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Ex post evaluation of Cohesion Policy programmes 2000-2006 financed by the European Regional Development Fund

Work Package 6c:

Enterprise Support - an exploratory study using counterfactual methods on available data from Germany

Final Report

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EXECUTIVE SUMMARY

Support to enterprises is one of the key priorities of the EU Structural Funds and an essential component of the Lisbon Strategy. During the period from 2000 – 2006 more than €45 billion were used to support enterprise investment and research and development (R&D) across the member states. Direct grants to enterprises were mainly used to support private investment to improve the private capital stock and a smaller share was appointed for enterprise R&D. Although a considerable part of the ERDF is used to support enterprises, most of our knowledge of the effects comes from beneficiary surveys.

The core of the actual investigation is to analyze the impact of direct non-repayable investment grants to enterprise using econometric techniques on investment and R&D behaviour at the firm level to supplement other work within Work Package 6 that was done during the ex-post evaluation for the period 2000 – 2006 to identify the impact of the ERDF on enterprise and innovation.

Counterfactual impact analysis at the firm level is a new approach to identify the impact of investment subsidies on firm's investment behaviour in physical investment and enterprise R&D. Although the techniques are well known and widely used in the area of active labour market policies or clinical trials, individual firm data to implement counterfactual impact methods are rare and therefore only few studies have been performed. A main reason is tthat most available samples do not contain a mark or variable that would allow to distinct between firms whether they have received direct aid or not.

Counterfactual impact analysis rests on the comparison of firm data between firms that have been treated, i.e. received direct aid and those who did not. The principle is similar to a clinical trial or a controlled experiment: The difference in the outcome variable, for example the time needed to recover from an illness, between treated and non-treated (placebo) units, can be viewed as the impact of the medicine after controlling for individual attributes. To perform a counterfactual analysis at the firm level and to come up with an estimate of the difference on investment of treated and non-treated firms, it is therefore necessary to have observations for firm that received direct aid and those who did not.

All statistical techniques used in the counterfactual impact analysis try to identify an unbiased estimate of the impact, i.e. the difference in the outcome variable of treated and non-treated units. The range of possible methods is wide, including ordinary least squares estimation, propensity score matching or difference-in-differences estimation among others, whereby the assumption one is willing to introduce and the set-up of the sample determines which estimator could or should be used. The updated EVALSED section on "Methods and Techniques" gives a clear and good overview and guidance.

In this experimental study we use two specific samples for East Germany, namely the IAB Betriebspanel and a survey on R&D behaviour of Thuringia firms that allow for a distinction between treated and non-treated firms. Both samples cover fully or partially the EU Structural Fund period from 2000 to 2006 and firms which received support via the ERDF, since the East German Länder received EU Structural Funds under Objective 1.

Since German re-unification, subsidies to support enterprise investment and enterprise R&D have been one of the major priorities. Investment support took the form of special tax reductions, investment grants (national and ERDF funded), investment bonus and specific credit

and guarantee programmes by state owned banks. R&D support was mainly given in the form of grants. It should be noted that the rationale for R&D support is market failure and positive externalities, whereas investment subsidies do not rest on market failure arguments, but rather the political wish to make capital investment cheaper in lagging regions.

For the 2000-2006 ERDF funding period, support through investment bonus amounted to €8.23 billion, or annually €1.18 billion. The level of investment grants for enterprises during the same period was €9.6 billion or €1.38 billion annually. The investment grants were also partly financed through the ERDF. For the years from 2000 – 2006 the total ERDF support amounts to €2.59 billion. The share of ERDF subsidies on the total amount of grants was more than a quarter, i.e. 27%. The monitoring data of the investment grants scheme report that due to the subsidized investments in total 107,000 workplaces were created and 439,000 workplaces were safeguarded. The figures show that investment aid was substantial for the development of the East German economy during the period under investigation.

With respect to R&D support, the federal government spent around €3.25 billion on enterprise R&D during the period 2000-2006. ERDF subsidies for R&D were handed out via the federal states and amounted to €1.02 billion. Thus, the ERDF funding took on a significant share of the overall direct R&D enterprise support in the years 2000-2006.

Turning now to the estimated impacts, i.e the estimated effects, using the counterfactual evaluation methods for East Germany, the different methods led to similar results that are fairly stable and fit into the available empirical evidence for East Germany:

- Investment grants induce strong investment effects. An average support of €8,000 per employee led to €11,000-12,000 of extra investment per employee and this result seems robust to different assumptions and the use of different econometric methods. We found no evidence of deadweight – on the contrary it seems that there is a leverage effect, where every euro of public money generates up to €1.5 of total investment.
- The estimated direct employment effect amounts to some 27,000. This is a very rough calculation, based on various assumptions and cannot be taken as an exact estimate. But it should be noted that it is significantly lower than the number of new workplaces (107,000) and the number of safeguarded workplaces (439,000) from the monitoring data. This confirms that gross jobs created tends to overstate impacts and gross jobs safeguarded even more so.Conversely, the total direct effect is somewhat higher than the number of new employees from the HERMIN macromodels – since the latter take into account economy wide effects, such as displacement and crowding out. Taken together, the results are in line with our knowledge about the net effects of the support of private investment, and confirm that the main impact of such support is more likely to be increased investment and productivity, with a smaller impact on job creation.
- Regarding R&D, grants of roughly €8,000 led to an additional €8,000 of investment, showing that this is more or less a 1-for-1 input to R&D activities. Due to the “partial public good” nature of R&D activities these additional R&D activities may well contribute to boost the long-term growth perspectives.

