"la Caixa" economic papers

No. 01 JUNE 2006

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Vertical industrial policy in the EU: An empirical analysis of the effectiveness of state aid

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Abstract[1]:

This paper assesses the effectiveness of vertical industrial policies within the EU. Vertical industrial policy is defined as government support for specific firms or industries (picking winners or supporting losers) and measured by state aid granted by Member States to the manufacturing sectors. This aid is authorized by EU regulations under certain conditions and regularly monitored. This paper uses Member States data on state aid to manufacturing to analyze the extent to which this government intervention affects the growth of Multifactor Productivity (MFP) in manufacturing. The analysis is conducted using both sectoral aid data and horizontal aid, since in many cases vertical aid is disguised as aid pursuing horizontal objectives. We control for the potential endogeneity of state aids policy. The results indicate that vertical state aid contributes positively to MFP growth.

JEL Codes: C23, L52, L53, L60, O47

Keywords: State Aids, Multifactor Productivity, Manufacturing Industry, Industrial Policy.

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1. A shorter version of this paper will be published in EIB Papers (June 2006), Volume 11, No. 2.

Matthias Bulach (IESE Business School) has contributed to this paper with the financial support of the EIB. Comments received from participants at the 2006 European Investment Bank Conference "An Industrial Policy for Europe" (Luxembourg, 19 January 2006) are gratefully acknowledged.

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1.1. Theoretical Foundations of Industrial Policy

For the purpose of this paper, we define industrial policy as "the set of government interventions that by way of taxes (or subsidies) and regulations on domestic products or factors of production attempt to modify the allocation of domestic resources that results from the free operation of the market"[2]. To narrow down what otherwise is a very broad definition, we will exclude measures directed to primary sectors as well as those related to non-tradable industries, such as housing services or retail trade. Policies which have a general nature, in the sense that they affect most of the firms in a country to a similar extent – for example, investment tax credits or subsidies for the employment of particular kinds of labour – will also be excluded. With this definition, it is clear that European laws that define the legality of state aids constitute the agreed framework for implementing industrial policies in Europe.

The main economic justification for state aid is the quest for efficiency. According to this view government aid aims to correct market failures. These include externalities, asymmetric information, market power, coordination problems and public goods. The most common example of positive externalities is the R&D activity of private companies. The failure to internalize the spillovers of R&D leads to under-investment by private firms. This may call for publicly funded R&D or the enhancement of incentives for private agents to invest in knowledge creation.

Asymmetric information is also used as a justification for granting aid to SMEs. Incomplete information about the potential of an SME to return a loan or on the risk of its projects may prevent the access to capital markets of some profitable SMEs. Moreover, when assessing the profitability of SMEs, externalities also play a role in the sense that the government may internalize the benefits of SME development on the rest of the economy.

Market failure justifications would call for government intervention following very clear general objectives of R&D or SME support. Additional arguments are needed, however, to justify the government intervention in specific industries or firms. Since there is a cost of public funds, optimization of government resources may call for intervention in specific sectors or industries in which externalities can have a larger impact on total welfare. In the case of R&D, even though at the European level the Commission may find desirable to support R&D across all the sectors, it may not be the case at the single state level. States will tend to support the R&D in those sectors in which a substantial part of the benefits from the externality are more likely to remain within the national boundaries.

Finally, there is yet another type of market failure justification that leads to industry-specific aids: the presence of agglomeration externalities. The notion of *cluster* denotes the necessity of firms devoted to similar or related activities to be located in geographic proximity due to the costly transmission of tacit knowledge over increased geographical distance. Industrial policy may foster the creation of clusters by possibly subsidizing firms generating these

2. See Gual (1995), page 9.

externalities[3]. On the other hand, governments may not have all the necessary information to determine which industries are capable of generating these agglomeration effects. The case for industrial policy on the grounds of this type of externalities remains uncertain.

Another possible justification for sector-specific state aids is linked to strategic trade policy. The basis for strategic trade policy developed first by Brander and Spencer (1983) lies in the market failure of imperfect competition. In oligopolistic market structures firms realise some excess returns. Governments hence have an incentive to support national champions in order to maintain those rents within national boundaries. A classical example in a European context is the Airbus case, documented in Neven and Seabright (1995). An argument along this line is used by Collie (2005) to analyze the effects of state aid to R&D.

This strategic trade policy justification may be particularly important in industries where network externalities are present. Those industries are prone to oligopolistic market structures once standards have been set. Hence, governments may want to intervene in order to help national firms during the early stages of competition for the market. Although in an EU context standards are elaborated on a market-determined basis – in which national bodies only specify the basic requirements related to public health and environmental and consumer protection – this justification is still applicable to industries with global geographic markets. Thus, there may exist industries for which the strategic trade justification could also be in the interest of the European Union as a whole.

Equity concerns, however, may also justify the provision of state aid to particular industries when the benefits in terms of social and cohesion goals outweigh the negative effects of distorting competition. Indeed, some forms of state aid involve a mix of efficiency and equity justifications. This is the case for aid provided under structural adjustment policies which is targeted at declining industries. These industries are characterized by structural changes and it is possible that the existence of some market failure[4] prevents their natural adjustment through the sole action of the markets. Typically, industrial policies towards these industries involve also an income redistribution whereby an overall restructuring process which is welfare enhancing includes measures to compensate the losers.

Regional aid also presents this mix of justifications. To the social and cohesion goals, Rodrik (2004) adds a market failure justification for aid targeted at depressed regions. Rodrik argues that there is a market failure in the process of discovering activities (not necessarily new) that can be profitably adapted to local conditions: social value of experimenting with new activities is high whereas private costs for entrepreneurs are significant and benefits, if they exist, would be shared with followers. In such cases, a partnership between government and private firms would be desirable.

3. For a discussion on industrial policy directed to clusters see, for example, Rodríguez-Clare, A. (2005), "Clusters and Comparative Advantage: Implications for Industrial Policy", Inter-American Development Bank, May 2005.
4. For example, rigidities in factor markets. See Neary, P. (1982).

1.2. The Regulation of State Aid

Industrial policy of EU member states is regulated and monitored in the framework of EU state aid legislation. The underlying objective is that whenever industrial policy undertaken by the Member States is suspect of having distortive effects on internal market competition, it should be regulated and monitored at the EU level.

The basis of EU state aid policy is contained in Articles 87 to 89 of the Treaty of Amsterdam[5]. There is a general ban on state aid that distorts competition and affects trade in Article 87(1). Article 87(2) states mandatory exceptions[6] from this general prohibition and Article 87(3) allows some discretionary exceptions, which includes among others: regional aid, aid to combat serious underemployment, aid for culture and heritage conservation, aid to advance important projects of common European interest, aid to deal with serious economic disturbances and aid to specific economic activities.

On top of these statutory foundations, Commission and Council regulations and guidelines specify administrative procedures for the implementation of state aid control[7].

Traditionally, state aid monitored by the Commission has been classified in four large categories: aid for horizontal objectives, regional aid, sectoral aid and aid to individual firms for rescue and restructuring.

Horizontal state aid[8] included aid awarded for so called "horizontal objectives". These included R&D, environment and energy saving, SME, employment, training, and risk capital. Aid awarded for horizontal objectives was mainly guided by the market failure justifications discussed in 1.1.

Regional aid aimed to promote the development of disadvantaged regions. Regional state aid included Member States regional aid granted to assisted regions on the basis of Article 87(3)a and (3)c. In addition to such regional state aid, the EU also provides support to projects that are financed jointly with the Member States, e.g. Structural Funds.

Sectoral aid has historically included three types of sectors. First, aid to agriculture, fisheries and transport. These sectors have been exempted from the general rules on state aid and have to comply with sector/specific regulations (Article 36 for agriculture and fisheries and Article 73, 76 and 154 for the transport sector). Secondly, a number of industries have been classified as "*sensitive*" due to the particularly severe economic problems they experienced. These industries included coal and steel, synthetic fibres and shipbuilding. For these industries, specific rules were adopted. In general, these rules tired to ensure that the industry adjusted to long/term decline. Third, a number of industries are supported because they have recently been exposed to the full forces of market competition. These included

5. In the Treaty of Maastricht and the Treaty of Rome, the paragraphs on state aid are numbered 92-94.
6. These exceptions include aid with social character granted to individual consumers, aid related to natural disasters and aid granted to Eastern Germany related to the effects of the postwar division of Germany.
7. For example, the Commission Regulation (EC) No. 794/2004 of 21 April 2004 implementing Council Regulation (EC) No. 659/1999 laying down detailed rules for the application of Article 93 of the EC Treaty.
8. Aid for regional development and rescue and restructuring is sometimes classified also as aid for horizontal objectives. For the sake of conceptual clarity they will however be treated separately throughout this paper.

financial services, air transport, maritime transport and motor vehicles. The goal was to facilitate a one-time adjustment to exogenous structural changes in market conditions.

Rescue and restructuring aid is aid awarded to individual firms in difficulties. A firm in difficulty is defined as one being unable, through its own resources and without outside intervention by the public authorities, to stem losses that will almost certainly condemn it to go out of business in the short or medium term.

Rescue aid is temporary assistance. It should make it possible to keep a firm in difficulty afloat for the time needed to work out a restructuring or liquidation plan and/or for the length of time needed by the Commission or the competent national authorities to reach a decision on that plan.

Restructuring aid is based on a feasible, coherent and far-reaching plan to restore a firm's long-term viability. Since it may distort competition, restructuring aid is governed by the "*one time, last time*" condition, i.e. it may be granted only once. The 1999 "Community Guidelines on State Aid for Rescuing and Restructuring Firms in Difficulty"[9] lay out the conditions and procedures for awarding aid. These Guidelines expired on 9 October 2004 and were replaced by the "Community Guidelines Applying Articles 87 and 88 of the Treaty to the Granting of Urgency and/or Restructuring Aid to Firms"[10].

In recent years, EU practice for new aid schemes has departed from the traditional classification. Horizontal objectives such as SME, training and employment are handled with block exemptions, and horizontal objectives with explicit guidelines for assessment include R&D aid, environmental aid and risk capital. Special rules for particular sectors include only postal services, broadcasting, audiovisual production electricity, shipbuilding and steel.

Overall, the design of state aid for the European Union has been based on both goals: alleviating market failures and attaining distributional objectives. With regards to support for cluster-like structures, is has not been explicitly regulated. However, industrial policy has increasingly concentrated on stimulating regional clusters[11]. Initiatives of cluster mapping have been launched for example in Belgium, Denmark, France, Austria, Finland, the UK and Norway[12] and some emphasis has recently been put on potentially positive effects of public policy in supporting clustering initiatives[13]. This support takes place mainly through the regional aid instruments or with horizontal instruments, such as R&D, SME or training aid[14].

