading regions, and firms in red biotech in particular face financing constraints in the medium run. Given these facts and the broader observation that most small biotech ventures around the world have so far tended to get stuck at that scale, an emphasis on thinking about individual businesses and their trajectories, particularly whether they can grow past a certain size, might be useful complement to a policy of actively encouraging start-ups.

6.5. Regional policy

Regions encourage innovation in different ways.[49] For example in the regions associated to Helsinki, Munich, Stuttgart and Milan the economies of agglomeration in clusters are more important than in Amsterdam, Paris and London, where the effect of being an internationally orientated metropolis is marked. At the same time it is possible to find highly organized systems with institutional support, and others, particularly in the larger cities, not very organized. The question is what role the public sector should play in the definition of these strategies.

Global and large centers such as London and Paris can follow a laissez-faire policy. Only investing in infrastructure (in terms of physical, human and technological capital), they can

49. See Vives and Torrens (2004a and 2004b).

leave initiative and the global connections to bloom. These metropolis can base innovation on the critical mass of versatile skilled personnel that they have. In contrast, smaller cities may need to trust in a few key sectors and a battery of active support policies in the area of innovation. Even so, a tendency towards diversification can also be observed in the smaller cities. This is the case in Stuttgart and Dublin, for example. The regional government in Stuttgart intervened to initiate a restructuring of production based on innovative sectors to confront the crisis at the beginning of the nineties due, among other factors, to international competition from low-cost countries. The basic clusters in Baden-Württemberg revolve around the area of mechanical engineering and the automobile industry with an expenditure on R&D only below that of Bavaria. Bavaria has banked on implementing an industrial policy of establishing centers of excellence in certain technological fields to promote synergies between research and enterprise. The most notable are the clusters of ICT (led by Siemens, Infineon and subsidiaries of Oracle and Microsoft), media and biotechnology (which has made it the second European centre after London). In Dublin an active policy has been followed in the electronics, pharmaceutical and financial sectors (though there is more production than R&D).

Intermediated-sized cities can follow a mixed policy, strengthening the effects of size with specific interventions. Amsterdam, Helsinki and Munich follow this intermediate route, as do Madrid and Milan. Amsterdam is a diversified city that has concentrated innovation in the service sector. Milan leads the technological dynamic of industry in Italy with a significant effort in innovation. Helsinki has led the transformation of Finland towards high technology with Nokia at the head. The ICT cluster was promoted by a rapid liberalization of the telecommunications market, a tradition in advanced engineering and a culture of cooperation among companies in the cluster and between companies and universities and research centers. Helsinki is also trying to diversify outside ICT into fields such as biomedicine and creative activities.

We can see, therefore, two possible successful strategies to promote innovation:

A relatively "interventionist" model of industrial policy in the sense of carrying out active policies of industrial restructuring and the encouragement of clusters in new, industrial as well as service, sectors, and that try to force the creation of economies of location/agglomeration that favor innovative environments.[50]

A model of exploitation of the intrinsic advantages of large metropolitan areas and their global connections, mainly the availability or the ease of reaching skilled personnel and good international communications.

50. In fact, a recent study (Greenstone and Moretti (2003)) shows positive net results for regions (in the USA) that have subsidized the installation of new productive plants.

In both models the role of the public sector is fundamental as a:

- provider of public goods: transport and communications infrastructures, investment in R+D, education at all levels and centers of excellence in research;

- land use planning and the provider/manager of adequate public services;

- guarantor of the efficient and competitive functioning of markets.

The complementarity of the factors means that the public sector has a crucial role as catalyst but not necessarily that of choosing sectors. Experience shows that it is normally very difficult to "pick winners". There is abundant literature on clusters that are successful after active public sector intervention, but not so much on initiatives that have failed. It is private initiative that has to decide where to invest once a suitable framework and the necessary basic conditions have been provided.

6.6. Policy conclusions

Internationalization and innovation policy

We have seen in Section 4.3 that innovation matters for productivity and to export. In fact, we find that importing, innovating and exporting are strongly complementary activities. However, these activities are developed *sequentially* by the firms. It follows that *stimulating firms to be active in the international sourcing market and generating innovations might be more productive policy measures than stimulating firms to enter the export market*. Given the lead time needed in importing and innovating, it is less likely that export promotion measures will be very successful in feeding back into future importing and innovating in order for firm to be able to successfully enter the export market. Rather the opposite should happen where firms are stimulated to import and innovate. The next logical step for these firms is then to enter the export market.

The integration of the agencies CIDEM and COPCA decided in 2007 is a step in the right direction. However, a more explicit connection between innovation and internationalization of activities is necessary. In fact, the merger of the cultures of the civil-service oriented CIDEM with the public-private consortium COPCA will not be without difficulties. Furthermore, there is currently no attention to the import/outsourcing side of the internationalization process. Another question mark is the role of the Invest in Catalonia agency within the new ACC1Ó. We may wonder whether it will have the adequate profile and clout to do its mission along the lines of, say, the Investment Development Agency of Ireland or the ambitious plans of the UK's UKTI in the Business, Enterprise and Regulatory Reform Department.

To foster innovation we have to take account of the environmental factors that influences it: infrastructure, the science and technology system, level of human capital, the degree of competitive pressure and regulatory burden. For example, there is evidence that new entrants tend to be more innovative and therefore dynamism in entry and exit in markets and competitive pressure are crucial for innovation.[51] Spain and specially Catalonia lags in some infrastructures, and entry and exit in industry shows in practice many rigidities. But the degree of competition has clearly increased in manufacturing since the entry in the EU and the human capital seems reasonably developed in many aspects. Public support (subsidies, fiscal allowances) to R&D is apparently one of the most generous systems in the EU.[52] The question is how to make it work. There is room to improve procedures for R&D subsidies and fiscal allowances. For example, simplifying drastically the procedure for SMEs, do not using subsidies to delay industrial restructuring, and inducing public agencies to take risks.

Interaction between science and business

The "Pacte Nacional per la Recerca i la Innovació" (PNRI) considers setting priorities in their research and innovation policies towards directions of progress and welfare, sectors and technologies, and, knowledge bases. While focus and prioritization are important elements in building a sustainable position as a knowledge economy, *currently there is a lack of basic information about the Catalan science and innovation system to help inform and direct such policy measures*: What are the strong points of the Catalan scientific base at an international level? Which organizations are fostering links with industry better? Which relations between universities and industry exist? Just the simple coordination on reporting would improve matters considerable. For example: TTOs use different classifications for industry links, R&D contracts and service contracts are often lumped together, national and international R&D contracts are typically not separated; newly created research centers as centers for high quality scientific research should play an important role in these links and, hence, in the information collection effort (are they cost effective? -how much money one top publication costs at different institutions?; the ICREA program has been able to attract high quality scientists to Catalonia, but what has been the effect of the program on departments obtaining ICREA researchers? Do these departments outperform other departments? Do they spur other departments to improve? The first rounds of ERC funding from the European Commission seem to suggest that there is a positive correlation between ICREA researchers and ERC funding obtained.