To summarize, the empirical results for investment subsidies for private investment and R&D investment in East Germany show that the support works and public subsidies do not replace private investment. On the contrary, enterprise subsidies lever in extra private money,

and are accompanied by a small employment effect. Furthermore, the literature survey shows that the results here are broadly in line with national and international evidence, so that they can be viewed as a hint how these measures work and that they have a positive impact at the firm level.

But it should also be emphasized that the results are only the first in a causal chain. Second round effects, like displacement or multiplier effects are not taken into account since the rest of the economy is by definition ruled out. Concerning the employment and growth target it can be concluded that direct investment aid deepens the capital intensity of the economy and boosts productivity, whereas additional employment in the short run is of second order. In the long- or medium-run however the modernised capital stock may contribute to an enhanced regional competitiveness and thereby induce positive employment effects.

Finally, the evaluation has demonstrated the potential of the counterfactual evaluation approach. The methods and their use could significantly expand our knowledge of the possibilities and limits of (direct) support to enterprise and firm-level R&D. The usefulness of the approach is likely as long as there is good data for both treated and non-treated firms. But the current work has also shown that obtaining these data can be difficult. To perform counterfactual evaluation it seems therefore necessary to set up regional or national data samples that contain the relevant data. The best way to do this would be by using scientific knowledge from the beginning and before a programme or measure is implemented.

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1

INTRODUCTION

Regular and rigorous evaluation is one the EU Structural Funds' key principles. Evaluations are important instruments to inform national and regional authorities, the general public, the European Parliament and other stakeholders about the outcomes of Cohesion Policy. Thus, over successive programming periods, the various programmes under the Structural Funds were evaluated in order to assess their impact on economic and social cohesion and to identify the added value for the Community. Results and conclusions of evaluations should help to improve the effectiveness and efficiency of programmes and provide lessons for the future.

Currently the European Commission, Directorate-General for Regional Policy is undertaking a large-scale ex post evaluation of Cohesion Policy programmes financed by the European Regional Development Fund (ERDF) between 2000 and 2006. The evaluation results will be valuable for the policy review of the EU budget and for the discussion of future Cohesion Policy after 2013. The overall evaluation is implemented by a series of eleven Work packages characterised by a broad range of methodological approaches. Most of these work packages focus on specific topics such as globalisation, demographic change and gender, or rural development. However, some of these work packages are intended to give a comprehensive picture about impacts of certain projects and programmes such as transport or environment infrastructure projects, or to consider the overall macroeconomic effects of the Objective 1 programmes.

Promoting competitiveness, innovation and research is among the key priorities of the Structural Funds, as well as being at the very core of the Lisbon strategy. Thus, the Commission has launched within Work Package 6 studies in the ex-post analysis of the period from 2000 to 2006 to assess the impact of direct and indirect support on enterprise development and performance:[1]

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1 Concering enterprise assistance we are following a typology of instruments that distinguishes between direct and indirect support, as it was made in Work package 6a, see http://ec.europa.eu/regional_policy/sources/docgener/evaluation/expost2006/wp6_en.htm. *Direct support* consists of financial support to a firm in the form of financial contributions, in one of the three main forms:

a) non-repayable grants (one-time payments with no further financial obligations
b) repayable loans (including 'financial engineering' for additional loan resources)
c) equity-based instruments (i.e. acquiring a share in the capital value of the enter-prise in return for an injection of investment)

Indirect support consists of non-financial support to firms, i.e. access to collective or third party facilities which are provided for a number of firms, for example:

- Work Package 6a - a general assessment of enterprise and innovation. The work included a survey of enterprise and innovation from both national and EU sources by Member State.
- Work package 6b deals with the largest 30 programmes for enterprise support. It includes a review of programme data on output, results and impacts as well as comparing this to changes in regional context indicators.
- Work package 6c - the current study – deals with the impact of *direct* enterprise support for investment and R&D at the firm level and tries to identify the impact using counterfactual impact analysis.

Whereas all three Work packages aim to asses the impact of ERDF enterprise assistance between 2000 and 2006, there are some differences in their methodological approaches and spatial coverage: Work package 6a is aimed at giving a comprehensive assessment of enterprise support in all Member States using qualitative and descriptive methods. The main focus is on in-depth case studies in selected Objective 1 and Objective 2 programme areas are in the centre of this evaluation study. Work package 6b instead relies on quantitative, mainly descripitve methods and is of a broader scope with respect to the number of operational programmes included in the evaluation. Within Workpackage 6b the 30 biggest spending programmes realised between 2000 and 2006 are evaluated by an analysis of programme data concerning output, results and impacts.