9. Official Journal No. C 288, 9.10.1999, p. 2.

10. The most significant changes include: the new concept of 'urgency aid' replaces 'rescue aid', allowing the beneficiary to undertake urgent measures, even of a structural nature; urgency and restructuring aid cannot be granted to firms up to five years since the start of operations in the relevant field; urgency aid must not only be temporary but also reversible; and the 'one time, last time' principle has been extended to urgency aid. For a more detailed discussion, see Anestis *et al.* (2005).

11. See OECD (2001).

12. For a discussion and description of these cluster mapping studies, see EU Commission (2002a).

13. See for example Trends Business Research (2001) discussing the potentially positive impact of public policy in the UK mentioning concrete manufacturing in the East Midlands, environmental industries and biotechnology clusters.

14. Aid for the following cluster initiatives has been classified as SME, R&D, training or regional aid:
- "Nanotechnology network" in the Netherlands (2004) as R&D aid.
- "Impulse Programme" in Germany (2002) as aid to SME in an eligible region under Art 87(3)a.
- "Black Country Cluster and Diversification Training Scheme 2002-2006" in the UK (2002) as aid for training.
- "SME networks" in Greece (2001) as SME-aid in an eligible region under Art. 87(3)a.
- "Support of Innovative Networks" in Germany (1999) as R&D aid.

2. The Facts about State Aid in the EU

Within the period 1995-2003, the overall volume of state aid in the EU15 has fallen by 23 bn EUR, from 76 bn EUR in 1995 to 53 bn EUR in 2003. This represents a compounded average annual decrease of 3.4%. In the same time period, state aid as a share of GDP decreased from 1.00% to 0.57%.

There are important differences in state aid between countries. State aid as a percent of GDP ranges from 0.26% in the UK to 1.41% in Finland in 2003. The states with highest ratios of state aid in 2003 are Finland (1.41%) and Portugal (1.25%). Those with the lowest ratio are UK (0.26%), Luxemburg (0.30%) and the Netherlands (0.30%).

The analysis of aid statistics by aid objectives is crucially affected by the way the Commission classifies aid schemes. Since aid schemes may have different objectives, the Commission classifies them according to the nature of the primary objective. Hence all measures with one of the horizontal objectives mentioned in 1.2 as primary objective are considered *horizontal state aid*. Regional aid is usually labelled as horizontal aid whereas aid for rescue and restructuring is included as a part of *sectoral aid* in the State Aid Scoreboard – the prime reporting tool of DG Competition[15] from which the following statistics are drawn.

State aid directed to **horizontal objectives** did basically not decrease in the 1995-2003 period (from 30.7 bn to 29.5 bn EUR)[16]. The most important horizontal objectives include aid to environment & energy saving (29% of aid awarded to horizontal objectives in 2003), R&D (18%) and SMEs (16%). In eight countries, practically all state aid (excluding agriculture, fisheries and transport) is channelled into horizontal instruments: 100% in Belgium, Sweden and Luxemburg; >95% in UK, Finland, Austria, Italy and Greece.

The decrease of 23bn EUR in overall state aid during the 1995-2003 period stems mainly from a decrease in **sectoral aid**. The manufacturing sector contributed the lion share (13 bn), followed by coal (4 bn), agriculture (3 bn) and transport (2 bn).

The result is a decrease of the share of sectoral aid in total aid from 60% in 1995 to 44% in 2003 (from 46% to 21% if excluding agriculture, fisheries and transport). Portugal is the exception with some 81% of its staid aid still dedicated to sectoral aid - mainly due to an aid tax scheme in Madeira. This shift towards aid for horizontal objectives is a clearly stated goal in the ongoing revision of the Lisbon Agenda[17] but, as we will argue below, it is likely that schemes classified as horizontal correspond in fact to (sectoral) vertical state aid.

Rescue/restructuring aid is not reported separately by the DG-Competition but as part of "sectoral aid" in the State Aid Scoreboard. There is hence no consistent and detailed volume data available on the amounts granted under these aid schemes over time[18]. In general there

15. For rescue and restructuring aid, few separate figures are provided by the EU. Wherever there are separate figures for regional development, this will be mentioned.
16. Separating aid for regional development offers a different view: State aid for regional development decreased from 18.3 bn in 1995 to 7.7 bn EUR in 2003. State aid for horizontal objectives (excluding regional development) almost doubled from 12.4 bn to 21.8 bn EUR (compounded average annual growth of 7.3%).
17. See European Commission (2005), "State Aid Action Plan. Less and better targeted state aid: a roadmap for state aid reform 2005-09".
18. Most of the data presented is based on number of aid cases or number of companies having received rescue or restructuring aid and is taken from a report of London Economics (2004).

tend to be few cases in rescue and restructuring aid, but they might be of major impact due to the size of the payments. In 1997 for example, the French financial services sector received state aid packages of a total of 25 bn EUR, representing 94% of total community aid to the financial services sector, 68% of total French state aid and 27% of total community state aid for that year (excluding railways). Most of this state aid package was earmarked for rescue and restructuring aid and can be mainly attributed to the Credit Lyonnais case[19].

Whether aid is classified as horizontal or vertical, it is interesting to assess the weight of different sectors in the economy as recipients of government support.

The manufacturing sector is clearly the most important sector towards which state aid is directed, capturing some 55-60% of state aid throughout the observed period. Agriculture is the second most important sector (20-25%), followed by coal with (10-15%) and services (including tourism, financial services, media and culture) with some 3-5%. The transport sector (2%) and fisheries (1%) only play a minor role.

The distribution of aid among these sectors is fairly stable over time. The agriculture sector is recently capturing a larger share, up from lows of 22% in 1995, 1996 and 1998 to some 25-26% in 2000-2003. The services sector captured a large share in 1997 (some 30%) due to large amounts of restructuring aid flowing to the French banking sector – 25.5 bn EUR, accounting for some 94% of total state aid awarded to the services sector in that year throughout the EU15 Member States. The coal sector experienced a decrease from highs of 14% in 1998 and 2001 to 10% in 2003.

There are however significant differences in aid distribution across Member States. Manufacturing is the most important sector only in nine Member States ranging from 74% of total aid awarded in Italy to 40% in Spain. In five Member States (Finland, Austria, the Netherlands, Ireland and France) agriculture is the sector receiving most of the aid, ranging from 74% in Finland to 40% in France. In Portugal, the services sector is by far the most important sector, accounting for some 63%. Aid to the coal industry is almost exclusively awarded in Spain (28%), Germany (20%) and France (10%) and came down from highs of 2 bn EUR in 1995 down to 22 MEUR in 2003 in the UK. Aid to transport (excluding railway) is most important in Sweden (10%) and Denmark (6%). Aid to the fisheries sector only reaches more than 1% of total aid in Spain (3%), the UK (2%) and Greece (2%).

There are no signs of convergence between Member States of aid distribution to different sectors for manufacturing and agriculture amongst the Member States. Comparing 1999-2001 with 2001-2003 only about half of the Member States converge towards the mean composition in these two sectors, accounting for over 80% of overall state aid. There is however some trend towards lower levels of state aid in services, transport, fisheries and coal.

19. See EU Commission (2005a), Note to table on page 14.

3. Vertical State Aid: Definition and Effectiveness

For the purpose of this paper, vertical state aid is defined as aid awarded to specific firms or sectors. This means aid schemes where the eligibility of beneficiaries depends on firm specific characteristics (e.g., in the case of rescue and restructuring aid) or the affiliation to certain sectors. Horizontal state aid is defined as aid awarded for general objectives, spanning over various firms and independent of industry affiliation. Examples of horizontal aid include aid for R&D, the development of SMEs or environmental protection.

Sectoral aid and aid for rescue and restructuring are discussed in this section as part of "vertical state aid":

- *Sectoral aid* is considered vertical aid because is aid awarded to firms of one particular sector and is subject to specific regulations by the Commission.

- *Aid for rescue and restructuring* is sometimes qualified as a horizontal aid measure by the Commission[20]. However when reporting state aid figures, it is usually included in the sectoral aid figures due to its potential negative impact on competition[21]. Since it is aid targeting individual firms, we include it in this section on vertical state aid.

In this section, we examine some of the key studies on the effectiveness of both sectoral and rescue and restructuring aid.

3.1. Sectoral Aid

There are two types of studies that examine the effect of sectoral aid: case studies for specific sectors and empirical analysis of broad support to manufacturing.

With respect to case studies, there are only a limited number of comprehensive descriptions on the effects of sectoral state aid: Röller and von Hirschhausen (1996) examine in two case studies state aid to the shipbuilding and synthetic fibre industry in East Germany (the former German Democratic Republic, GDR) after market opening in the early 1990ies. The Danish Competition Authority (2002) analyses an aid scheme to the shipbuilding industry.

Despite overcapacity in the European shipbuilding industriy, a major restructuring backed by state aid measures was undertaken in order to turn around the economically not viable East German shipyards after German reunification. Röller and von Hirschhausen (1996) conclude that there was no static economic rationale justifying the large investment in the East German shipyards[22]. The shipbuilding industry most hurt by this additional capacity seems to have been the West German shipyards whose market share fell from over 30% to the 21% range, whereas the distribution of market shares among the large European

20. Compare the classification of rescue and restructuring aid as aid with horizontal objective in the online version of the state aid Scoreboard, http://europa.eu.int/comm/competition/state_aid/scoreboard/conceptual_remarks.html (August 15th, 2005).
21. EU-Commission (2005a) state on p. 20: "In contrast, aid to support specific sectors is likely to distort competition more than aid for horizontal objectives and also tends to favor other objectives than identified market failures. Moreover, a significant part of such aid is granted to rescue or restructure companies in difficulty, one of the most potentially distortive types of State aid."
22. The market structure is highly competitive and no static gain was to be expected from an increase in competition due to existing overcapacity. Moreover, the amount of state aid was very high.

shipbuilding countries Denmark, Spain and Italy was not significantly altered. Looking at the case from a dynamic perspective they argue that some economic rationale might be found as the Eastern German shipyards are likely to become one the most productive shipyards in Europe. This however implies rent shifting from one European country to another which from a European perspective has to be classified as inefficient.

For the state aid to the synthetic fibre industry, Röller and von Hirschhausen conclude that there is no static economic justification for the state aid provided. The industry is highly competitive both on the supply and on the demand side. As in the shipyard case, overcapacities exist so that the state aid did not increase competition. Again, the competitors suffering most from this aid seem to have been those of West Germany since they lost significant market share – the three largest European synthetic fibre producers increased market share (Spain, Benelux) or kept it constant (Italy). From a dynamic perspective, there might have been some rent shifting, however no immediate adverse effect on European industry is detected. Neither does the state aid seem to have led to the survival of strategically important productive assets in transitory difficult times – another of the dynamic justifications of state aid mentioned by Röller and von Hirschhausen.