The "Document de Bases del Comitè Permanent d'Experts" of the PNRI (April 2008) suggests the organization of an agency for the evaluation of the Catalan innovation system. The current PNRI proposes to outsource this evaluation to expert committees and recognized international organizations. However, such an agency could play a critical role in coordinating, harmonizing

51. See Vives (2008) for a study of the links between competitive pressure and innovation. Acemoglou et al. (2006) claim that competition is more important for productivity for industries close to the technological World frontier.
52. See Busom (2006).

and collecting the information of all the relevant players in the Catalan innovation system and provide an important input to the proposed "Consell Català de Recerca i Innovació" (CCRI). Only through the clear and effective measurement can decisions based on solid data be contemplated, implemented and evaluated. An independent organization should monitor and register the scientific and science-business activity in Catalonia. Furthermore, public research funding could be made partially dependent on the relative score of the different universities and centers on these measures.[53] In conclusion, *an independent agency that measures and evaluates progress in Catalonia along different research and innovation dimensions, with a particular focus on links between science and industry*, should be established. This agency should coordinate international panels of experts and commission evaluations of Universities and research centers to independent international institutions.

Policy makers should provide *correct incentives for the players in the Catalan science and innovation system*. To start with the bureaucratic inertia in universities is very strong with a lack of tradition of reward of excellence, lack of sufficient discrimination in funding among research groups, and rigid procedures which discourage new ideas and adaptation of the needs of society. The problem is not only of insufficient funding but also, and more importantly, of an organization which does not provide the incentives for excellence. Here the *programs of excellence ICREA and the establishment of independent research centers should be continued and expanded with funding and creation of those research centers done on a competitive and transparent basis*. That is, with a public contest for funds on specific areas that want to be developed and not by opaque procedures that do not allow the bidding of potential candidates research groups. Furthermore, while excellence in scientific research is rather easily measurable, if done properly, successful linkages between science and industry are harder to detect. Here the example of the centers for translational science funded by the NIH in the US may be helpful. These types of centers will be evaluated according to different measures: not only publication output but also reaching milestones and their ability to work in multidisciplinary groups, patent, collaborate with industry and succeed in clinical trials. Being innovative in setting up these structures will determine whether Catalonia not only creates supply and demand for science output, but also bridges the "Valley of Death" better than other regions vying to become knowledge economies.

Industry and university use a large variety of channels for knowledge interaction. Restricting the analysis of industry-university interactions to only a few types of channels may produce misleading results as there are significant differences in the orientation on certain types of interaction by industrial sectors and fields of science. The three large universities have very different profiles in their interactions with industry. Policy should focus on *providing incentives and autonomy for the universities* in the development of these interactions between science and business according

53. Flanders has established a comparable policy center (Steunpunt O&O Indicatoren: www.steunpuntooi.be) which evaluates and monitors the scientific as well as scientific-business activity; public research funding is made partially dependent on the relative score of the different universities on these measures.

to their expertise. For example, policy makers could organize a *competitive fund for industrial research finance*, where the amount of funding that a university draws is proportional to its weight in a composite measure capturing the involvement of the organization in industry science links. The Flemish government has actually experimented with such a measure. Within this measure, patents, EU funding, spinoffs, R&D contracts, licensing, doctorates delivered, and publications and citations are all weighted to determine the share of each university in the industrial research fund. As such the funding is distributed on a competitive basis.

Coordination between Spanish and Catalan research institutions should be improved. Today there is no systematic co-ordination between the Governments of Spain and Catalonia in terms of the governance and development of a strategic and operational policy for science, technology and innovation.

Fostering mobility of researchers and understanding between science and business. Science and PhD training should be at the highest international levels. Without high quality science and PhD programs, firms are unlikely to tie into the Catalan science system. Furthermore, high quality PhDs attract good faculty as researcher like to work with and train good young researchers. Therefore, *supporting PhD programs and research which is competitive at the international level* is crucial for this objective. In Catalonia there are too few PhDs that flow to industry. This is again a demand as well as a supply issue. *PhD employment by firms has to be incentivized*.

Contract R&D has to be promoted since it is a very valuable way for companies to connect to science. The focus of these links with firms should be *international as well as domestic*. World class science should attract worldwide interest. Over time policy makers should encourage the development of local knowledge intensive firms that draw on the science developed in the local environment. Such a process is jump started by the creation of start ups and spinoff from the university that draw upon the local scientific knowledge base. Furthermore, when attempting to attract larger international players the focus should be on the research link rather than the employment generation. Researchers are much less foot-lose than pure production sites.

Business training for scientists and PhDs should be stimulated. The scientific curriculum should be complemented with a basic understanding of business principles. Scientist should have a basic understanding about how value is created in the economy. Many inventions fail in the product market exactly because the difference between technical value and economic value is not clearly understood. Furthermore, such programs might open the researcher's appetite for an entrepreneurship activity.

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7. Company Strategy

Factor endowments, demand conditions and governmental policy all influence competitiveness, but do not entirely determine it: companies' strategies mediate between these influences and actual outcomes –and their evolution over time. This section begins by looking at the evolution of Catalan firms, large and small, along various dimensions and compares them with firms from other parts of Spain. It then reverts to the issue of whether Catalonia's "productivity problem," if it has one, is primarily due to too little R&D-based innovation –and suggests, at a minimum, two additional foci. First, there are the distinctive problems of microenterprises, who are too "straitjacketed" to engage in much strategizing and for whom renovation rather than innovation seems to be the name of the game. And second, if larger Catalan firms that appear to enjoy more degrees of strategic freedom are indeed stuck, breaking out of that state is likely to require changes in strategies that cut across functional areas, i.e., strategic innovation rather than just engagement in more R&D. This part incorporates the work of and Ramon Casadesús-Masanell and Joan Enric Ricart. The chapter ends with some implications for policy makers.

7.1. The evolution of Catalan firms since 1990

In summarizing and trying to make sense of the performance and strategies of Catalan firms since 1990, it is useful to start with a reminder of the competitive context. After the full integration of the Spanish and Catalan economies into the EU, firms had to adapt their strategies to compete in a highly open and competitive environment. The need for change was reinforced by the crisis of 1993, although the devaluations of 1993 and 1995 did provide firms with some breathing room. A room which will not enjoy in the present crisis.