This current study completes the picture provided by the qualitative and quantitative approaches in Work packages 6a and 6b. It can be regarded as a "complement" of both studies:

- On the one hand, the investigation is laid out as a regional case study and designed to evaluate the effectiveness and efficiency of direct grants to firms under the six Operational Programmes initiated by the ERDF in East Germany.[2] The study is based upon enterprise survey data, namely the IAB Establishment Panel.
- On the other hand the study uses a quantitative methodology, by carrying out a control group and counterfactual impact analysis results. The econometric work applies various advanced techniques such as matching or difference-in-difference estimation to the enterprise survey data.

The main objective of this study is to deliver empirical results on the effects of direct investment and R&D support on firm's target variables such as investment, R&D expenditures and employment. Our analysis takes into account the regional context and the policy environment, including other measures and programmes of enterprise assistance available in East

a) services providing information, management advice, consultancy, business, financial advice
b) intangible mechanisms such as technology transfer, knowledge transfer, collaboration, participation in partnerships and networks. These may be made available through regional innovation systems, clusters or poles of excellence
c) tangible 'public goods', such as shared infrastructures and buildings, including business incubators. These may be made available through regional innovation systems, clusters or poles of excellence.

2 The 6 ERDF Operational Programmes concerned are Brandenburg, East Berlin, Mecklenburg-Western Pomerania, Saxony, Saxony-Anhalt and Thuringia.

Germany as well such as investment allowances, interest-reduced loans, public guarantees and different forms of indirect support.

The general structure of the study is as follows. The next section contains a survey of the empirical evidence of the impacts of direct enterprise support based on an extensive literature analysis. After that we will give a short overview of the financial enterprise support schemes in East Germany. Section 4 and Section 5 are then the main building Chapters of the study. On the basis of micro data from two business surveys, we use various empirical methods in order to assess the impact of direct financial support instruments on East German enterprises. These two surveys are the IAB Establishment Panel covering enterprise data from 1996 to 2007 and the one-time GEFRA business survey for Thuringia in 2004. The IAB Establishment Panel is used to assess the impacts of direct investment grants on firm investment behaviour, whereas the effects of R&D grants on R&D activities of enterprises are analysed on the basis of the GEFRA business survey. In Chapter 6 we summarise the results from interviews performed with Programme managers and responsible persons from the Managing Authorities of the ERDF concerning their assessment of the empirical results. The last Chapter summarises our results and draws some policy conclusions. The appendices contain a short description of the methods[3] and the results as well as detailed tables from the

3 Readers which are interested in more methodological details are refererred to the update of EVALSED (2009): http://ec.europa.eu/regional_policy/sources/docgener/evaluation/evalsed/sourcebooks/method_techniques/counterfactual_impact_evaluation/index_en.htm

2

REVIEW OF THE LITERATURE

2.1 INTRODUCTION

In this Chapter we present a review of existing firm level studies about the effects of enterprise support in the area of investment and R&D activity. This brief survey provides valuable insights which underlie our own methodological approach and enable us to judge our own results. Along with the survey detailed tables are given in the appendix in which the existing literature is condensed and subdivided along the following categories:

- author, year of publication
- source of data / area (regional context)
- sample period, number of observations.
- estimated specification
- empirical method(s) used for the quantitative analysis
- results / treatment effect

The first section shows the results for direct investment subsidies, whereas the second summarises the empirical results for R&D support. The concluding section summarises the results for both areas of intervention.

2.2 DIRECT INVESTMENT SUBSIDIES

Subsidies to induce additional investment and employment to the regions take different forms. Some are non-repayable, such as one-off support grants, tax and interest reductions. Others are repayable, such as low interest loans and equity. The present section reviews the impact of these investment incentives on key variables such as investment, employment and productivity based on micro-level investigations.

The use of economic theory varies considerably among the various studies based on firm level data. In general, those micro approaches, which either explicit use of a fully theory-based model of the firm's rational decision making process with respect to production and demand for factors, or at least employ a somewhat eclectic (ad-hoc) approach to the firm level investment function, show the closest connection to the macro studies based on national or regional data. As an example for closely theory-based studies see Harris and Trainor 2004 for estimating firm level production functions, as well as Devereux et al. 2006 for an application of the location choice model.

On the other hand, with the increasing availability of firm level data, statistical-theory-driven estimation strategies has also been developed which typically centre around statistical discrimination measures between treated and non-treated firms, such as the 'difference in difference' approach or binary choice modelling approaches based on survey data with loose ties to economic theory.

Both strands of the literature made significant contributions to our knowledge of how investment subsidies work in the "real" economy.