The Danish Competition Authority (2002) analyses the performance of the shipbuilding industry in Denmark, which received practically all Danish sectoral state aid in the last decade (1995-2005). It concludes that turnover, employment and the number of shipyards has been declining over the last decades, parallel to an increase of public subsidies' share of wages to a level of over 70% in 2001. There is some evidence of rent seeking activities by the subsidies' recipients, as productivity at Danish shipyards has increased less than at the rest of the manufacturing industry and wages for workers at shipyards have been 8-20% higher than for other workers in the metal and iron industry in the same regions. However, profits have been low, indicating that state aid has not been channelled into excessive (accounting) profits.

With respect to the empirical analysis of broad aid to the manufacturing sector, very little work has been done so far trying to measure its impact within the EU[23]: Bergström (1998) and the Danish Competition Authority (2001) concentrate on analysing the effects of public capital subsidies on total factor productivity and growth. They use data on firm level and compare the development of firms having received state aid with that of those not having received any type of aid.

Bergström (1998) analyses 72 companies in the manufacturing sector that received state aid in Sweden in the period 1989-1995 and compares them to a randomly picked sample of 832 non-aid-receiving firms. He analyses selective regional subsidies, i.e. subsidies that are specifically directed towards firms in support areas and that the firms had to apply for. These subsidies include localisation subsidies and loans, development support, support to sparsely populated areas and loans to investment firms and must be used primarily for investments

23. Lee (1996) finds in a study for Korea that government industrial policies primarily targeted low-productivity industries in 1963-1983. He finds that subsidies such as tax incentives and subsidized credits have not been successful in promoting productivity growth. Beason and Weinstein (1996) find in a study on Japanese industrial policy that a disproportionate amount of state aid was awarded to sectors with decreasing returns to scale and low-growth sectors. They similarly report no evidence of productivity enhancement through industrial policies.

in machinery and buildings. He finds that in the short run, productivity of subsidized firms increases more than the one of non-subsidized firms but that already after three years relative productivity is lower in subsidized than in non-subsidized firms. Bergström (1998) concludes that effects of subsidisation might give rise to allocative inefficiencies and/or technical X-inefficiencies due to slack or rent-seeking activities.

The Danish Competition Authority (2001) conducts a similar study on companies who got granted some form of aid in the period 1994-1997. The subsidy objectives include mainly horizontal objectives such as R&D, quality development, export and international cooperation, entrepreneurs, environment, energy and regional business development. They analyse 1,491 aid-receiving companies from industries belonging to 5 different sectors (manufacturing, business activities, trade/hotels/restaurants, transport and construction) and compare them to 22,112 non-aid-receiving firms. Using the pooled sample, they find no significant influence of firm-specific subsidies on productivity growth. The authors analyzed as well the aggregated value at the industry level of all firm-specific subsidies. Results showed a negative correlation between overall subsidy intensity on an industry level and firms' productivity growth. The direction of causality in this relationship is, however, unclear: it might be that subsidies are given to firms with lower productivity growth *ex ante* or that high subsidies actually cause low productivity growth. When the analysis is conducted separately for industries belonging to each of the five sectors, they find that for the manufacturing sector this correlation turns out to be significantly positive: industries with higher productivity growth show higher subsidy intensity.

3.2. Rescue and Restructuring Aid

Between 1995 and 2003, there were 94 rescue and restructuring cases notified to the Commission. To our knowledge, the only comprehensive study investigating cases of state aid for rescue and restructuring is one by London Economics (2004) for the European Commission examining all the companies that received state aid for rescue and restructuring from 1995-2003 and where the aid process had ended by 2004[24]. London Economics considered only 86 cases relevant for further examination[25], of which 60% (52 cases) were restructuring cases. Over time, the number of cases increased with a peak in 1998 (15 cases) and since then the number hovers around 5-8 cases per year. About 60% of the cases concentrate in three Member States: Germany (26 cases), Italy (16) and France (12). Sectors most affected by state aid for restructuring and rescue have been construction/engineering (10 cases), the financial sector (9) and machinery (8).

London Economics define an aid-receiving company as having failed if it became bankrupt or was liquidated, the latter result including the sale of small parts of its (core) business. Cases in which the aid has not still been repaid or the restructuring plans have not finished (15 cases) are excluded from the analysis, as it is considered that the case has not yet ended, and thus the impact of the aid cannot be assessed. Among the 71 companies examined there

24. A case is considered as having ended, if rescue aid has been repaid or restructuring plans have come to an end.
25. Five cases where excluded due to being located in the region of the former German Democratic Republic (DDR), for one case the decision was still pending, one case was considered being an R&D case and two cases essentially addressed the same state aid package.

were 29 rescue aid cases and 42 restructuring aid cases. Out of the 29 rescue aid cases, 14 survived, 14 folded and for one the status is still undetermined (since the firm is insolvent[26]). Out of the 42 restructuring cases, 33 survived, 8 folded and for one the outcome is still undetermined.

As for determinants of the survival rate they model the influence of various factors on the probability of survival using a Probit model and find the following:

- *General characteristics of aid case*: Cases of restructuring aid imply a higher probability of survival than cases of rescue aid – as can also be deducted from the descriptive statistics mentioned above. They furthermore conclude that the more recent the aid has been given (in this case after 1999) the higher the chance of survival. This might however be biased due to the fact that the more recent the award of aid, the less time the case had to turn out to be a failure and does not necessarily imply higher effectiveness of state aid. Other characteristics such as size, age and legal status of the firm, sector growth post-aid measure, condition of the company at time of aid award and relative amount of aid awarded are not found to have any significant impact.

- *Reasons for difficulty*: If the company has come into trouble due to a market decline or poor management, its chances to survive post restructuring or rescue are significantly higher – and increase by approximately 30%. Other reasons for difficulties such as external failure, liquidity problems, low competitiveness or financial liabilities do not have any significant effect on survival.

- *Design of rescue/restructuring plan*: The following ten features of the rescue and restructuring plans were tested on significant impact on the probability of survival: duration of restructuring, capacity reductions, personnel reductions, focus on core business activities, cost-cutting, financial consolidation, selling or closure of plants and assets, new investment, training and upgrading and plant relocation. None of these features was found to have a significant impact on survival rates.

London Economics (2004) further analyse the post-aid performance of the firms having received aid in the period 1995-1999. They analyse relative growth in employment, turnover, profitability and labour productivity from the year of award of the aid until 2002. They compare aid-receiving firms with a set of comparable firms in terms of geography, activities and size. The main findings include:

- *Employment*: out of the 22 aid-receiving companies analyzed, about half increased employment faster than the industry average. However, all but one stayed below comparable average on average employment.

- *Turnover*: out of 21 companies analyzed, 9 (43%) grew faster in turnover than comparable competitors, with again only one company reaching levels above industry average.

26. Insolvency differs from bankruptcy since the former is a transition state: either the firm recovers and survives or ends up in bankruptcy.

- *Profitability (profits per employee)*: out of the 18 companies analyzed, 13 (72%) improved their relative position with four reaching above average profitability levels and the remaining 14 remaining well below average.

- *Labour productivity*: out of the 21 firms analyzed, 16 (76%) increased labour productivity faster than industry average with four companies improving the productivity from below to above industry average.

- Summarizing the empirical evidence, two main results seem to stand out:

  – Design rules of restructuring and rescue aid plans (including relative amount of aid) do not seem to affect the probability of survival. On the contrary, this probability increases when the difficulties of the firm stem from poor management or market decline.

  – In terms of overall growth (turnover, employment) state aid receiving companies did not manage to significantly outperform their competitors after the award of state aid. However, there is some sign that firms in difficulties do partially close the gap regarding profitability and productivity levels after the reception of state aid.

4. Assessing the Impact of Vertical Aid on Manufacturing Productivity

4.1. Vertical or Horizontal Aid?

In the manufacturing sector, four sub-sectors are eligible for so called sectoral aid under specific aid schemes: steel, shipbuilding, synthetic fibres and motor vehicles. Additionally, aid for rescue and restructuring is considered as vertical state aid to the manufacturing sector.

Overall, total state aid to manufacturing (including that with horizontal objectives) dropped in line with the overall decrease from 44 bn EUR in 1995 to 29 bn EUR in 2003 (some 5,1% annual decrease). Also parallel to the overall trend, this decrease is almost exclusively due to a decrease of vertical aid directed to the manufacturing sector (from 14.4 bn to 1.3 bn in the same time period). This leads to an increase in the share of state aid with horizontal objectives directed towards the manufacturing sector from 68% in 1995 to 94% in 2003. Only two states channel a significant amount of their state aid to the manufacturing sector through vertical instruments: Ireland (68%) and Portugal (91%).

However, a closer look at so called "state aid with horizontal objectives" on an aggregate level for the manufacturing sector reveals some interesting details:

- About 96% of total state aid for horizontal objectives is awarded to the manufacturing sector (average 1995-2003; this figure is decreasing over time from 97% in 1995 to 94% in 2003)[27]. This ranges from around 80% in Sweden and Portugal to almost 100% in the UK, Finland and Greece.

- State aid is classified as "with horizontal objectives" by the EU Commission always when the *primary* objective is a horizontal one. However there are numerous cases of state aid, where the primary objective is horizontal, but the measure of state aid is limited to a certain industry, sub-sector or sector[28]. In these cases there appears to be a mixture of horizontal objectives with vertical orientation of the aid measures. The data published in the State Aid Scoreboard does not allow distinguishing between horizontal aid designed for all sectors and "horizontal" aid awarded only to specific industries, sub-sectors or sectors.

An indicator of the extent to which state members are able to provide vertical state aids in the form of "horizontal objectives" can be given by analyzing the pattern of, for example, Spanish aid notifications between 1993 and 2005. During that period, Spain submitted around 305 notifications of state aid, the major part of which were notified as aid to

27. However, this might be also due to measurement difficulties when attributing state aid volumes to different sectors: On sectoral distribution, EU Commission (2005a) states on p. 15: "*The data currently available do not provide an accurate picture of the final recipients of the aid. Nevertheless, they do give some indication as to which sectors are favored by each Member State.*"

28. State aid case NN15/2000 – UK, "Civil Aircraft Research and Technology Demonstration Programme" is considered a horizontal R&D measure even though it is directed exclusively to the civil aviation industry.
State aid case N443/1999 – Germany, "R&D Aid to 'Institut für Solare Technologien, GmbH'" is classified as R&D aid and is exclusively awarded to support research of photovoltaics technology.
State aid case N74/2005 – Sweden, "Environmental Aid to Volvo Truck Corporation" is classified as environmental aid and is exclusively awarded to incentive environmental measures in the motor vehicles industry.
State aid case XS118/2003 – Germany, "Polenbürgschaft" is classified as an SME block exemption case, however is exclusively awarded to the industrial machinery sector in Brandenburg, Eastern Germany.

investment, to SMEs, to training or as regional aid. Aid to investment constituted the main objective of 21 cases, 9 of which were explicitly targeted towards specific sectors. Of the 44 notifications of state aid with primary objective being regional, 22 were targeted at specific sectors, sub-sectors or firms. Of the 60 cases notified as aid for SME as primary objective, 22 were specific.