Table 7.1 first summarizes the evolution of a sample of Catalan firms over the 1990-2006 period and then compares them with other Spanish firms in the final year of the period.[54]

54. Consider Jaumandreu's analysis of an unbalanced panel, drawn from ESEE (Encuesta sobre Estrategias Empresariales), a firm-level survey of Spanish manufacturing by the Ministry of Industry, that tracks more than 4,000 firms subdivided geographically -Catalonia, the rest of Spain and Madrid –and by size (small firms with less than 200 workers versus large firms with 200 or more) over the 1990-2006 period. Although the survey results are available starting in 1990, the data for the first year are not entirely comparable to those for later years.

To begin with the performance of Catalan firms, profitability has increased significantly since the early 1990s up to 2006, when it was negative in economic terms and, in that sense, unsustainable. The increase in profitability has been driven by continuous decreases in the yearly cost of funds (data reported by firms on the nominal interest rates paid on debt) since (accounting) price-cost margins themselves have tended to be remarkably stable over time and similar across large and small firms. The decreasing capital costs themselves seem to be driven by integration with the EU and, more recently, the introduction of the Euro.

Turning to human resources, unit labor costs show stability for small firms and a continuous sharp reduction for big firms despite, in both cases, the increase in nominal wages over time. This, along with the decline in capital costs is a reassuring pattern that casts doubt on the idea that Catalan competitiveness may have been constrained by rising costs or simply be the result of the devaluations of the first half of the 1990s. Further reassurance is supplied by two indicators of firms' efforts to upgrade human capital: decreases in the proportion of firms using temporary contracts and, especially, in the proportion of employment accounted for by temporary contracts at the firms that use them. (These shifts were triggered by changes in the terms of such contracts, but are no less significant for that). In addition, there is a continuous increase in the number of small firms that employ graduates and a remarkable increase in the proportion of graduates employed in all firm types. Somewhat surprisingly, the proportion of graduates is roughly the same for small and big firms.

Table 7.1: Firms' strategies to enhance productivity: Catalonia

	Small firms						Big firms					
	1991	1994	1997	2000	2003	2006	1991	1994	1997	2000	2003	2006
Costs												
Price Cost Margin	0.142	0.122	0.120	0.111	0.110	0.118	0.126	0.113	0.122	0.121	0.108	0.115
Cost of funds	0.149	0.113	0.064	0.056	0.041	0.042	0.127	0.096	0.058	0.050	0.038	0.039
Wage (thousand Euros)	16.4	19.6	21.9	24.6	28.1	31.5	22.9	29.5	32.2	34.5	37.9	43.0
Labor unit cost (Wage bill/Output)	0.307	0.310	0.275	0.277	0.289	0.278	0.259	0.253	0.225	0.206	0.207	0.194
Product differentiation												
Product is standard	0.595	0.597	0.619	0.513	0.491	0.494	0.687	0.737	0.730	0.786	0.663	0.647
Advertising												
Proportion of firms that advertise	0.598	0.669	0.661	0.688	0.676	0.686	0.810	0.876	0.825	0.807	0.752	0.733
Expenditure over sales (0/00)	2.4	1.5	1.4	1.3	1.3	1.7	3.3	3.5	3.5	4.1	2.8	3.3
Human capital												
Temporary workers												
Proportion of firms with temp. w.	0.745	0.753	0.732	0.679	0.572	0.506	0.908	0.905	0.889	0.886	0.851	0.776
Temporary workers proportion	0.319	0.297	0.253	0.191	0.155	0.136	0.182	0.165	0.162	0.135	0.109	0.110
Graduates												
Proportions of firms with graduates	0.67	0.677	0.677	0.714	0.728	0.788	0.988	0.985	0.992	0.993	1.000	1.000
Proportion of graduates	0.122	0.12	0.12	0.143	0.149	0.167	0.100	0.126	0.132	0.169	0.161	0.200
Technology adoption												
Use of digitally controlled mac-tools	0.216	0.312	0.327	0.379	0.445	0.433	0.448	0.474	0.476	0.621	0.663	0.595
Use of CAD	0.167	0.224	0.210	0.313	0.329	0.359	0.399	0.431	0.444	0.543	0.535	0.526
Use of robots	0.082	0.118	0.097	0.134	0.139	0.224	0.405	0.431	0.405	0.521	0.485	0.500

Source: Computed with ESEE data

Table 7.2: Firms' strategies to enhance productivity: Comparisons 2006

	Catalonia		Rest of Spain		Madrid	
	Small firms	Big firms	Small firms	Big firms	Small firms	Big firms
Costs						
Price Cost Margin	0.118	0.115	0.118	0.123	0.112	0.137
Cost of funds	0.042	0.039	0.043	0.041	0.041	0.045
Wage (thousand Euros)	31.5	43.0	25.8	39.0	30.0	44.5
Labor unit cost (Wage bill/Output)	0.278	0.194	0.295	0.201	0.315	0.226
Product differentiation						
Product is standard	0.494	0.647	0.574	0.620	0.483	0.556
Advertising						
Proportion of firms that advertise	0.686	0.733	0.711	0.728	0.730	0.689
Expenditure over sales (0/00)	1.7	3.3	1.3	2.2	1.6	2.1
Human capital						
Temporary workers						
Proportion of firms with temp. w.	0.506	0.776	0.618	0.866	0.526	0.800
Temporary workers proportion	0.167	0.110	0.244	0.164	0.157	0.125
Graduates						
Proportions of firms with graduates	0.788	1.000	0.677	1.000	0.687	1.000
Proportion of graduates	0.167	0.200	0.150	0.178	0.164	0.318
Technology adoption						
Use of digitally controlled mac-tools	0.433	0.595	0.429	0.670	0.422	0.600
Use of CAD	0.359	0.526	0.329	0.534	0.361	0.467
Use of robots	0.224	0.500	0.186	0.555	0.130	0.511

Source: Computed with ESEE data.

Focusing on output rather than inputs, small firms, in particular, have stepped up their efforts at product differentiation through increased variety and broader involvement in advertising, although advertising-sales ratios themselves show no clear trend. The proportion of large firms that advertise as well as their advertising-to-sales ratios are higher than for small firms, and while product variety is reported to be lower, this may simply reflect differences in the industries that they are present in –or limitations of standardization the measure employed.

In terms of deployment of technological improvements, it is useful to supplement the earlier discussion of innovation, which flagged questions about Catalan firms R&D expenditure levels, with data on the adoption of new technology involving, in the terms introduced earlier, elements of renovation rather than innovation. These indicators show a relatively quick pace of adoption of digitally-controlled machine tools, computer-aided design and robots, particularly by small firms, which start from much more modest –and variable– levels of use of these advanced but general purpose technologies.