Economic-theory-driven models

Studies rooted in the tradition of plant production function estimation usually employ Cobb-Douglas or CES type models to measure the effect of public policies on total factor productivity (TFP) growth. For example, in Harris and Trainor (2004) the authors estimate a linear static production function model with a set of explanatory variables, time variables to control for business cycle effects and a binary dummy variable for 'Selective Financial Assistance' (SFA) capturing different capital subsidies. From this baseline specification, SFA receiving plants are also allowed to interact with explanatory variables in the model through various ways such as: i) composite dummy effects (multiplication of the SFA-dummy with employment, capital stock, etc.) to investigate whether plants which received SFA might operate using different technologies compared to non-assisted plants, ii) interaction terms between SFA-assistance and plant age and ownership structure, as well as iii) disaggregation of SFA into capital grants and all further SFA assistance (plus application of i) and ii) to disaggregated effect). The model is estimated for Northern Ireland and accounts for possible endogeneity of capital, employment, intermediate inputs and SFA. The results show that manufacturing real gross output would have been up to 10% per year lower if SFA had not been given The authors also find that capital grants are more likely to have a positive impact on TFP compared with other forms of grant-aid and that the impact of SFA aid was stronger towards the end of the sample period from 1990 – 1998.

A further strand of the recent empirical literature employs the location choice model to study the effect of investment subsidies on the economic performance of assisted firms (see e.g. Head et al., 2004, Devereux et al., 2006). These contributions typically link the above question with the role of agglomeration forces in the location decision of (new) firms and typically revolve around a profit maximizing firm's production decision givn certain demand and cost equations. The latter in turn includes measures for wages and cost of capital as factor prices, which are influenced by wage and capital subsidy rates. Together with a proxy for agglomeration effects to capture different types of similarities among firms (industry, national and group affiliation) these policy variables are included in an empirical model estimating the firm's conditional location choice as a probability function for an investor to invest in a specific region conditional on a set of further market and firm related characteristics such as market size and labour costs. The results of Head et al. (2004) for the US show that next to agglomeration forces also investment-aid policies significantly increase the investment inflow to the respective state. Further, the timing for investment support schemes may be of importance. They show that with endogenous agglomeration effects, a state that adopts pro-investment policies first can retain an advantage even after the policy change is emulated by rivals. Similar results for the UK are found in Devereux et al. (2006).

Generally, empirical studies in this tradtion show positive effects on investment and productivity, whereas the effect on employment is less clear.

Statistical-theory-driven models

Turning to predominantly statistical-theory driven counterfactual impact analysis, different approaches can be used. These range for easy to install parametric estimation procedures to complex parametric and non-parametric methods.

One approach is the difference-in-differences estimation which employs treatment effect estimation to investigate the impact of private sector investment aid (the treatment) on funded firms (the treated group) relative to individuals that are not funded (the control group). Measuring the change in response of each group (typically labelled the 'group difference') over a period of time, the difference between these responses is the 'difference-in-difference' estimate of the impact of the private investment aid programme.[4]

Another class of counterfactual evaluation utilizes binary choice approaches – probit or logit regressions – in order to identify the additional investment effects of funding programmes. Binary choice models for analysing investment incentives are used in a first step by both parametric selection models and non-parametric matching approaches.

Selection models typically centre on an ad-hoc investment function augmented by a correction factor, the so called Mills-Ratio to account for a possible selection bias. Problems of endogeneity and sample selection due to unobservables are also considered by the more traditional instrumental variable estimation in which investment and policy variables are jointly determined by exogenuous economic forces.

In recent counterfactual evaluation of investment subsidies the matching approach has received increasing attention as an alternative to the classic parametric regression approaches. The main advantage of this non-parametric estimation method comes from the fact that the matching procedure does not rest on restrictive assumptions about the functional form and the distribution properties of the error terms.

In the following we give a brief summary of previous empirical work which has been done in this field of counterfactual analysis. The summary is structured by the outcome variables which are used in the research papers, starting with the impact of subsidies on investments.

For East Germany, Ragnitz (2003), Stierwald and Wiemers (2003), and Lehmann and Stierwald (2004) investigate the effect of the national investment support scheme (GRW „Verbesserung der regionalen Wirtschaftsstruktur") on investment intensity of firms. Analysing assisted and non-assisted firms in East Germany using the Heckman selection model, Ragnitz (2003) estimates that capital subsidies have a substantial effect on the investment level (per employee) of assisted firms, which is about three times higher than the corresponding level for non-assisted firms. However, the results vary strongly by industry, as well as by firm characteristics

4 At the micro level the concept of treated and non-treated individuals seems to be more accurate than at the macro level (which compares funded and non-funded areas). An example for this latter approach for Italian regions is Bondonio and Greenbaum (2004). Both authors set up a parametric difference in difference specification to estimate the impact of business incentives offered in the EU Objective 2 areas in northern and central Italy. Their main empirical result is that investment incentives are found to be most effective in areas that faced the least pre-intervention employment loss.

such as age of the firm, ownership structure, and international orientation of sales. The studies also shows deadweight effects of the funding (but which are estimated to be considerably lower compared to other results for East Germany) of about one third of total investment.