We conclude, that looking at state aid labelled as "horizontal" on an aggregate level for the manufacturing sector raises some doubt of whether to consider it as horizontal or vertical state aid. Considering only aid labelled as "sectoral" (i.e. including aid for steel, shipbuilding, synthetic fibres and motor vehicles and rescue & restructuring) surely underestimates the real amount of vertical aid. Considering all aid to the manufacturing sector as being of a vertical nature most likely overestimates truly vertical state aid. For the sake of the later empirical analysis, we will therefore analyse effects of both aid labelled as "sectoral" and total state aid to the manufacturing sector.

4.2. Effects of Vertical Aid on Manufacturing Productivity

4.2.1. Introduction

There are several variables that could be used as a measure of performance on which to assess the effects of state aids. However, productivity appears to be the most important given the ultimate relationship between productivity and economic growth.

Country differences in productivity can be explained by endogenous growth models, in which the mechanisms of technology diffusion play an important role. These models predict a convergence of the technology levels of a country to those of the leading country. Nevertheless, the steady state equilibrium predicted by these models is conditional on parameters – such as the cost of innovation/imitation, the regulatory environment or other institutional factors – that are considered as given and exogenous. Empirical applications need to control for these parameters in the estimation of productivity growth and it seems natural to think of state aids as one of these parameters.

Studies analysing convergence of multifactor productivity (MFP) across countries include Bernard and Jones (1996), Griffith et al (2001), Scarpetta and Tressel (2002) and Nicoletti and Scarpetta (2003). The evidence indicates that there is convergence towards the technological leader and that the larger the gap to the leader, the faster the convergence[29]. The last three papers use this framework to analyze, in the same spirit as in this study, the effect of changes in several variables of interest. Griffith et al (2001) use it to analyze the effect of R&D investment. The interaction between regulation and convergence has been the focus of investigation by Scarpetta and Tressel (2002) for OECD countries. The purpose of this paper is to augment this approach by introducing state aid and to investigate the interaction of state aid with MFP-growth, MFP-convergence and the impact of regulation. We concentrate the analysis at the manufacturing sector level given the measurement problems that characterize the non-manufacturing industries. Moreover, manufacturing is a footloose industry and thus more prone to receive vertical state aids.

29. See Griffith *et al.* (2000) and Scarpetta and Tressel (2002).

4.2.2. Determinants of Multifactor Productivity Growth

Following the convergence literature[30], we introduce technology transfers as a source of productivity growth for countries behind the technological frontier. The technological frontier is defined by the country with the highest MFP in a given year.

In this context, multi-factor productivity is modelled as an auto-regressive distributed lag ARDL(1,1) in which the level of MFP is co-integrated with the level of MFP of the technological frontier country F,

$$\ln A_{i,t} = \theta_1 \ln A_{i,t-1} + \theta_2 \ln A_{F,t} + \theta_3 \ln A_{F,t-1} + \omega_{i,t} + \varepsilon_{i,t} \qquad (1)$$

where A_F is multi-factor productivity in the frontier country and ω stands for all observable and non-observable factors influencing the level of MFP. We assume additionally convergence towards steady state, i.e. growth rates of MFP are equal across countries and over time and $\omega_{i,t}$ is constant. Formally, this means that $\Delta \ln A_{i,t} = \Delta \ln A_{F,t}$ and $\Delta \ln A_{i,t} = \Delta \ln A_{i,t-1}$. With this and (1) we can derive the steady state condition: $(1-\theta_1) = (\theta_2+\theta_3)$. Rearranging (1) and assuming steady state convergence, MFP-growth can be written as an error correction model of the form:

$$\Delta \ln A_{i,t} = \theta_2 \cdot \Delta \ln A_{F,t} + (\theta_1 - 1) \cdot \ln(A_{i,t-1}/A_{F,t-1}) + \omega_{i,t} + \varepsilon_{i,t} \qquad (2)$$

Equation (2) describes the variation in the level of technology around its long-run trend as a function of a set of exogenous factors ($\omega_{i,t}$), the variation in the leader's technology around its trend and an error correction, given by the second term, which depends on the relative value of country *i* technology compared to the leader. The first term, which captures the diffusion of technological advances from the leading country to the rest, is expected to be positive. The second term, which captures the catch up of lagging countries to the technology leader, is expected to be positive too. Note, however, that catching up implies that $(\theta_1 - 1)$ is negative because $\ln(A_{i,t-1}/A_{F,t-1})$ is negative too since $A_{i,t-1} < A_{F,t-1}$. The larger the parameter $(\theta_1 - 1)$ is, in absolute terms, the stronger is the effect from catching up. The MFP of countries farther from the technology frontier is expected to grow faster.

The set of $\omega_{i,t}$ variables affects the equilibrium level of technology in country *i*. Therefore, a natural way to assess the effect of **vertical state aids** on productivity is to introduce them as a variable in $\omega_{i,t}$. Its expected sign is ambiguous, since the efficiency justifications for the different components of our notion of vertical aid may be quite weak – agglomeration effects, credit constraints – and may not compensate the distortions they create – rent capture, allocative inefficiencies, etc. Moreover, they may have an indirect effect on productivity through their effect on competition. But the relationship between competition and innovation has not a clear sign, either[31].

Other variables are believed to affect this equilibrium level and are, thus, included in $\omega_{i,t}$. The reasons for their inclusion are discussed next.

30. For a detailed derivation see Griffith *et al.* (2000); compare also Scarpetta and Tressel (2002) and Kolasa and Zolkiewski (2004).
31. See Aghion and Griffith (2005).

As stressed by the endogenous growth literature, the accumulation of R&D knowledge is an important source of output growth. Our measure of MFP growth accounts for all the part that cannot be explained by the accumulation of physical capital and labour. In this respect, the growth of the R&D knowledge stock is part of MFP growth. Following the argumentation in Griffith et al. (2000) and Scarpetta and Tressel (2002) we include **R&D intensity** as a determinant. Assuming a small rate of depreciation of this knowledge stock, its growth is mostly determined by R&D investment. Therefore, R&D intensity can be directly entered as an explanatory variable. To avoid endogeneity problems of current R&D investment, we use lagged intensity. Similarly, the endogenous growth literature also points to the accumulation of public capital, e.g. infrastructures, as an additional source of growth (see for example Ashauer (1989)). Since physical capital measures only include private capital, the effect of productive public capital is included in our MFP measure. Hence, we include the growth of public capital as an additional variable.

Scarpetta and Tressel (2002) find that **product market regulation** (PMR) and **employment protection legislation** (EPL) do have a significant (negative) impact on MFP growth rates. Moreover, differences in regulation might have considerable effects on the efficiency of state aid so that this interaction effect will also be tested. We therefore introduce PMR and EPL indicators for the different countries. Specifically, we use an indicator of administrative barriers (ADMIN) to proxy for PMR in the manufacturing sector (see 4.2.6.).

Other factors such as the quality of human capital and industry structure are believed to be reasonably stable over the estimation period within the individual countries and hence will be captured via the introduction of **country dummies**.

Due to the relatively small data set, no time dummies are introduced. The results of Smolny (2002)[32] suggest that large part of the annual fixed effects can be captured by introducing a dummy for the **business cycle**. We use the EU15 output gap as a proxy for the business cycle in order to capture these effects.

The final function to be estimated reads as follows:

$$\Delta \ln A_{i,t} = \beta_1 \cdot \Delta \ln A_{F,t} + \beta_2 \cdot \ln(A_{i,t-1}/A_{F,t-1}) + \beta_3 \cdot (AID_{i,t-1}/VA_{i,t-1}) + \beta_4 \cdot (R_{i,t-1}/VA_{i,t-1}) + \\ + \beta_5 \cdot ADMIN_i + \beta_6 \cdot EPL_{i,t} + \beta_7 \cdot (Y_t - Y_t^*)/Y_t^* + \delta_i + \varepsilon_{i,t} \qquad (3)$$

Similar to equation (2), in equation (3) we would expect $\beta_1 > 0$ and $\beta_2 < 0$, with $\beta_1 \cdot \Delta \ln A_{F,t}$ and $\beta_2 \cdot \ln(A_{i,t-1}/A_{F,t-1})$ capturing technology diffusion and catch up, respectively. AID denotes state aid as a share of manufacturing value added (VA); R denotes R&D intensity, ADMIN is a time-stable indicator to proxy for product market regulation, EPL a time-varying indicator for employment protection legislation[33], and $(Y-Y^*)/Y^*$ denotes the EU-15 output gap; δ is a country fixed effect and ε an i.i.d. shock.

32. In a cross-sectoral study on sources of productivity growth in Germany by Smolny (2000), the introduction of time dummies did not affect R^2. It reduced moreover the influence of a proxy for business cycle by half and rendered it not significant, indicating that a large part of the fixed time-factor is captured by a business cycle proxy.

33. Two observations in time (1990 and 1998) are available. The rest has been estimated from the changes in legislation reported in EPL time series breaking points, OECD Employment Outlook 2004, chapter 2 Annex.

4.2.3. The Measurement of Multifactor Productivity

In order to calculate MFP-growth and relative MFP level of country i compared to the frontier country, the superlative index number approach of Caves *et al.* (1982a, b) is used. It can be seen as the discrete time analogue of the continuous time formula derived by Solow to measure the rate of technological progress. The difference comes from the use of a translog production function instead of the more standard Cobb-Douglas. However, the assumptions on constant returns to scale and perfect competition in the input markets are maintained.

MFP growth is then given by the following expression:

$$\Delta MFP_{i,t} = \ln\left(\frac{Y_{i,t}}{Y_{i,t-1}}\right) - \frac{1}{2}(\alpha_{i,t} + \alpha_{i,t-1})\ln\left(\frac{L_{i,t}}{L_{i,t-1}}\right) - \left(1 - \frac{1}{2}(\alpha_{i,t} + \alpha_{i,t-1})\right)\ln\left(\frac{K_{i,t}}{K_{i,t-1}}\right)$$

where $\alpha_{i,t}$ is the share of labour in value-added.

Relative levels of MFP of country i compared to the frontier country are derived using an analogous approach. First, the level of MFP in each country is evaluated relative to a common reference point – the geometric mean of all countries – using the following productivity index:

$$MMFP_{i,t} = \ln\left(\frac{Y_{i,t}}{\bar{Y}_t}\right) - \frac{1}{2}(\alpha_{i,t} + \bar{\alpha}_t)\ln\left(\frac{L_{i,t}}{\bar{L}_t}\right) - \left(1 - \frac{1}{2}(\alpha_{i,t} + \bar{\alpha}_t)\right)\ln\left(\frac{K_{i,t}}{\bar{K}_t}\right)$$

where an upper bar above the variable denotes a geometric mean across countries.