The second panel in Table 7.2 compares Catalan firms with firms from Madrid and from the rest of Spain in 2006. There are some modest differences: Catalan firms seem more advertising intensive and less prone to temporary employment, and small Catalan firms use more skilled labor and are somewhat more prone to have adopted new technologies. But the differences are minor –especially relative to firms from Madrid– and seem more likely to be related to differences industry mix and sampling variance than to fundamental differences in strategies. That conclusion also holds up when one looks at the time period since 1990 rather than just the terminal year of 2006.

7.2. The productivity puzzle revisited

To summarize the previous subsection, costs and investments in human capital, product differentiation and the adoption of new technologies all seem to follow paths consistent with improved productivity and enhanced competitiveness. Given these patterns, reconsider the one respect in which Catalan firms seem not to have progressed and may even have regressed, R&D. As noted in the discussion of productivity, R&D-intensity has stagnated since about 2000, while the proportion of firms introducing process and product innovations has actually decreased! Are Catalan firms engaging in too little innovation and, specifically, R&D?

The plausibility of the notion that Catalan firms are, as a group, underinvesting in R&D seems somewhat at odds with the evidence presented in the previous section about their efforts to upgrade along multiple other dimensions. With all the attention lavished on R&D at many levels –ranging from the Lisbon Agenda to Catalan public policy– firms are unlikely to have simply ignored the R&D alternatives open to them. And while it is easy to imagine errors in evaluating R&D alternatives, especially given the uncertainty that surrounds the returns from them, a general tendency toward underinvestment would seem to require some sort of systematic constraint or bias.

One obvious structural constraint, discussed in the course of the analysis of the food and beverage and automotive/transportation sectors, is provided by the very large number of very small firms –microenterprises with, say, fewer than 20 employees. Such firms seem to be underrepresented in the ENSEE sample compared to their incidence in the general population of firms and are, in any case, lumped together with firms up to ten times as large, making it hard to draw inferences about them from that dataset. But given the fixed cost nature and uncertainty of R&D, common sense suggests that such microenterprises are too "straitjacketed" or constrained to engage in much strategizing or innovation. For such firms, renovation rather than innovation is likely to be the key to productivity improvement, as discussed in the context of the sectoral studies

What kinds of behavioral biases might limit the amount of R&D undertaken by Catalan firms that *are not* structurally constrained by their size or resources? One possible answer is provided by the slack offered by declining unit and labor costs, which may have limited the pressures on firms to upgrade. This possibility is suggested by Genescà and Salas (2007), who show that ex-post competitiveness (return on assets minus opportunity costs) has increased since the 1990s but find very limited growth in ex ante competitiveness, measured in terms of productive, technological, human, commercial, relational, and entrepreneurial capital.[55]

A somewhat different kind of behavioral bias is suggested by Oliver's (2007) study of the Catalan economy.[56] Translating his conclusions, "The Catalan Economy is immersed in a transformational process from a model based on low costs and fundamentally an internal demand (or external demand of relatively low quality) to a new situation characterized for a need for high quality factors in human, productive and technological capital". Oliver cites in this context three forces that have had a major impact on the environment in which Catalan firms operate: increased international linkages; internal restructuring that has seen decreases in primary and industrial labor and significant increases in labor in construction and especially services; and demographic/labor market changes characterized by a sharp fall in the birth rates and a rapid rise over the last 10 years in immigrant flows.

This latter argument is elaborated by Casadesús-Masanell and Ricart who anchor their analysis in a stylized representation of the traditional Catalan "business model" –others might call it strategy that developed in the course of early industrialization– at least compared to other parts of Spain –in response to an environment characterized by:

1. Availability of technology, often imported, that increased the scale thresholds for efficient operation.

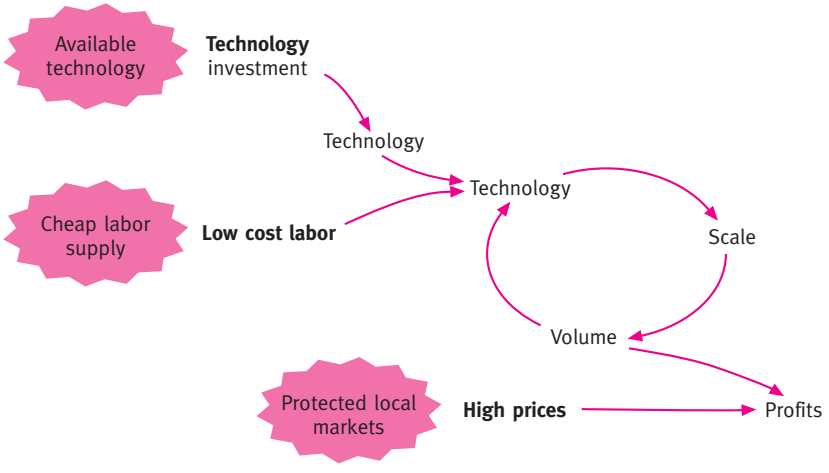
2. Inflows of low cost labor, especially from other parts of Spain, able to handle the relatively simple industrial processes involved.

55. Genescà and Salas (2007).
56. Oliver (2007).

3. A Spanish market protected from foreign competition that grew rapidly (enough) during the postwar decades of autarchic development.

See Figure 7.1 for a simple rendition of the traditional strategic response to these environmental conditions. Note, in particular, the virtuous cycle linking low cost, volume and economies of scale as the core of what this business model was about.

Figure 7.1: Interactions with the Environment



Source: Casadesús-Masanell and Ricart (2009).

Casadesús-Masanell and Ricart go on to suggest that this traditional business model often involves a functional organization (and more broadly, organizational choices aligned around a configuration that Ghemawat and Ricart (1993) have characterized as "static efficiency"). They argue that although some firms have improved on this traditional business model or strategy by stepping up investments in technology, marketing and R&D, very few firms have managed more than incremental strategic changes despite the drastic changes in their circumstances (see above). Casadesús-Masanell and Ricart also look at a few exceptions to this rule: a handful of companies that *have* managed to transform their business models or strategies, mostly through effective pursuit of internationalization and its correlates.