Stierwald and Wiemers (2003) use a slightly modified econometric specification in line with Ragnitz (2003). Their results suggest that investment support schemes have a positive influence on investment of assisted firms. However, the results also show deadweight effects of about 35% (investment per employee) and 28% (investment per turnover unit) respectively. Finally, Lehmann and Stierwald (2004) analyse the influence of the Joint Task programme on the investment behaviour of East German enterprises using a matching procedure. Their estimates suggest that investment support has a significant positive influence on the amount of investments: investment subsidies cause a more than 100% increase in investments by the assisted firms.

Atzeni and Carboni (2006) and Bronzini et al. (2008) also investigate the effect of investment subsidies on investments of Italian firms. Both studies suggest that subsidies have in total a positive effect on private investments. By using a difference-in-difference estimator, Bérges (2009) come up with the result that investment supporting schemes cause additional investments by the assisted firms; however these investments did not trigger faster growth.

The work of Bergström (1998) uses OLS in order to investigate the effect of subsidies on productivity at the firm level for Swedish companies. The results suggest that subsidization is positively correlated with growth of value added. Moreover, the study shows that in the first year after having received incentives, productivity at the firm level increases. However, after the first year the results show that additional subsidies worsen total factor productivity (TFP) growth, which may signal that in the long run subsidization can even lead to less efficient enterprises.

Pellegrini and Centra (2006) use a conditional difference-in-difference (CDID) estimator as a combination of a standard difference-in-difference estimator and the (single index) matching estimator to estimate the impact of subsidies on indicators like turnover, employment. These outcome variables are then modelled as a function of selected covariates in a panel setting with individual and time-effects and a dummy for being assisted or not. Their results for Italy indicate that growth in turnover, employment and fixed assets has been more dynamic in subsidised firms and that such firms have invested more as well as increased the number of employees stronger than firms in the control group. The analysis also shows a trade-off between employment, turnover and labour productivity: The higher the reduction in the user capital cost, the higher is the additional investment, which leads to production and employment growth, but also lowers the firm's labour productivity growth.

Duch et al. (2007) analyse the effect of subsidization on firm performance in Spain by using a propensity score model (PS). Their results show that assisted firms performed a higher value added growth on average than non-assisted firms. Furthermore, the results point to the fact that firms with low value added grow faster than those which already reached a high level of value added. The study also presents evidence that diversified, central, and exporting firms constitute higher growth rates for value added. Finally, the study does not find significant growth differences between the high technology manufacturing and service sectors. In general their work indicates that public subsidies have a positive and significant impact on the growth of value added.

Using PS in a recent study Gadd et al. (2009) estimate the effect of subsidization on firm performance. According to their estimation results for the probit equation, both firm characteristics and regional context matter for the probability of firms of receiving public support. After performing the matching algorithm the authors find a significant positive difference in employment growth indicating that firms which received the investment subsidy increased their number of employees stronger than their matched firms in the control group. However, profitability, measured as differences in return on total assets, does not differ significantly between supported and non-supported firms. According to Gadd et al. this result is in line with previous results for Sweden which suggests that investment subsidies had some effect on employment, but not on return on total assets.

Starting from a different perspective, Haapanen et al. (2005) use a probit model to study conditions under which the receipt of an investment subsidy is a necessary requirement for investments using micro level data from Finland. The dependent variable of their model is the necessity of investment subsidy specified as a binary variable with the following outcomes: 1 = Investment subsidy is a necessary requirement for the project implementation, 0 = otherwise. The results show that the necessity of investment subsidy varies significantly between investment projects:

- investment subsidies are much more crucial for distant regions compared to central locations;
- investment subsidies are less important for firms with large overall turnover;
- and necessity of investment subsidy increases significantly with the size of the investment project and intensity of aid.

Also for the case of Finland, studies of Tokila et al. (2007), and Tokila and Haapanen (2008, Institute for Small Business & Entrepreneurship (isbe)) estimate the effect of government grants on deadweight spending. The results of Tokila et al. (2007) suggest that the probability of zero deadweight is lower in lagging and peripheral regions. Furthermore, the deadweight effect is smaller for new firms than for old ones, and declines with the size of the investment project, i.e. project size rather than firm size matters. The industry dummy variables imply that deadweight effects differ by industry. The analysis suggests that deadweight spending is smaller for projects in wood manufacturing, transport, storage, communication and financial intermediation.

Tokila and Haapanen (2008) analyse that deadweight spending might be smaller in projects executed by recently set-up firms. Moreover, deadweight is smaller in regions with lower economic development. Controlling for industry differences the results suggest that deadweight tends to be high in real estate, renting and business activities, and small in wood industry.