For each year, the country with the highest MFP relative to the geometric mean (MMFP) is defined as the frontier country and denoted $MMFP_{F,t}$[34]. In order to derive $RMFP_{i,t}$ (the superlative index number measure of relative MFP for each country i in each year), $MMFP_{F,t}$ is subtracted from $MMFP_{i,t}$ for each country and each year:

$$RMFP_{i,t} = MMFP_{i,t} - MMFP_{F,t}$$

One problem with this estimation of MFP is that the share of labour in value-added ($\alpha_{i,t}$) tends to be rather volatile. This might be due to measurement errors, short-run fluctuations in demand conditions and possibly the fact that wage negotiations are not on an annual basis. Following Harrigan (1997) and Griffith *et al.* (2001), we exploit a property of the translog production function with constant returns to scale and the assumption on competitive input markets to smooth the share of labour compensation. Indeed, the equalization of the marginal product of labour to the wage rate produces, in the case of this production function, a stable relationship between the share of labour compensation and the logarithm of the capital-labour ratio. Assuming that the observed share differs randomly from this stable relationship, one can estimate:

$$\alpha_{i,t} = \upsilon_i + \varphi \cdot \ln(K_{i,t}/L_{i,t}) + \varepsilon_{i,t}$$

34. For the identification of the frontier country non-EU OECD countries (e.g., Canada, Japan and the United States) are also included in the analysis in order to identify the world technology leader.

where $\varepsilon_{i,t}$ is an i.i.d. error term and υ_i are country fixed effects. This formulation with country fixed effects assumes that the structure of production differs among countries only through differences in the first order translog parameters[35]. The fitted values of $\alpha_{i,t}$ from this equation are used in the calculations of $\Delta MFP_{i,t}$ and $MMFP_{i,t}$ above.

4.2.4. The Measurement of Vertical Aids

As already stated above, we will use the figures reported as 'sectoral aid' and 'total aid' to manufacturing in the EU State Aid Scoreboard to estimate the bounds of the effect of vertical aids on productivity. We should note, however, that about 20% of state aid is directed towards R&D activities. Since aids to R&D may affect the R&D intensity of the industry in an unknown way, the inclusion of both variables in the estimation would bias the coefficient.

A possible solution is to replace R&D intensity with a function of its determinants, which would include aid for R&D in the manufacturing sector as an unobservable, and use 'total aid' as the measure for vertical state aid. In this case, the effect of the unobserved aid for R&D would be captured by the coefficient of 'total aid'. Due to data constraints, however, we have chosen to include both variables and perform robustness checks replacing business R&D by a measure of the part of this R&D that is solely financed by industry, that is to say, without any kind of public support.

4.2.5. Endogeneity of State Aids

Vertical state aids may be more likely to be awarded to industries or firms facing particular levels of productivity (low, in the case of supporting losers; high, if picking winners). In this sense, one cannot say that state aids are exogenous with respect to productivity growth. We thus have to distinguish the effect of state aids on MFP growth from the correlation between these two variables which is explained by the rule followed to award the aids. Hence, instrumental variables are used to estimate the effect of state aids on productivity growth controlling for the fact that productivity growth may itself determine the amount of aid. We have used two sources for instruments:

- Political economy variables: political characteristics of a country are likely to determine the willingness to concede aids to particular sectors, either because some parties care more about equity/efficiency than others or because certain governmental structures are more subject to capture by interest groups.

- State aids to other sectors: the willingness to grant aid can also be inferred from the observation of the level of aids granted to other sectors of the economy. These aids are correlated with aid to manufacturing and awarded independently of the productivity of the manufacturing sector. They are thus good potential instruments.

35. See Caves *et al.* (1982a, b).

4.2.6. Data Sources

Since state aid data is available on an aggregate basis, the manufacturing sector has to be modelled as a whole. Panel data is used for 11 EU Member States[36] and a series from 1992-2003. The data set is unbalanced due to missing data and Austria, Finland and Sweden entering the EU only in 1995.

Output

We use value added figures from the OECD STAN database (Vol. 2005) for the manufacturing sector. In the convergence literature a value-added concept is normally used for output since the analysis includes industries with different levels of vertical integration (see the discussion in Schreyer and Pilat (2001)). This approach will be followed here.

Capital stock

We use the fixed capital stock data from the OECD STAN database (Vol. 2005) for the manufacturing sector. Where data was missing, the fixed capital stock series were estimated with the help of gross fixed capital formation data and using the perpetual inventory method[37].

In the convergence literature the impact of capital utilization on the measurement of convergence of MFP is discussed. Griffith *et al.* (2001) adjust capital stock for utilization by using a smoothed output series and find no significant impact on their results. Our estimations use unadjusted capital stock.

Labour input

Following Griffith et al (2001) we use *number employed* as base measure from the OECD STAN database (Vol. 2005). We also use total hours worked from the ILO database. Griffith et al (2001) and Scarpetta and Tressel (2003) both test for robustness of their findings when hours worked is used instead of number employed and adjustments are made for different skill levels among countries and industries and find no significant alteration of their results.

PPP

A measure of purchasing power parity is needed in order to convert the value of production to common units, while taking into account differences in the purchasing power of each country's currency. In the most recent convergence literature, industry-specific expenditure PPPs are generally used instead of overall GDP-PPPs in order to take into account that that relative prices might evolve differently across countries[38]. However, Scarpetta and Tressel

36. Ireland, Luxembourg and Portugal were dropped from the EU-15 sample due to the short series on gross capital stock formation, which yielded poor estimates of their private capital stocks.
37. See Scarpetta and Tressel (2003) and OECD (1999) for a description of the perpetual inventory estimation method. For estimation of average service lives (ASL), data in OECD (1999) was used, taken from *Methods used by OECD countries to measure stocks of fixed capital, OECD Paris (1993).* For countries where no ASL data was available the average of similar neighbor countries was considered an adequate proxy.
38. See for example Griffith *et al.* (2001), Nicoletti and Scarpetta (2003) and Scarpetta and Tressel (2002). Kolasa and Zolkiewski (2004) use GDP-wide PPPs when analyzing the determinants of MFP for Poland and estimating convergence towards Germany.

(2003) run a sensitivity analysis on the use of overall GDP-PPPs and find that their results are not significantly altered. Since we are only looking at the manufacturing sector as an aggregate and at a rather homogenous set of countries (EU-15) our baseline estimate uses overall GDP-PPPs. Overall GDP-PPPs are taken from the OECD.

Labour share of value added

Data on the labour share of value added is taken from the OECD STAN INDICATORS data base.

State Aid

Data on state aid is reported as aid to the manufacturing sector as percent of value-added and taken from the online version of the State Aid Scoreboard of the European Commission.

R&D

Data on R&D intensity is drawn from the OECD ANBERD (Vol. 2004) database. R&D intensity is defined as the ratio of Business Expenditure in Research and Development (BERD) to value-added. This database, combined with information coming from the *Main Science and Technology Indicators* (MSTI), also from the OECD, enables us to divide the business expenditure on R&D into privately financed and financed by the government or other public bodies.

Public Capital

Data on public capital is taken from Kamps (2005) estimates of net government capital stock, in volume. The data covers the period 1960-2001 for 22 OECD countries.

Regulation Indicators

Indicators on product market regulation and employment protection legislation are taken from Boylaud *et al.* (2000).

We chose to proxy **product market regulation** for the manufacturing sector using the economy-wide aggregate indicator of administrative regulations, following the reasoning in Scarpetta and Tressel (2002)[39]. The indicator of administrative regulations (ADMIN) measures barriers to private entrepreneurial activities such as administrative burdens for entrepreneurial activity and regulatory and administrative opacity (e.g., complexity of rules and procedures for licenses and permits). The indicator was calculated for 1998 and is assumed to be time constant. This probably underestimates efforts for European wide harmonization of rules and regulation – however, significant differences in their implementation and administrative processes still persist.

39. Scarpetta and Tressel (2002) choose this proxy "because it refers to norms and regulations that are applied to all industries, while the overall indicator also includes economic regulations some of which are more sector specific, and do not apply to the manufacturing industries" (footnote 13, p. 15).

For **employment protection legislation**, indicators are available for 1990 (for the late 1980s) and 1998 and include both regulations for regular and temporary contracts. The EPL indicator used in the econometric analysis is time varying using the indicators for 1990 and 1998, and completing missing years with the help of the compilation of changes in legislation reported in the table "EPL time series breaking points", OECD Employment Outlook 2004, chapter 2 Annex.

Output Gap

Data on EU15 potential output, and the output gap as the difference between actual and potential output, is taken from the AMECO database from the European Commission.

Political Economy Variables

We use the 2005 update of the DPI2004 database of Political Institutions compiled for the World Bank, which provides data for a large number of countries from 1975 to 2000. From 2000 onwards, data have been updated using the sources cited in the database – when possible – and official sources for parliamentary elections in European countries.

4.2.7. Some Descriptive Statistics

The computation of MFP levels and growth rates according to the methodology described in previous sections yields the figures summarized in table 4.1. We present also the sample means of the state aids variables.

TABLE 4.1 Descriptive Statistics

(1992-2003)	MFP GROWTH		DISTANCE TO FRONTIER (% of leader technology level)		VERTICAL STATE AIDS TO MANUFACTURING (% of VA)		TOTAL STATE AIDS TO MANUFACTURING (% of VA)	
COUNTRY	Mean	St. Deviation	Mean	St. Deviation	Mean	St. Deviation	Mean	St. Deviation
Austria	1.73%	0.0244	75.10%	0.0142	0.10%	0.0015	1.37%	0.0019
Belgium	1.60%	0.0231	82.31%	0.0214	0.28%	0.0043	2.23%	0.0054
Denmark	1.47%	0.0430	63.79%	0.0186	0.07%	0.0011	4.49%	0.0101
Finland	5.35%	0.0325	75.74%	0.0819	0.08%	0.0013	1.75%	0.0038
France	2.61%	0.0232	90.77%	0.0321	0.39%	0.0026	2.10%	0.0050
Germany	1.36%	0.0236	77.06%	0.0215	1.18%	0.0115	3.65%	0.0117
Greece	n.a.	n.a.	n.a.	n.a.	0.78%	0.0146	7.18%	0.0444
Ireland	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Italy	0.56%	0.0293	67.10%	0.0324	0.68%	0.0071	4.58%	0.0241
Luxembourg	n.a.	n.a.	n.a.	n.a.	0.00%	0.0000	2.56%	0.0087
Netherlands	0.45%	0.0290	82.37%	0.0380	0.08%	0.0005	1.23%	0.0017
Portugal	n.a.	n.a.	n.a.	n.a.	0.63%	0.0075	1.86%	0.0077
Spain	0.24%	0.0135	63.46%	0.0348	1.08%	0.0098	2.74%	0.0088
Sweden	3.49%	0.0371	86.39%	0.0520	0.00%	0.0000	0.77%	0.0059
United Kingdom	0.11%	0.0210	86.88%	0.0786	0.01%	0.0002	0.79%	0.0015

NOTES: n.a.: Not available due to missing data either on capital stocks or volume value added.
Data on state aids for Austria, Finland and Sweden starts in 1995.