Regardless of whether one agrees with this exact characterization of the traditional Catalan business model and its (non)evolution, Casadesús-Masanell and Ricart's stress on the multiple dimensions of business models or strategies and the complex interactions across them is useful because it helps connect the question of how Catalan firms might have gotten stuck strategically to a recent behavioral literature that looks at that question in a broader context. The recent behavioral literature notes that a strategy in all its complexity –much of which is suppressed in Figure 7.1– might

arise either through *ex ante* design or through *ex post* search and adjustment. And it suggests that the actual evolution of successful strategies probably involves elements of both: full articulation ahead of time of a strategic position with high dimensionality seems daunting; at the same time, strategy seems unlikely to be purely emergent. Given profit-seeking behavior by boundedly rational firms, a more plausible picture of managerial processes involves some top-down prespecification of both some broad principles and some particular policy choices that represent starting points of processes of local search and adjustment aimed at improving firms positions over time over what might be thought of as a "fitness landscape": a mapping of policy choices along multiple dimensions to performance.[57]

Unfortunately, this plausible process of strategy development is guaranteed to lead to the best possible outcome only if fitness landscapes are single-peaked, i.e., only if there is one best way of competing. Single-peaked fitness landscapes result from choices that are unrelated or are all subject to complementarities with one another (a plausible characterization of the subsystem of "modern" manufacturing techniques in Table 7.1).[58] But the trade-offs that have been described as the core features of business strategymaking (Porter [1996]) lead one to expect rugged landscapes, with one global peak but many local peaks.

The significance of this distinction is that the process of strategy development described above is guaranteed to lead only to a local peak: a set of policy choices that is internally consistent in the sense that any one-policy-at-a-time change would be dysfunctional. However, local peaks come without warranties as to their global or absolute desirability, local peaks are not all equal so there is no assurance that local search processes will, on their own, lead to satisfactory performance. And to embellish the landscape imagery, if the local peak that a firm or a group of firms is clinging to happens to be submerging because of environmental changes (cf. the ones described above in the Catalan context), strategic change is particularly pressing.

To summarize, if there *is* some kind of overarching issue with Catalan firms strategies –of which clinging to a traditional business model is just one possible example– solving it is likely to require strategic change by firms, i.e., multiple policy changes by them rather than just enhanced R&D or change along some other focal dimension. The next subsection discusses the implications of this perspective for public and especially business policymakers in somewhat greater detail.

7.3. Implications for policy makers

A focus on firm strategy inevitably shifts attention from public policy to business policymakers. For the former, it is an invitation to peer inside the black box of the firm to understand how firms are really likely to respond to public policies (e.g., an R&D subsidy) –and how their responses

57. Gavetti and Levinthal (2000) and Ghemawat and Levinthal (2008).
58. As noted nearly two decades ago by Milgrom and Roberts (1990).

might differ. And there are also implications for the management of the public-sector entities that are supposed to work with business firms. But it is not clear what role beyond informational one government can play to directly encourage more creative strategy selection (and implementation) by business firms.

The implications for business policymakers are much richer, and can helpfully be visualized in terms of a *rugged landscape characterized by lots of local peaks, each of which depicts a coherent bundle of mutually reinforcing choices*. This representation suggests, first of all, that *incremental analysis and incremental change may not lead an established firm to a new, fundamentally higher position*. Rather, the firm may have to consider changing many of its activities in unison to attain a higher peak. To improve its long-run prospects, it may even have to step down and tread through a valley. (Consider the wrenching and far-reaching changes required to turn around IBM, for instance).

Ruggedness also implies that more than one internally consistent way to do business often exists within the same industry. Although only a limited number of viable positions are available, more than one high peak usually appears when the interactions among choices are rich. Some strategists would go even farther. As Michael Porter puts it, "My work stresses that there are many different ways to compete, many different ways to deliver value to customers, and many different customer needs. Strategy is fundamentally about deciding what you are going to be as an organization while also adopting best practices."[59]

That quote as well as the landscape imagery are also reminders that the creation of competitive advantage involves choice. In occupying one peak, a firm forgoes an alternative position. Relatedly, the imagery can be used to visualize the role of competition. There is often more added value to occupying one's own separate peak than from piling on to a heavily populated summit. Claiming a distinctive peak may even insulate a firm from competitive pressures and retaliation.

The last two points about creativity and choice, lead to the broad question of how firms can develop "new game" strategies, i.e., identify untenanted, attractive peaks to scale. While the importance of this question is general, it is amplified by the belief –if one shares it– that Catalan firms may, in some important sense, be stuck.

It is worth beginning by noting that industry environments vary in the amount of room that they afford to develop new game strategies. Industries that are early in their life cycles, that exhibit rapid declines in real prices, that are relatively unburdened by sunk cost commitments and that experience frequent changes in trends and shocks can be expected to afford more room, *ceteris paribus*, for new game strategies. But these are simply expected correlations, not absolute conditions. Even traditional sectors like food and processing or, even more strikingly, textiles, do suggest a number of examples of Catalan companies that have managed to rethink

59. Porter (2008).

how to compete. So perhaps the more important point to make is that all industry environments afford room for rethinking along these lines.

Much of Casadesús-Masanell and Ricart's contribution is focused on developing a rigorous, general framework for thinking about new ways of competing ("business model innovation"). Their recommendations involve focusing on creating virtuous cycles (ideally more than one, and with complementarities across cycles), ameliorating the effects of vicious cycles, and managing interactions with other players with, again, a view to minimizing negatives and maximizing positives.

As a complement to Casadesús-Masanell and Ricart's focus on working through the virtuous/vicious cycle heuristic in depth, consider what else we know from a large literature on how firms can come up with a better set of strategic options to evaluate:[60]

1. *Systematically vary the options considered in terms of scale, timing, ownership, etc.*. These may seem to be incremental tweaks rather than truly innovative, but getting the scale or timing right on a new initiative can be *the* determinant of whether it creates or destroys value. And issues of whether something should be "owned" (done inside the firm) or not are obviously fundamental –yet are often glossed over (e.g., a firm making a backward vertical integration decision without analyzing alternatives ranging from spot transactions to long-term contracts). "Fine-tuning" options in this sense can effect far-reaching improvements in the set of options considered– and the one selected.

2. *Broaden the scope of the scanning effort*. Broadening and shifting the scope of the strategic scanning effort can involve focusing on changes as a way of uncovering what's new; expanding the scope of external scanning efforts to include the entire value system in the industry, not just direct rivals; putting oneself in other players shoes (again, not just direct rivals), directing attention to weak signals from the periphery, and fostering thinking across multiple businesses or geographies through questions such as "Where else would this work?" Broadening the scope of the scanning effort to look at multiple geographies is particularly worth highlighting given the internationalization pressures on Catalan firms. Thus, even if a Catalan firm has no direct interest in India or China, it may be worth its while to look at the kinds of strategies being developed by low-cost/high-volume competitors there.