2.3 R&D AND INNOVATION SUBSIDIES

In this section we turn to the question how public R&D intervention affect private R&D and innovation activities (measured by R&D related outcomes such as patents, new products or new production processes). The central issue here is whether public support for private R&D shows complementarities or if public R&D merely substitutes for private R&D. In the latter case no additional effects would emerge. However, it should be borne in mind that even if it

is possible to establish a positive relationship between public support for private R&D and innovation this does not guarantee that there is a positive impact on economic performance. Of course, it is only if public R&D subsidies succeed in increasing private sector R&D and innovation that political target variables such as output, employment, or labour productivity could be enhanced.

Empirical research concerning the impact of public R&D support can broadly be distinguished between macroeconometric studies looking at the effects of R&D subsidies on national or regional aggregates on the one hand and firm level analyses quantifying the effects on R&D or innovation activities at the firm level on the other hand. We will concentrate our briefly review on this second strand of the literature. The crucial advantage of investigations at the firm level compared to studies at the macro-level is their ability to identify industry and firm heterogeneity. Industries differ in their technological opportunities, market structures and possibilities to internalise returns from innovation. For firms one can expect important differences in innovative activities depending on the firm size, international orientation and general business strategy.

Studies at the firm level typically concentrate on one country and sometimes on a specific industry within a country. The dependent variable is usually private R&D expenditure or R&D intensity (defined as R&D expenditure per employee or value added) at the firm level and the question of interest is whether public R&D subsidies succeed in raising the level of private R&D expenditure. Some studies also use more innovation related measures (innovativeness, patent numbers) as dependent variable. Due to their ability to identify heterogeneity on both the industry and firm level, microeconomic studies are rather demanding in terms of data quality and availability. They require not only information about the receipt of public R&D subsidies at the firm level but also about a wide range of firm characteristics.

A range of analytical tools has been applied to guarantee an appropriate identification strategy from a methodological perspective. The methods start from simple OLS in a cross-section or panel data setting to more sophisticated IV regression or Heckman selection models to correctly account for endogeneity and/or sample selection bias in the specified equation or system of equations. In addition, as a rather novel alternative to standard parametric estimation, recently non-parametric matching estimators have gained attention.

Looking at the large bulk of empirical studies in the field of public R&D support, in the following we account for results in an international context as well as the German national and regional level:

At the international level Busom (2000) and Gonzalez et al. (2005), among others, study the relationship between public subsidies and private R&D expenditures of Spanish firms and find a positive effect of subsidies on private R&D expenditure. Busom (2000) for instance applies a two-stage economic treatment model by first estimating a probit-model on the probability of participation in a program and then regressing the R&D activity on several covariates, including a selection term for the probability to receive public funding (the propensity score). For participants and non-participants the propensity score is estimated separately and the difference in the R&D expenditure between both groups is assumed to be the result of the subsidy. For most of the firms R&D subsidies leads to higher private R&D expenditure.

Lach (2000) investigates the effects of R&D subsidies granted by the Israeli Ministry of Industry and Trade on local manufacturing firms. He applies different estimators, such as the

before–after–estimator, the difference–in–difference estimator and different dynamic panel data models. Although Lach finds heterogenous results from different models applied, he finally concludes that subsidies do not completely crowd out company financed R&D expenditure. His long–run elasticity with respect to R&D subsidies is 0.22. Likewise applying a matching estimator Duguet (2003), for French firms reports a similar positive relationship with only partial crowding-out effects.

However, for Scandinavian countries the results are rather mixed: While Clausen (2007) for Norway also established a positive relationship between public R&D support and private R&D activity via increasing research expenditure on average. Taking a disaggregated perspective the same author finds that complementarities were particularly in order for "far from the market" subsidies with high technological uncertainty, while "close to the market" subsidies were found to crowd-out private R&D spending. Kaiser (2004) using Danish micro data found neither evidence for crowding-in nor crowding-out effects on private R&D with statistically insignificant and very small parameter estimates (except for the service sector).

Wallsten (2000), using US firm data, considers a simultaneous equation model to pay attention to the possible interdependence between public R&D funding and R&D expenditure. He investigates the Small Business Innovation Research (SBIR) program and concludes that it is necessary to account for possible endogeneity of federal R&D grants. According to the results of the study SBIR awards crowd out firm–financed R&D spending dollar for dollar (full crowding–out). The subsidies do neither have an effect on R&D activities nor on employment. However, he mentions another possible and important impact of public funding: “[...] while the grants did not allow firms to increase R&D activity, they instead allowed firms to continue their R&D at a constant level rather than cutting back.” (Wallsten, 2000, p. 98).

There has also been a broad body of literature with respect to the German case (see e.g. Licht and Stadler (2003), Almus and Czarnitzki (2003), Czarnitzki and Licht (2006), Aerts and Schmidt (2006) among others). Almost exclusively all studies find positive effects of public grants to stimulate private sector R&D activity - both for aggregate economy wide aggregates as well as explicit studies at the manufacturing and service sector industry-level (for the latter see e.g. Czarnitzki and Fier (2002)). Authors like Czarnitzki and Hussinger (2004) also link the obtained results for enhanced private sector R&D activity obtained through public grants by estimating a knowledge production function with innovation output as dependent variable and input-oriented R&D activities (such as R&D expenditures or intensities) as relevant factor inputs. The empirical results in this two-step approach indicate that there is indeed a positive transmission channel from public support over private sector R&D activity to private sector innovation output (e.g. patenting).