France is the European country which is closer to the frontier in the manufacturing sector – which is determined either by Canada or by the United States – during the sample period. On the other side, the group of laggard countries is formed by Italy, Denmark and Spain in the last position. MFP growth rates also vary considerably across countries and across time for any given country. The Nordic countries experience on average the highest growth rates, whereas Spain and the United Kingdom show growth rates very close to zero. Germany and Spain stand out as the countries granting the higher percentage of vertical state aids over value added to the manufacturing sector. Given their moderate figures regarding total state aid, it seems that these two countries award a large part of state aids to manufacturing through vertical instruments. On the contrary, Denmark awards the majority of its state aid, which is considerable, in the form of horizontal aids. Finally, Sweden and the United Kingdom appear as the least supporting countries towards the manufacturing sector.

It can also be helpful to examine the simple correlations between state aids and MFP growth across the different countries (see table 4.2).

TABLE 4.2 Simple Correlation between Aid Variables and MFP growth in the Following Period

	VERTICAL AIDS AT t-1	TOTAL AIDS AT t-1
Austria	0.0126	0.1913
Belgium	0.4009	0.5515
Denmark	–0.0818	0.2509
Finland	–0.2368	0.0323
France	0.5225	0.3284
Germany	0.1881	0.2946
Italy	0.5116	0.3192
Netherlands	–0.3249	–0.2859
Spain	–0.2403	–0.1820
Sweden	–	–0.2373
United Kingdom	0.0098	–0.3163

With regards to vertical aid, correlation coefficients show both positive and negative relationships. Overall, however, there seems to be a weak positive correlation between state aids and the growth rate of MFP in the next period for the countries awarding significant amounts of vertical aid. This positive relationship is somewhat clearer for total state aids, though it is still negative for countries with low levels of total state aid. Spain stands out as the single case of high levels of state aids associated with a negative correlation with MFP growth.

4.2.8. Results

Table 4.3 presents the results of the baseline specification of the model[40]. When the error correction model is estimated without controlling for any of the possible alternative determinants of the MFP, the coefficient of the technological gap is negative as expected, but not significant. On the other hand, technological diffusion from the leader country appears to be strong. Fixed effects, which control for any unspecified and country-specific variables, are only significant for some countries, with the reference country being UK. Once R&D intensity, the growth of public capital (*gkpub*) and the output gap[41] are included, the coefficient of the technological gap becomes significant and increases in magnitude (in absolute terms) with a value of –0.175 which does not change much in subsequent regressions.

Column (3) shows the results when the controls are introduced. The coefficient of R&D intensity is positive and significant while that on public capital is not statistically significant. Fixed effects for Finland and Sweden become not significant, while negative effects for Denmark appear significant at the 5% level. This may indicate that Finland and Sweden were able to maintain higher growth rates of MFP with respect to the UK due to relatively higher levels of R&D intensity. In the last column we estimate the model including an interaction term of R&D intensity with the technological gap. If the coefficient is negative this implies that the effect of R&D expenses is stronger the farther a country is from the technological frontier. Contrary to Griffith *et al.* (2001), we cannot find any evidence of this interaction term being relevant. This also implies that in our estimates R&D does not affect the speed of convergence. When compared to other studies, our estimates of the diffusion and convergence parameters appear to be somewhat higher, especially the diffusion estimate. In particular, the estimate obtained by Griffith *et al.* (2001) is around 0.13 and that of Scarpetta and Tressel (2002) is not significant for manufacturing industries. This compares to our estimate of around 0.60 which hold across specifications. The estimates for the convergence parameter vary between –0.07 and –0.097 in Griffith *et al.*[42] and –0.02 to –0.05 for the manufacturing sectors in Scarpetta and Tressel. In our study the estimate is about –0.175[43]. Those two studies use industry-level data and estimate the same parameters for all industries. The present study uses aggregate manufacturing data, and this implies that the parameter estimate is like an unweighted average of the effects of specific industries, and may incorporate diffusion effects across industries.

40. The estimation of an error correction model presupposes the existence of a cointegration relationship between the levels of MFP of each country and the frontier that should be tested. However, this test requires the use of these level variables, which we do not observe since only levels relative to other countries can be computed. As a less formal test, we performed unit root tests on the MFP growth series and report serial correlation tests for the error terms of the regressions. We performed Levin-Lin and Im-Shin unit root tests for panel data with the MFP growth of the non-frontier countries. The presence of a unit root was rejected in both at 1% level. For the frontier, we used the Dickey-Fuller test with a MacKinnon p-value of 0.073.

41. The output gap for the EU is included in the estimation to capture any effect from the business cycle that can affect equally all countries in the sample. Given the short dimension of our panel, this is preferred to the inclusion of time dummies. The estimation of the model including time dummies has the effect of dropping the growth rate of the MFP of the leader due to multicolinearity.

42. The estimate decreases to around –0.02 when interactions terms with other variables are included.

43. Table 6 specification (1) is the single specification where this parameter is significantly larger (–0.36). However, this value has to be reduced with the coefficient of the interaction terms. For the case of countries with medium levels of vertical aid intensity, the resulting catch-up coefficient is –0.177 (–0.3648 + 0.1875). For the case of countries with higher vertical aid intensity, the coefficient of the interaction term is not significant and therefore it is difficult to assess the extent to which the sum of the two parameters departs from –0.36.

TABLE 4.3 Base Specification

VARIABLE	(1)	(2)	(3)	(4)
Austria		0.0069	0.0000	0.0000
Belgium		0.0095	0.0045	0.0045
Denmark		–0.0012	–0.0373**	–0.0373**
Finland		0.0340***	0.0192	0.0192
France		0.0234 ***	0.0271**	0.0271**
Germany		0.0045	–0.0144	–0.0144
Italy		–0.0082	–0.0168	–0.0168
Netherlands		–0.0011	0.0014	0.0014
Spain		–0.0123	–0.0181	–0.0181
Sweden		0.0252**	–0.0034	–0.0033
$\Delta MFP_{Frontier\ t}$	0.5171***	0.5348***	0.6260***	0.6259***
$RMFP_{i,\ t-1}$	–0.0008	–0.0414	–0.1751***	–0.1748
output gap EU_t			–0.0079**	–0.0079**
$R\&D/VA_{i,\ t-1}$			0.6873**	0.6864
$R\&D/VA_{i,\ t-1}$ x $RMFP_{i,\ t-1}$				–0.0040
$gkpub_{i,\ t}$			–0.3151	–0.3154
cons	0.007	–0.0115	–0.0770***	–0.0769**
Statistics	(1)	(2)	(3)	(4)
Observations	131	131	100 (b)	100 (b)
Adjusted R^2	0.239	0.363	0.455	0.448
Serial correlation		2.183	2.252	2.443

LEGEND: * p<.1; ** p<.05; *** p<.01.
Due to the presence of heteroscedasticity, robust standard errors are used.
Serial correlation is Bhargava *et al.* modified DW for balanced panels (b) and Baltagi-WU LBI for unbalanced ones.
NOTE: See List of Variables in page 36.

Next, we analyze the effect of state aids on manufacturing multifactor productivity. As discussed in a previous section, total state aid to manufacturing includes aid awarded to R&D objectives and coefficients are likely to be biased. In order to mitigate the possible bias in the coefficients, we have replaced R&D intensity by the equivalent variable for R&D that is privately funded by the industry. Table 4.4 shows the results for the effect of vertical state aids as classified by the Commission (that is, for "sectoral state aid"). Three different specifications are estimated, for which we present both the OLS and the instrumental variables GMM estimates.

We considered two possible sets of instruments: political economy variables and state aid intensities in other sectors of the economy. The political variables we considered as potentially correlated with state aids were the number of years the political party of the head of government has been in office, the ideology of the party in office (left-wing, right-wing or center), a measure of the strength of the government – where weaker governments are considered to be those formed by a large number of parties with few seats in the parliament –, the number of seats of the government in the parliament, a measure of the strength of the opposition (defined as in the case of the governing majority) and the number of seats of the

TABLE 4.4 The Effect of Vertical State Aids on MFP growth

	SPECIFICATION (1)		SPECIFICATION (2)		SPECIFICATION (3)	
VARIABLE	WLS	IV GMM	WLS	IV GMM	WLS	IV GMM
Austria	0.0000	–	0.0000	–	0.0000	–
Belgium	–0.0045	–0.0067	0.0000	–	0.0263	0.0241
Denmark	–0.0351	–0.0319	–0.0505**	–0.0462**	–0.0274	–0.0262
Finland	0.0072	0.0050	0.0019	0.0002	0.0167	0.0119
France	0.0210	0.0163	0.0192	0.0164*	0.0539**	0.0497**
Germany	–0.0308*	–0.0404**	–0.0328**	–0.0371***	–0.0078	–0.0106
Italy	–0.0194	–0.0236	–0.0270	–0.0256	0.0000	–
Netherlands	–0.0018	–0.0047	–0.0320*	–0.0338**	–0.0087	–0.0144
Spain	–0.0216	–0.0316	–0.0510*	–0.0541**	–0.0140	–0.0176
Sweden	–0.0125	–0.0128	–0.0468*	–0.0468*	–0.0067	–0.0124
$\Delta MFP_{Frontier\ t}$	0.5576***	0.5411***	0.5144***	0.4987***	0.5420***	0.5252***
$RMFP_{i,\ t-1}$	–0.1425**	–0.1346**	–0.1508**	–0.1401***	–0.1421**	–0.1374**
$R\&D/VA_{i,\ t-1}$	0.8347**	0.8100**	0.8771***	0.8748***	0.8134**	0.8396***
$gkpub_{i,\ t}$	–0.4038	–0.3339	–0.3202	–0.2042	–0.3841	–0.2660
Output gap EU_t	–0.0053	–0.0035	–0.0001	0.0009	–0.0029	–0.0024
$AIDV/VA_{i,\ t-1}$	**0.8280***	**1.5728****	0.4918	0.9051	**0.8684****	**0.8679***
EPL_{t-1}			0.0289**	0.0272***		
$ADMIN_i$			–0.0260**	–0.0252***	–0.0249	–0.0253
$EPL_{t-1\ (med)}$					0.0318	0.0336
$EPL_{t-1\ (high)}$					0.0525	0.0559
cons	–0.0645***	–0.0616***	–0.0694***	–0.0663***	–0.0501**	–0.0496***
Statistics						
Observations	88	88	88	88	88	88
Adjusted R^2	0.354	0.333	0.407	0.399	0.380	0.369
Serial correlation	2.500	2.500	2.558	2.558	2.525	2.525
First Stage statistics						
Partial R^2 excluded inst.		0.315		0.278		0.389
Shea partial R^2 p-value		0.000		0.000		0.000
Hansen J p-value		0.810		0.717		0.687
Instruments		$prtyin_{i,\ t-1}$ $herfgov_{i,\ t-1}$ $centre_{i,\ t-1}$		$prtyin_{i,\ t-1}$ $herfgov_{i,\ t-1}$ $centre_{i,\ t-1}$		$prtyin_{i,\ t-1}$ $herfgov_{i,\ t-1}$ $centre_{i,\ t-1}$

LEGEND: * p<.1; ** p<.05; ***p<.01.
Due to the presence of heteroscedasticity, robust standard errors are used.
Serial correlation is Bhargava *et al.* modified DW for balanced panels (b) and Baltagi-WU LBI for unbalanced ones.
NOTE: See List of Variables in page 36.

opposition. With respect to aids to other sectors of the economy, we considered state aids awarded to coal, to financial services, to transport, to other non-manufacturing sectors and to other services.