3. *Shift the perspective*. Looking at competitors from very different geographies is just one way of trying to achieve a radical shift in perspective. Many others have also been proposed but can only be selectively and briefly mentioned here. Drop one assumption, a few, or even all (e.g., think about how one might solve a particular problem if starting afresh or if money were no object). Identify the unwritten rules that drive the industry and competitor behavior and try to break them. Emphasize threats as well as opportunities as a way of increasing

60. For a more extensive discussion, see Cassiman and Ghemawat (2006).

receptivity to change. Follow outside-in paths, from possible answers to the issues facing a business –threats and opportunities– that they might address, as well as inside-out paths, from issues to answers. Understand how to do the opposite of what you actually wish to achieve and then do the opposite of *that*. Adopt a can-change attitude toward the current state of affairs by asking yourself, "Why not?" Think of other ways of flipping things around (e.g., changing who pays whom). Use techniques developed to enhance lateral or parallel thinking. And take the idea of putting yourself in your competitors shoes one step farther by analyzing your company as a competitor from *their* perspectives.

4. *Harness the creative powers of the whole organization*. Yet another way of stretching thinking about strategic options involves moving beyond the "one big brain" model of strategic innovation and shaping organizational processes and structures to reflect what we know about creativity. Again very briefly, recommendations include: cultivating open-mindedness; risk-taking and a commitment to learning; tolerating divergent thinking; developing suitable sensors; making strategic planning more discovery-driven or more like an extended dialogue; emphasizing rich information flows; conducting data-driven analysis and deep immersion in and mastery of the details of the business; countering known biases (e.g., the "not invented here" syndrome); relying on intrinsic as well as extrinsic commitment devices such as incentives; and continuously revitalizing, challenging and even unsettling the organization. Of course, such organizational traits affect the evaluation of new options and their generation.

To conclude, whether Catalan firms have been stuck is perhaps not as interesting as the point that even in mature sectors, there may be significant headroom for firms to come up with new, improved ways of competing. Once one shifts from thinking about a closed universe in which "all the possibilities can be exhaustively enumerated in advance, and all the implications of all possibilities explored in detail so that they can be neatly labeled and placed in their proper pigeonholes"[61] to a more realistic but complex vision of an open universe in which that is infeasible, it is clear that there is scope for coming up with hitherto unthought-of moves (or countermoves). The recommendations supplied above make a small start at this very important agenda item.

61. Binmore (1990).

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8. Agenda for action and policy implications

Catalonia is in a contest with other developed regions in the world to attract economic activity and business decision centers. Regions compete in terms of location, variety of resources and in terms of offering a style of life and "culture", in the general sense as well as in the business sense. Regions also compete, in terms of the quality of the nucleus of services and infrastructure, as objective elements of the quality of life that they offer. For example, if taxes are equal companies choose regions with more quality in infrastructures and services. The implications of this latter type of competition are important, as investments in quality have the character of fixed expenditure and the entry of new competitor regions with high quality can displace regions with lower quality that, until that moment, competed successfully on the international market. Therefore, for example, a country that maintains low quality tourist services (poor infrastructure) can be displaced by the entry of countries with better quality services. We have seen how globalization pressures bring up these questions in the automobile industry, and with dramatic force in a crisis situation. The only response for regions with labor costs that are not competitive with the new entrants is to enhance productivity with a coherent strategy which opens the economy to global sourcing, renovation, and broad-based innovation. This would allow firms to compete, for example, in terms of product innovation, going up the quality ladder. This strategy needs an active policy on the matter of infrastructure, competitive environment and the creation of the necessary critical mass in crucial factors. Without this policy the region can become sandwiched between those offering superior quality, on the one hand, and those that are more cost efficient, on the other.

The success of a region in terms of economic growth is affected by a set of *complementary factors* such as the degree of competition in the markets, the stock of human capital, the capacity to generate new knowledge, the quality of the service infrastructures (transport, communications, etc.), the availability of sufficient business finance, an efficient and fair fiscal system, a cohesive society, and the level of the quality of life. The public sector is crucial in the provision of these factors.

Strengths and weaknesses

Catalonia has some assets to start with: a diversified industrial base, a high degree of openness of the economy (both in terms of trade and capital flows), a commodity hub for Spain and with

important logistic potential in the Mediterranean, a tradition of entrepreneurship with a segment of dynamic internationally oriented firms –a few with international dimension, a high quality life (helped by location advantage and mild climate), a reasonable level of human capital, and some leading research and teaching centers. At the same time infrastructure (port, airport, railways, local transportation) lags behind; the overall level of innovation in the economy is low; the size distribution of firms is tilted towards small firms with low productivity, lack of tradition of cooperation, as well as absence of locally rooted large multinationals and important dependence of multinationals with far remote headquarters; the process of entry and exit in industry shows in practice many rigidities, outcome, in part, of a rigid labor relations system; the service sector lacks competition; the education system is failing with dismal performance of primary and secondary education and inadequacy of professional education; the University and science system is bureaucratic-driven and there are no incentives for excellence; constraints to mobility are important and the knowledge of the English language still low; R&D policy has tended more to dispersion than to consolidate critical mass in key areas; and the administration is heavy handed in terms of regulatory measures with the ratio between institutional complexity and command budget high.

Catalonia shares with Spain many other problems. In Spain, Justice is slow and inefficiently organized, inflicting high costs on the operation of firms. Administrative procedures are cumbersome and the cost of doing business is high. Sectoral regulators still have a long way to attain the desired independence and technical capability. Spain has a very high index of protection of labor leading to a dual labor market (with a segment of protected jobs and another of temporary laborers), low levels of part time work and a welfare system that does not incentivate work. Collective bargaining is at an intermediate degree of centralization, very far from the decentralized extreme and not close to the centralized one (both with good properties). This system does not allow neither to fine tune salary conditions to the productivity at the firm level, nor to internalize general economic conditions when setting wages. The rental housing market is very narrow because the property rights of owners are not firmly established. The pension system must be reformed in order to guarantee its viability. Competition in services is weak and this discourages the use of information technology. Particularly severe competition issues arise in the energy and commercial (retail) sectors. In energy, on top, a general policy on the future of the technology generation mix should be defined having in mind the extremely high dependence on imports.

Catalonia, and Spain, have the opportunity to converge in the long term not with average EU-27 or EU-15 but with the best performers in the EU if structural adjustments are made. A couple of factors may help: (1) Spain (and Catalonia in particular) have a relative weight of the public sector in the economy more aligned with the UK level than with France and Germany, and (2) society, despite all weaknesses, is still more flexible and adaptable than the more entrenched middle Europe. The current crisis should be a rallying point for action. The risk of not taken action is a protracted period of low economic activity and bleak prospects. No devaluation will save the Catalan industry as in the early 1990s. In the last two decades Catalan firms have made efforts to become more competitive. This follows from looking at efforts to

reduce costs, investments in human capital, product differentiation and the adoption of new technologies. Innovation effort has lagged behind, mostly because of the constraints faced by small firms. However, the drastic reduction of financing costs, as well as the immigration influx, that the entry in the euro has brought may have limited the pressures of firms to upgrade. There are indications than there has not been yet a clear break with the traditional Catalan business model derived from the autarchic period with cheap labor, imported technology and a protected market. Obviously, there are a few exceptions to this rule since a handful of companies *have* managed to transform their business models, mostly through effective pursuit of internationalization. We think that the present crisis will end forever the traditional business model for a simple reason: it will not survive.