Among the few references who deal with regionalized studies for Germany, Fier (2002), Almus and Czarnitzki (2003) as well as Czarnitzki and Licht (2006) explicitly look at the results for a subsample of East German firms. All studies again find that public R&D support has a significant positive effect on private sector R&D intensity. Using nonparametric matching estimation Almus and Czarnitzki report an increase in the innovation activity of East German firms receiving public fundings of about 4 percentage points on average relative to the non-subsidized control group. Czarnitzki and Licht (2006) additionally compare the degree of additionality in public R&D grants with regard to private sector innovation input between the East and West German economy in their non-parametric matching approach. The authors find that input additionality has been more pronounced in East Germany for the transition period until the year 2000 compared to Western Germany.

Though the results for (East) Germany seem to be much in line with the international evidence, one potential drawback of all studies so far is that they rely without exception on the same data set - the Mannheim Innovation Panel (MIP) as the German part of the Common Innovation Survey (CIS).[5] One of the central aims of our study is to check whether the obtained supportive results for Germany may be potentially sensitive to a kind of "data bias".[6]

2.4 CONCLUSIONS

This brief survey contains an overview of the empirical evidence about the effectiveness of investment subsidies and R&D incentive programmes to the private sector as a tool of regional policy. Throughout we focused on micro level studies. All of the work reviewed tried to assess the impact of direct financial support for enterprises rather than indirect support through advice, information, etc. There have been many attempts to measure the impact of government support for investment, R&D and innovation at the micro level. In total, this is a very challenging task because of the many factors involved and, due to the fundamental evaluation problem, the general lack of data available for the outcomes in case of the counterfactual situation.

One advantage of micro data is that the policy effect induced in the first round can be measured more accurately than with macro data. However, a disadvantage of these models is that their connection to underlying theoretical concepts of the firm's profit maximisation process is rather loose – despite the fact that various empirical specifications for firm level production, cost and investment functions are estimated. Another disadvantage concerns the missing connection to the rest of the economy. Each firm's response to public aid is estimated in isolation. Therefore no conclusion can be drawn about the overall impact of investment or R&D subsidies since displacement effects cannot be taken into account. Nevertheless, positive effects at the firm level on investment and employment are a necessary, but not sufficient precondition for positive overall impacts at the level of the economy.

Taken together, the results suggest considerable variation in the effects of public support. This reflects the different circumstances between countries, regions, sectors and firms, differences in the design of local policy and delivery, and, of course, differences in the quality of data and analytical methods used by the various investigations. As a very broad generalisation, the firm level counterfactual impact analysis suggests that government support for investment, R&D and innovation has a positive effect on the immediate target variables investment and R&D activity, but the impact on employment and output is less certain, because pftem an increase in productivity or total factor productivity is observed. The respective tables in the appendix summarise selected contributions in some detail both from a methodological as well as an empirical point of view. They clearly show that the empirical findings for both intervention areas (private investment and R&D) are specific to the country

5 The MIP has been raised for the manufacturing sectors since 1993, or service sectors since 1995 (Janz, Ebling, Gottschalk and Niggemann 2001). In some cases the MIP is harmonized with patent information from the German Patent Office (see e.g. Czarnitzki & Licht, 2006, as well as Aerts & Schmidt, 2006).

6 For instance, one possible drawback of the MIP is that it only covers firms with at least five employees (Janz, Ebling, Gottschalk and Niggemann 2001).

and region and to the time period. Furthermore, in reporting and comparing the results of the various firm level studies differences in data and methodology should always be kept in mind.

Direct investment subsidies

In general, the estimation results show a tendency for a positive impact of investment subsidies at the firm level. The evaluations at the firm level typically find a positive impact of investment subsidies on investment behaviour and growth of value added for assisted firms, with less clear evidence for positive employment effects. The majority of the studies shows positive productivity effects, although some studies suggest that subsidization tend to decrease firm's productivity. Finally, the few investigations on deadweight signal that subsidization can lead to inefficient spending and that there is no complete deadweight.

Direct R&D subsidies

Briefly summarizing the literature on the relationship between public and private funding of R&D – the input additionality – the majority of studies find that no complete crowding out takes place. Due to data restrictions, some analyses cannot differentiate between 'no complete crowding out' and 'complementarity'. But, the studies which can differentiate, many find that public and private R&D expenditure are complementary. The results suggest that there are positive effects of R&D subsidies on R&D and innovation activity.