State aids to other sectors of the economy do not seem to explain state aids to manufacturing given the rest of exogenous regressors: first stage regression results yield non significant coefficients for these instruments. Only aid to other non-manufacturing sectors

seems to be significant. Nevertheless, it looses its significance once the other political economy variables are added to the estimation. Therefore, state aids to other sectors of the economy cannot provide any new relevant information to explain the intensity of state aids to manufacturing other than that provided by political variables.

Political variables appear then to be the most suitable instruments. Among them, those that appear to better explain the level of state aids while are uncorrelated with MFP growth are the following: the number of years the party of the chief executive has been in office (*PRTYIN*) – which positively affects this level; the composition of the government (*HERFGOV*), with weaker governments (formed by several parties with modest shares) awarding higher levels of aid; and the ideology of the chief executive party, with centrist (*CENTRE*) parties awarding less aid than the rest. The results are in line with the characteristics of governments that are more prone to capture. The longer a party is in power, the higher is the probability of links with representatives of the different industries. At the same time, weaker governments are formed by small pivotal parties which can have some lobbying power to implement the measures that please their electorate. Finally, centrist parties are perhaps those whose ideology is less oriented towards particular pressure groups.

Specification (1) shows the estimates obtained for the baseline model with the controls and the addition of the vertical state aid variable. Results show a positive and significant effect of vertical aids on manufacturing productivity: an extra percentage point of vertical state aids generates approximately 0.83 percentage points ($0.0083 = 0.828 \cdot 0.01$) of MFP growth in the manufacturing sector. However, when vertical aids are instrumented with political variables, the magnitude of the coefficient is more than doubled and significant. This result is confirmed across the rest of the specifications. The fact that the OLS coefficient is biased downwards indicates that there is a negative correlation between the lagged values of vertical aids and the error term in the equation describing MFP growth. Recall that the OLS estimate of the aid coefficient is the sum of the true parameter plus a bias term, whose sign is given by the covariance between the lagged values of vertical aid and the error term in the equation describing MFP growth. Taking the coefficient of the IV estimates as a consistent approximation to the true coefficient, we conclude that the OLS estimate is biased downwards and hence, that the covariance is negative. We would like to infer from this covariance the sign of the MFP growth parameter in the equation determining the level of vertical aids: that is, whether aids go to winning or loosing sectors. Unfortunately, it is not possible to do this without the estimation of the aids equation. Although the expression for the covariance depends on the particular specification of this equation, both positive and negative values of the coefficient are compatible with a negative covariance[44].

44. Consider, for example, the following linear specification for the aids equation:

$$AIDV_{i,t} = \mu \cdot AIDV_{i,\,t-1} + \alpha \cdot political_{i,t} + \delta \cdot \Delta MFP_{i,t} + u_{i,t}$$

where political refers to any political variable in country i which influences aids. The expression for the covariance between $AIDV_{t-1}$ (which appears in the equation (3)) and the error term ε_t of equation (3) is then: $Cov(AIDV_{t-1}, \varepsilon_t) = -[\delta/(\mu+\delta\beta_3)] \cdot Var(\varepsilon_t)$. We can see that a negative covariance is compatible with positive and negative values of δ depending on the magnitudes of the other parameters in the equation. However, if we assume that $0<\mu<1$, it is easily seen that the true sign of β_3 is inversely related to the sign of the covariance, which means that not taking into account the endogeneity leads to underestimates of the true parameter.

Specification (2) adds to the model the indicator on employment protection legislation (EPL) and that of administrative regulations (ADMIN). The effect of vertical state aids shows up again as positive but becomes not significant even after the correction for endogeneity. Administrative regulations have a negative and significant effect on MFP growth. However, we also find in this case a positive and significant effect of the employment regulations, contrary to the findings of Scarpetta and Tressel (2002). A categorization of this indicator into three possible levels[45], shown in specification (3), seems to point to the positive effect coming from countries with higher levels of EPL[46], though the results are not statistically significant. Vertical state aids become again significant with this specification, although its magnitude and the magnitude of the bias seem to be smaller.

We estimated yet another specification with a categorization of the level of vertical state aids into low, medium and high level. Countries with a null amount of vertical state aid were classified as having low vertical aid. Countries with levels higher than one standard deviation over the mean were classified as countries with high level of vertical aid. The categorization was time varying and we took advantage of the fact that there are countries in the sample with zero level of aid in some years while a positive level for some others. Unfortunately, the correlation of the instruments at hand with the outcome of this categorization was not significant. Hence, instrumental variable estimation was not possible for this specification and thus we do not show the results of the OLS estimation. Briefly, these results pointed to the effect of vertical aids to be negative for medium levels of aid and positive for higher levels. Nevertheless, none of the estimates was significant and we cannot exclude the possibility that the bias of the OLS coefficients is underestimating a positive effect in both categories.

The same kind of exercise has been performed for the total level of state aid to manufacturing. The results in table 4.5 show the same pattern as for the vertical state aids. The significance, however, is stronger – possibly due to the fact that the total amount of aid to manufacturing has not suffered from the pressure to be reduced, which creates a trend in the vertical aids data that hinders identification. Marginal effects, except for the first specification, seem to be higher than for the case of vertical aids. Depending on the specification, an extra percentage point of total state aids intensity yields between 0.76 and 1.05 percentage points of MFP growth.

As a final step in the analysis, we consider an alternative specification where the potential effect of state aid on MFP growth depends not only on the level of state aid, but also on the distance of any particular country to the technological frontier. This implies interacting the regressors RMFP and AIDV/VA, as we did in the base specification for RMFP and R&D/VA. With this specification, a negative sign for the interaction term would indicate that the positive direct effect of vertical state aids on MFP growth (captured by the parameter for AIDV/VA) becomes larger the farther away is a country from the technological frontier (the more negative is RMFP). Nevertheless, theory is inconclusive on this issue, and the parameter could well be positive.

45. Low EPL for those countries with an EPL indicador below the sample mean less one standard deviation; High EPL for those with an EPL higher than the mean plus one standard deviation; EPL medium for the rest.
46. High EPL could favour MFP growth if the employment protection legislation leads to a higher investment of workers on knowledge and skills which are firm-specific.

TABLE 4.5 The Effect of Total State Aids on MFP growth

	SPECIFICATION (1)		SPECIFICATION (2)		SPECIFICATION (3)	
VARIABLE	WLS	IV GMM	WLS	IV GMM	WLS	IV GMM
Austria	0.0000	–	0.0000	–	0.0000	–
Belgium	–0.0065	–0.0116	0.0000	–	0.0363*	0.0403**
Denmark	–0.0519**	–0.0599***	–0.0620**	–0.0636***	–0.0413*	–0.0431**
Finland	0.0067	0.0078	0.0015	0.0081	0.0226	0.0214
France	0.0213	0.0128	0.0214*	0.0201**	0.0662***	0.0651***
Germany	–0.0297	–0.0409***	–0.0310**	–0.0346***	0.0036	–0.0016
Italy	–0.0351	–0.0552***	–0.0357**	–0.0463**	0.0000	–
Netherlands	–0.0036	–0.0036	–0.0335*	–0.0249	–0.0072	–0.0130
Spain	–0.0278	–0.0311	–0.0574**	–0.0481**	–0.0110	–0.0071
Sweden	0.0013	0.0053	–0.0358	–0.0223	0.0116	0.0048
$\Delta MFP_{Frontier\ t}$	0.5623***	0.5032***	0.5298***	0.4831***	0.5498***	0.4913***
$RMFP_{i,\ t-1}$	–0.1592**	–0.1124*	–0.1746***	–0.1260**	–0.1589**	–0.1039*
$R\&D/VA_{i,\ t-1}$	0.7117**	0.5280	0.8140***	0.6299*	0.7233**	0.6564**
$gkpub_{i,\ t}$	–0.3631	–0.3663	–0.2746	–0.3278	–0.2973	–0.1764
Output gap EU_t	–0.0060	–0.0021	–0.0011	0.0015	–0.0039	–0.0004
$AID/VA_{i,\ t-1}$	0.3585	**1.0458****	0.1366	**0.7626****	0.3597	**1.0071****
$EPL_{i,\ t-1}$			0.0290**	0.0233*		
$ADMIN_i$			–0.0265**	–0.0233**	–0.0307	–0.0406**
$EPL_{t-1\ (med)}$					0.0337	0.0485
$EPL_{t-1\ (high)}$					0.0493	0.0540
cons	–0.0651***	–0.0544***	–0.0718***	–0.0591***	–0.0493**	–0.0373*
Statistics						
Observations	88	88	88	88	88	88
Adjusted R^2	0.375	0.302	0.424	0.368	0.392	0.339
Serial correlation	2.476	2.476	2.558	2.558	2.475	2.475
First Stage statistics						
Partial R^2 excluded inst.		0.324		0.289		0.262
Shea partial R^2 p-value		0.000		0.000		0.001
Hansen J p-value		0.818		0.963		0.858
Instruments		$centre_{i,\ t-1}$ $aidv\_ononm_{i,\ t-1}$		$centre_{i,\ t-1}$ $aidv\_ononm_{i,\ t-1}$		$centre_{i,\ t-1}$ $aidv\_ononm_{i,\ t-1}$

LEGEND: * p<.1; ** p<.05; ***p<.01.
Due to the presence of heteroscedasticity, robust standard errors are used.
Serial correlation is Bhargava *et al.* modified DW for balanced panels (b) and Baltagi-WU LBI for unbalanced ones.
NOTE: See List of Variables in page 36.