The need for a coherent set of policies

A coherent set of policies are needed to leverage the strengths of Catalonia's economy (diversification, industrial base, climate, quality of life...) to move the industrial and service sectors towards products and services further up in the quality ladder, to improve the productivity of the vast segment of small firms which are far away from the technological frontier, and compete effectively in the world market. Catalonia is competing with other advanced regions of the world, in order to do so effectively it needs to have a first class infrastructure, skilled human capital, and a vibrant competitive environment. Technological change and globalization pressures imply that restructuring is unavoidable. The present crisis is an opportunity to restructure industry and services to induce a sustained productivity increase.

The present crisis will serve to reduce costs, in fact, it will put tremendous pressure to cut costs and move operations to locations where it is more advantageous to produce. Productivity, broad-based renovation and innovation and internationalization, together with removing artificial obstacles to capital reallocation, are the name of the game. The cluster development initiatives that have formed one of the principal platforms of industrial policy in Catalonia for more than a decade have been useful. Now they have to be rethought because with the need to have complete clusters of activities locally has been superseded by the international fragmentation of the value chain and the idea that innovation is *the only* route to productivity growth may miss the broad perspective on productivity enhancement. Indeed, traditional indicators of market shares and market growth may need to be replaced by indicators of productive growth in absolute and relative terms to competitors. A distinction must be made also between those firms and segments which are at the technological frontier, and for which the pressure to innovate is formidable, and those which are well inside the frontier, for which renovation and replication is crucial in order to advance towards the frontier. This calls for an approach which integrates fostering innovation and renovation in the broader context of fostering growth and placing industrial activity and advanced services at the center stage. This means exploiting opportunities to reach efficient scale (specially important given the fragmented structure of the Catalan industry system with predominance of small firms), to replicate and reach the technological frontier where it has not been reached yet, to allow the

less efficient to be replaced by the more efficient, and not to block redeployment of resources from declining to uprising activities. This broad strategy needs a vibrant market with effective rivalry and low barriers to entry and to exit. In a recessive conjuncture care has to be taken not to block the process of exit of inefficient firms while at the same time helping efficient producers which are innocent bystanders of the collapse of credit markets. Small firms are certainly the most vulnerable to the contraction in bank credit, and many may need help to survive the crisis, but such help will represent an efficient deployment of resources (rather than a failure to redeploy) only if there is some way to turn small firms which are inefficient into ones which are efficient. Consolidation will be needed, it is not farfetched to surmise that the industrial landscape of Catalonia after the crisis will look quite different that the one we see today.

The stated policy of the Government of Catalonia (Generalitat) tries to address many of the weaknesses highlighted in this report and summarized above. For example, in June 2008 a revision of the "Acord estratègic per a la internacionalització, la qualitat de l'ocupació i la competitivitat de l'economia catalana 2008-2011" was published. The document together with the PNRI and the "Pla de política industrial (2009-2013)" will become reference points for policy action. We provide below some recommendations which go beyond and/or may complement the plans of the administration. The present crisis should serve as catalyzer for action in areas that need reform.

In terms of agenda for public action it should be noted that quite a few of the long term policies related to perceived weaknesses are in the hands of the Spanish government. Indeed, Spain needs reforms in institutions in the area of justice, labor market, rental housing market, pensions, and competition in services, to name some leading problems. In all those cases reform has to come from laws enacted at the Spanish level, although there is some leeway for intervention of the regions. In some other cases, like education, the regions have more of a say. In our recommendations we will concentrate mostly on issues for which the Catalan government has some relevant levers of action.[62]

The following should be *key ingredients for a coherent strategy*:

- Back to basics. Catalonia needs:
  - To build on its industrial tradition as engine of productivity to pull the economy:
    - Special care has to be given to the segment of dynamic firms active in the international market.

62. Most recommendatios are derived directly from our analysis while a few come out of the consensus of experts in topics not dealt with in the present study, and since they are consistent we the gist of our report are included for completeness.

  - Medium and low tech sectors should not be forgotten but rather the internationally competitive segments upgraded. The strategy of replication, replacement and redeployment of productive assets together with innovation should be followed.

  - Public policy will need to acknowledge and anticipate heterogeneity in industry contexts and firms strategies. While small firms may need help and encouragement in reaching the minimal efficient scale, larger ones may need to have obstacles to full insertion in the international division of labor removed.

  - Sectoral development initiatives and cluster development should be refocused with a broad perspective centered in productivity growth and international linkages.

  - Professional training should be fostered.

  - The financial sector must be deepened to provide credit to small and medium firms and to innovators.

- To have a regional strategy:

  - Not forgetting inter-regional trade and integration.

  - Developing transport and communications infrastructure with Valencia and the South of France. The Euroregion should go from the drawing table to investment reality.

  - Having Barcelona as backbone of the competitive strategy of Catalonia.

- Foster human capital formation, openness, and internationalization

  - In education and R&D what is key is a change in organization and incentives rather than more public spending.

  - Require excellence and international standards in new projects.

- Look ahead, do not look back.

  - Eliminate barriers to capital reallocation, do not protect declining sectors but help transitions.

  - Barriers to reallocation of resources have to be lowered at the same time that those in trouble receive transition help.

  - The crisis must serve as rallying point for reform and restructuring. For quite a few productive segments this may be the last opportunity to get in shape to face the international market.

- Increase competition

  - In services (implementing the EU services directive) to lower costs and induce adoption of information technology. This may be particularly important in a sector such as commerce retail.[63]

  - In education to improve quality.

  - In funding R&D&I projects and research centers with competitive bidding to promote excellence.

  - In the labor market eliminating rigidities and turning the protection of unemployment into the protection of work.

  - Enforcing competition policy in product and service markets.

- Make government intervention simple and incentive-responsive

  - Government should provide the basic structure for the functioning of the market economy rather than micro manage.

  - Simplify regulation and the structure of government agencies.

  - Increase transparency in government action.

  - Change organization and incentives in public entities (and civil service) towards service and excellence.

Some recommendations for the public sector:

- Create a government for the Barcelona area (with real transfers from local governments). This would help in consolidating Barcelona and Catalonia as commodity hub for Spain with a better coordination of infrastructure port, airport, local transport.

Education

- Schools should have more autonomy to compete for students and professors.

- More transparency on the performance of schools (e.g. with the publication of rankings of results) so that parents can make informed choices.