Table 4.6 shows the result of the inclusion of "sectoral" state aid variables interacted with the technological gap, the employment regulations and the administrative barriers. These two last interactions are introduced as specification checks to test whether the effect of state aid is different for countries where high product and labour market regulations already affect the adoption of new technologies. Unfortunately, we could not find enough instruments to be able to control the endogeneity of all the variables related with aids. Hence, the results presented in this table should be interpreted with caution.

TABLE 4.6 The Effect of Vertical State Aids on MFP growth. Alternative Specifications

VARIABLE	(4)	(5)	(6)
Austria	0.0000	0.0000	0.0000
Belgium	0.0000	0.0000	0.0000
Denmark	–0.0797***	–0.0665***	–0.0666**
Finland	–0.0095	–0.0064	–0.0037
France	0.0152	0.0204*	0.0198
Germany	–0.0374***	–0.0413***	–0.0379***
Italy	–0.0292	–0.0301*	–0.0352**
Netherlands	–0.0377**	–0.0386**	–0.0368*
Spain	–0.0687***	–0.0684***	–0.0746***
Sweden	–0.0450	–0.0609	–0.0520*
$\Delta MFP_{Frontier\ t}$	0.5799***	0.5535***	0.5547***
$RMFP_{i,\ t-1}$	–0.3648***	–0.1872***	–0.1916***
$R\&D/VA_{i,\ t-1}$	1.1850***	0.9805***	0.9125***
$gkpub_{i,\ t}$	0.0787	–0.0938	–0.0621
Output gap EU_t	0.0001	–0.0008	–0.0010
$EPL_{i,\ t-1}$	0.0299**	0.0339	0.0308**
$ADMIN_i$	–0.0289***	–0.0309**	–0.0312**
$AIDV/VA_{i,\ t-1\ (med)}$	0.0501*	–0.0053	–0.0108
$AIDV/VA_{i,\ t-1\ (high)}$	0.0318	0.0759	0.0568
$AIDV/VA_{i,\ t-1\ (med)}$ x $RMFP_{i,\ t-1}$	0.1875*		
$AIDV/VA_{i,\ t-1\ (high)}$ x $RMFP_{i,\ t-1}$	0.0944		
$AIDV/VA_{i,\ t-1\ (med)}$ x $EPL_{i,\ t-1}$		–0.0008	
$AIDV/VA_{i,\ t-1\ (high)}$ x $EPL_{i,\ t-1}$		–0.0232	
$AIDV/VA_{i,\ t-1\ (med)}$ x $ADMIN_i$			0.0032
$AIDV/VA_{i,\ t-1\ (high)}$ x $ADMIN_i$			–0.0180
cons	–0.1355***	–0.0753*	–0.0683**
Statistics	(4)	(5)	(6)
Observations	90	90	90
Adjusted R^2	0.484	0.458	0.451
Serial correlation	2.485	2.500	2.496

LEGEND: * p<.1; ** p<.05; *** p<.01.
Due to the presence of heteroscedasticity, robust standard errors are used.
Serial correlation is Bhargava *et al.* modified DW for balanced panels (b) and Baltagi-WU LBI for unbalanced ones.
NOTE: See List of Variables in page 36.

When interactions with the technological gap are included, both the direct and the indirect effects of "sectoral" state aids are positive and significant for those countries with medium level of aids. No significant effect is found for countries with high levels of aid. The direct effect points to countries with intermediate levels of vertical aids having on average 0.5 percentage points more of MFP growth, though the positive sign of the indirect effect suggests that this figure could decrease as a country moves farther from the technological frontier. At the same time, the speed of convergence is on average smaller for countries with medium levels of aid. Altogether, these results could signal a different allocation rule of state aids for these countries, with market failure corrections being less important than governmental capture. Nevertheless, as we have seen before, the effect of state aids is

underestimated and thus, the interaction terms could well change sign if endogeneity bias was corrected for. Finally, interactions with employment regulation yield no significant results, nor do those with administrative barriers. The analysis has also been performed for total state aids (not shown) yielding similar inconclusive results.

To summarize the main findings discussed in this section, our results point to a positive effect of pure vertical state aids on productivity growth in manufacturing. This effect cannot be attributed to the fact that governments could tend to award aids to sectors with better productivity. This paper does not provide an answer to this question. Nevertheless, independently of the rule followed by governments, there is some evidence that productivity tends to grow higher the higher the levels of aid conceded in the previous period. It is also possible that the effect of state aids last more than a single period. However, the short dimension of our panel prevents us from exploring a richer structure for the lags of state aids.

The effect of "sectoral" aid, as classified by the Commission, provides an estimate for the worse case scenario, since the efficiency-based arguments used for justifying it are weak. This estimate is positive and significant for the majority of the specifications. Total state aids data provides the best case scenario, given that it includes aids that can be justified on efficiency grounds. In this case, the results are more significant and they seem to indicate that the positive effects are reinforced, possibly through a positive impact of state aids on R&D intensity.

With regard to the model proposed, it yields robust estimates for the diffusion of technology (0.5), for the speed of convergence (around –0.15), and for R&D (0.8). The estimated aid coefficient is not as robust, varying in magnitude and significance with different measures of EPL. In general, when controlling for employment protection legislation, the effect of state aids decreases (becoming non-significant for some specification). Aid, EPL, and PMR all measure different aspects of state intervention, and a challenge for further work will be to more clearly separate out the impact of aid from other intervention. This would surely call for a structural analysis of the joint determination of the allocation rule for state aids and productivity growth.

Our results have to be interpreted with caution, however, given the short dimension of our panel. Better estimates on private capital stock should enable us to use the information on state aids for the full EU-15. This would include Ireland and Portugal, two of the states with a higher proportion of vertical state aids over total aid. On the other hand, a longer time series would allow us to better capture the influence of common shocks through the use of time dummies and to define a better lag structure for state aids.

5. Conclusion

To a large degree, of the industrial policy of EU member states can be understood as being implemented through the agreed framework of EU state aid legislation. The objective of state aid policy is that whenever industrial policy undertaken by the Member States is suspect of having distortive effects on internal market competition, affects trade or might give rise to a subsidy war, it should be regulated and monitored at the EU level. With this idea in mind, a set of regulations describes and limits the types of state aid that can be used in the EU. Overall, the design of state aid policy for the European Union is based on efficiency considerations. Nevertheless, a non negligible part is awarded on equity grounds, mainly in the form of regional and sectoral aid and of aid for rescue and restructuring.

Sectoral aid and aid for rescue and restructuring are two examples of vertical state aid. That is to say, aid awarded either to specific firms or industries. Horizontal state aid, in contrast, is in principle awarded in order to support broad economic goals (such as R&D, environmental care, energy saving, SME etc.) independently of the sector in which the firms operate. Similarly regional aid, in principle, supports activities of whatever kind in regions in need. The Commission has recognized that the vertical aid categories are "likely to distort competition more than aid for horizontal objectives and also tend to favor objectives other than identified market failures". As a consequence, the Commission is encouraging member states to reduce this kind of aid.

Despite the efforts of the Commission, a careful analysis of the state aid figures provided in the State Aids Scoreboard reveals that, although the share of vertical aid has decreased, governments seem to have some scope to use horizontal aid mechanisms to support specific industries. In particular, about 96% of total state aid for horizontal objectives is concentrated in the manufacturing sector and there are a number of state aid notifications for which the primary objective is horizontal but the measure of state aid is limited to targeted industries.

Given that the efficiency justifications for the different varieties of vertical aid may be quite weak and may not compensate the distortions they create, this persistent use of vertical instruments calls for an overall assessment of the effects of the current state aids policy. Existing evidence is scarce and points to sectoral aid resulting in rent-shifting in the short-term. With respect to rescue and restructuring aid, the only existing study to our knowledge indicates that firms in difficulties seem to partially close the gap with the rest in terms of productivity levels. Finally, some studies on a broader definition of aid suggest that state aids may increase the productivity of subsidized firms in the short-term over that of non-subsidized ones. However, the effect becomes negative after some time.

Using a model of productivity convergence across countries, we have assessed the effects of vertical aids in the manufacturing sector. There are several variables that could be used as a measure of performance on which to assess the effects of state aids. However, productivity appears to be the most important given the ultimate relationship between productivity and economic growth. We focus on the manufacturing sector because of the measurement problems that characterize the non-manufacturing industries. Moreover, manufacturing is footloose in nature and thus more prone to receive vertical state aids.

Following our discussion about the possible use of horizontal objectives to channel what can be considered as vertical aid, we view what the Commission defines as "sectoral" aid as a worst case scenario on the effects of state aid on productivity. Total state aid, on the other hand, would give a best case scenario. Overall, our results point to a positive effect of vertical state aids on productivity growth. The effect of "sectoral" aid seems to be positive and significant. The best case estimates provided by results on total state aids are even more significant and they seem to indicate that the positive effects are reinforced, possibly through a favourable impact of state aids on R&D intensity. Nevertheless, given the correlation with other state interventions, further research on a structural model of state aids seems worthwhile.

Although our results have to be interpreted with caution, they seem to contradict the view that the efficiency reasons behind sectoral and rescue aid are quite weak. Indeed, they seem to support the task of the European Commission in effectively monitoring potentially distortive state aid.

List of Variables

$\Delta MFP_{Frontier,t}$: MFP growth in the frontier country.

$AIDV/VA_{i,t-1}$ (**$AID/VA_{i,t-1}$**): Vertical (total) aid intensity of country *i* during the previous period.

$ADMIN_i$: Administrative Regulations for country *i*. Constant along the sample period.

$AIDV/VA_{i,t-1\,(med)}$ (**$AIDV/VA_{i,t-1\,(high)}$**): Dummy variable taking the value of 1 when country *i* had a medium (high) level of vertical aid intensity of during the previous period.

$EPL_{i,t-1}$: Employment Regulations indicator for country *i* during the previous period.

$EPL_{t-1\,(med)}$ (**$EPL_{t-1\,(high)}$**): Dummy variable taking the value of 1 when country *i* had a medium (high) level of employment regulations.

$gkpub_{i,t}$: Public capital growth of country *i*.

$prtyin_{i,t-1}$: The number of years the party of the chief executive had been in office in country *i* during the previous period.

$herfgov_{i,t-1}$: Strength of the government of country *i* during the previous period (Herfindahl index of parties in the government).

$centre_{i,t-1}$: Dummy variable taking the value of 1 when the chief executive party governing country *i* during the previous period was of centrist ideology.

$aidv\_ononm_{i,t-1}$: Aid intensity of vertical aids granted to the "other non-manufacturing" sector in country *i* during the previous period.

Output gap EU_t: Output gap in the EU.

$R\&D/VA_{i,t-1}$: R&D intensity of country *i* during the previous period.

$RMFP_{i,t-1}$: Level of MFP of country *i* relative to that of the frontier country during the previous period.

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