63. The Spanish Government has transferred to the regions the regulation of licenses for large commercial establishments based on environmental and urban planning issues. The Catalan Government has traditionally had a restrictive stance on the issue.

- A central exam for students and school evaluation programs should be implemented.
- The authority of school professors should be firmly reestablished.
- A culture of excellence, independence of thought, and effort should be promoted.
- The use of English as working language at school should be implemented with a credible timetable.
- Professional training should be put at the center stage to improve productivity.[64]
- In higher education, the universities should have autonomy to select professors and students with public financing according to results, charge fees closer to the real costs of education and a system of fellowships should be developed so that deserving students are not left out.[65]

Innovation and internationalization

- There is room to improve procedures for R&D subsidies and fiscal allowances: simplify drastically for SMEs, end the restrictive attitude of fiscal authorities to assess what qualifies as innovation, do not use subsidies to delay restructuring, and encourage agencies to take risks.
- Do not discourage firms from locating R&D centers where they are most productive (since to have multiple R&D centers, e.g. Madrid and Barcelona, is good).
- Focus policies more broadly on helping firms access international markets rather than developing policies narrowly and solely focused on getting firms to export. There is currently no attention to the import side of the internationalization process despite that access to international (technology) markets directly affects and enhance the export decision.
- Stimulate the product innovators in higher tech markets to improve the health and resilience of the Catalan economy.
- The integration of CIDEM and COPCA decided in 2007 is a step in the right direction but will need to mesh successfully the culture of two different organizations. Furthermore, a more explicit connection between innovation and internationalization of activities is necessary. This implies adding requirements for exports when giving innovation subsidies or putting in requirements for (product) innovation when giving export subsidies. A question mark is whether the Invest in Catalonia agency within the new ACC1Ó will have the adequate profile and clout to do its mission.

64. See the discussion in Homs (2009).
65. See the discussion of those issues in CYD (2009).

Science and business

- Both supply and demand should be increased, policy should, not get obsessed with links but with fostering excellence. In particular do not try to adapt frontier research groups to the needs of a low-tech industrial base.

- Reform the structure of the science and innovation system:

  - The University system should move from the bureaucratic mode to an excellence-oriented one which responds to the needs of society. The governance of the University should depend on Councils with strong representation of external members.[66] Meanwhile the University should not be a privileged channel to implement scientific policy.

  - The ratio of structure/complexity in public support to R&D investment has to be lowered dramatically.

  - The PNRI points in the right direction with the merger COPCA-CIDEM, and coordination of the agencies (AGAUR, ICREA, FCR), but could go further (under the principles administrative simplicity, with each agency with a clear mission). A possible model is to have one Research Agency plus another for Innovation/Technology/Internationalization (like Finland's two agencies: Academia and Tekes). This would merge CERCA with AGAUR/ICREA/FCR.

  - Centralize information on science performance and relations science-business in order to evaluate the Catalan science and innovation system.

  - Provide correct incentives for the players in the system, in terms of excellence, evaluation and autonomy of centers:

    - Competitive (transparent) bidding for projects/new centers.

    - Establish a competitive fund for industrial research finance.

    - Support international standards (PhD programs, research).

  - Improve the coordination with institutions of the rest of Spain.

- Foster mobility and understanding, promoting:

  - A program of PhD's in firms.

  - Business training of scientists.

66. See the discussion in CYD (2009).

- For the case of biotechnology:

  - More attention should be given to green and white biotech given better prospects of relative position in terms of biochemistry research, and shorter investment cycles and funding requirements.

  - The limitations (managerial, technical, finance) of the Catalan cluster should be overcome fostering international linkages (among other things by lessening geographic, administrative and linguistic barriers).

  - Scientific knowledge should be complemented with business knowledge.

  - Think through the whole venture cycle instead of just seeding start-ups.

The improvement imperative for the private sector

The agenda for action for the private sector flows from the likely need for significant changes to "business as usual" at many companies in Catalonia –even after the crisis is "past." While there is much discussion about how long that will take, we think that the point that is underplayed is the post-crisis world is likely to differ significantly from the pre-crisis one.[67]

While the contours of the post-crisis world are still murky in many respects, it seems clear that *the acceleration of productivity growth will be an overarching target*, both because of the general pressure to improve (the majority of competitive advantages do not last five, let alone ten years) but also because of some specific features of the Catalan case:

- The pre-crisis productivity gap.

- The low level of innovation and technological capital accumulated.

- Constraints on simply continuing to import cheap capital (and labor) to bridge the gap.

- Additional pressure from a higher inflation rate than the average for the Eurozone.

- Lack of currency devaluation as a tool for correcting external imbalances.

- The possibility of a longer-run decline in average industry profitability if there is chronic excess capacity (i.e., if the recovery is slow).

67. As General Electric's CEO, Jeff Immelt recently warned, "If you think this is only a cycle you're just wrong. This is a permanent reset. There are going to be elements of the economy that will never be the same, everÖSmart businesses are the ones that are going to hunker down in the cycle, which you've got to do, but that also understand we're going to come out of this in a different world."

Another clear implication seems to be that *job creation in industry will be key* because of

- An unemployment rate that has already swollen to uncomfortable levels.
- Poor prospects for growth in construction and in some service sectors (e.g., finance, insurance and real estate, and possibly tourism).
- The likelihood of further restructuring and job losses within the industrial sector itself.

The twin objectives of accelerated productivity growth and net job creation cannot be met just by restructuring so as to reduce personnel or personnel costs, however necessary such moves may be in the short run. Instead, *firms will actually need to focus on productivity and productivity growth as performance metrics*, and to engage in benchmarking with local competitors, competitors from other Spanish regions, and internationally. Creative thinking along a multiplicity of dimensions will be necessary. For firms at the technological frontier, innovation (both science-based and general) will be crucial to remain at the forefront of developments and be competitive. More in general, however, achievement of escalated productivity targets will require firms to broaden their view of the possible mechanisms for productivity growth, beyond the focus on science-based innovation, in two ways.

First, process, service, and strategic innovations need to be taken into account. The requirements for strategic innovation, in particular, can be summarized as involving broadening the options considered and the scope of the external scanning effort, systematically trying to look at one's business from different perspectives, and harnessing the creative powers of the whole organization (for example, by cultivating open-mindedness and tolerance of divergent thinking; encouraging risk-taking and a commitment to learning).

Second, innovation, even broadly defined, is far from the only mechanism for productivity improvement. Especially for the very large mass of very small firms in Catalonia, renovation, involving mechanisms such as reaching efficient scale, rectifying (other) obvious internal deficiencies and replicating or imitating innovations and techniques developed by others, seems to us likely to offer a more important immediate set of productivity levers than innovation (without dismissing it).

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