3

FINANCIAL SUPPORT SCHEMES IN EAST GERMANY

3.1 OVERVIEW OF THE FINANCIAL SUPPORT SCHEMES

This Chapter is about the subsidy scheme for the direct support of the East German economy as it was implemented immediately after the fall of the Berlin Wall and has continued to exist, more ore less unchanged, up to and beyond the funding period of 2000-2006 of the ERDF. The focus is to give a brief historical survey and a quantitative empirical description of the funding, whereas in the appendix a rather general technical survey of the various programmes for the direct support of East German enterprises is given. The aim of this Chapter is to illustrate, on the one hand, the amount and the coverage of the – with regard to the ERDF – funding by the Federal Government and the Federal States. On the other hand, this Chapter highlights the financial importance of the ERDF funds in relation to the overall funding areas to which the ERDF was primarily applied. The results demonstrate the great importance of direct enterprise support programmes for the economic development of the new East German states and also signal that the ERDF played a significant role in the respective support schemes.

3.2 SUPPORT STRATEGY AND POLICY FOR "RECONSTRUCTION EAST"

Already in the preliminary stages of the German economic and monetary union, there were initial approaches to specific economic support schemes for the East German states. These consisted of a number of special tax rules for East German businesses, some of them were enacted by the former GDR administration, while others were introdueced by the West German Federal Government to abolish obstacles for investments of West German enterprises in East Germany. At the same time, the Federal Government launched the first specific credit and guarantee programmes for East German businesses. With the creation of a monetary, economic and social union a tax-free bonus for investments made in the GDR (“investment allowance”) was introduced in May 1991. This introduced for the first time a higher incentive rates in favour of East Germany.

For most of the funding measures, which did not comply with GDR law at that time, a transitional rule was included in the Unification Treaty in order to extend their validity until the end of 1991. It was also determined in the Unification Treaty that support programmes for the new East German states should be developed. Special attention was given to the Joint Task Programme “Improvement of Regional Economic Development” (GRW) which supports investment via direct subsidies and was, apart from tax reduction, subsequently the main measure to promote enterprise investment.

After the introduction of the economic and monetary union, the decline of the GDR economy accelerated. Within a few months, there was a serious drop in industrial production, as well

as a rising unemployment. Against this background, the Federal Government realized that further financial support was necessary to assist economic development in East Germany. The Federal Ministry of Economics published a strategy paper, entitled “Economic Recovery East”, were a financial boost was announced using a multitude of support measures which, for the most part, were essentially already in use.[7]

The introduction of the programme “Economic Recovery East” can be regarded as the completion of the first phase of the specific economic aid schemes for the East German states. Since spring 1991, a host of specific measures was available, such as tax concessions and direct financial support. These measures were implemented within the scope of the already existing bodies of regulations, programmes, or instruments. In general, eligibility requirements were simply extended to include the new states and substantial additional funds were made available. In the course of the realization, the Federal Government had access to established state aid and support organizations, such as the Kreditanstalt für Wiederaufbau (KfW), the European Regional Programme (ERP) special assets, or the Deutsche Ausgleichsbank (DtA). In its main features, i.e. with respect to its instruments and thematic orientation, the structure of the support scheme largely remained constant in the following years. However, with regard to the amount of the allocated funds and the detailed regulations, changes were made continuously in the practical implementation of the policy (See Deutsche Bundesbank, 1995, p. 51; Paque, 2009, p. 92f.).

Apart from the development of the infrastructure and the comprehensive use of labour-market policies, support of investment, R&D, and innovations in East Germany was one focal point from the beginning. Furthermore, additional non-investment-related measures in the areas of sales and export promotion (e.g. trade fair, counselling, management training programmes, and export credits) were funded. However, the financial importance of these additional measures remained marginal. Bearing this in mind, the following two sections concentrate on the direct support of investment and R&D activity.

3.3 INDUSTRIAL INVESTMENT INCENTIVES

The industrial production facilities were drastically reduced in the new German states right after the reunification. Improvement in the productivity of East German industry, in order to approach the standard of West German industry, required a step-by-step development of competitive capital stock, as well as capital deepening. The direct support of enterprise investments played a significant role in the macroeconomic state aid strategy for the new states. Investment support was implemented using the following three instruments:

- tax reductions, granted in form of the investment allowances and special (higher) depreciation rates;
- investment grants, direct payments within the framework of the Joint Task Programme (GRW); and,
- credit and guarantee programmes that had been launched by special governmental institutions and state aid banks, such as the ERP, the KfW or the DtA.

7 See Annual Report, 1994, p. 154

3.3.1 TAX REDUCTIONS: INVESTMENT ALLOWANCES AND SPECIAL DEPRECIATIONS

Through the introduction of tax reduction measures, the Federal Government tried to boost private investments in the new German states already at an early stage. A feature of the main tax redurction measures was the granting of investment allowances, as well as special depreciation regimes, which had been implemented as a package deal in the so-called '1991 Tax Amendment Act'. [8] In the Investment Subsidy Act, a 12% non-refundable allowance was granted on purchase and production costs of flexible assets.[9] In addition, within the first five years, a 50% special depreciation could be claimed, under the Development Area Act, for the purchase and production of flexible and fixed assets and also for expansions and extensions to property assets.[10] East German enterprises had a legal entitlement to these investment subsidies and special depreciations.

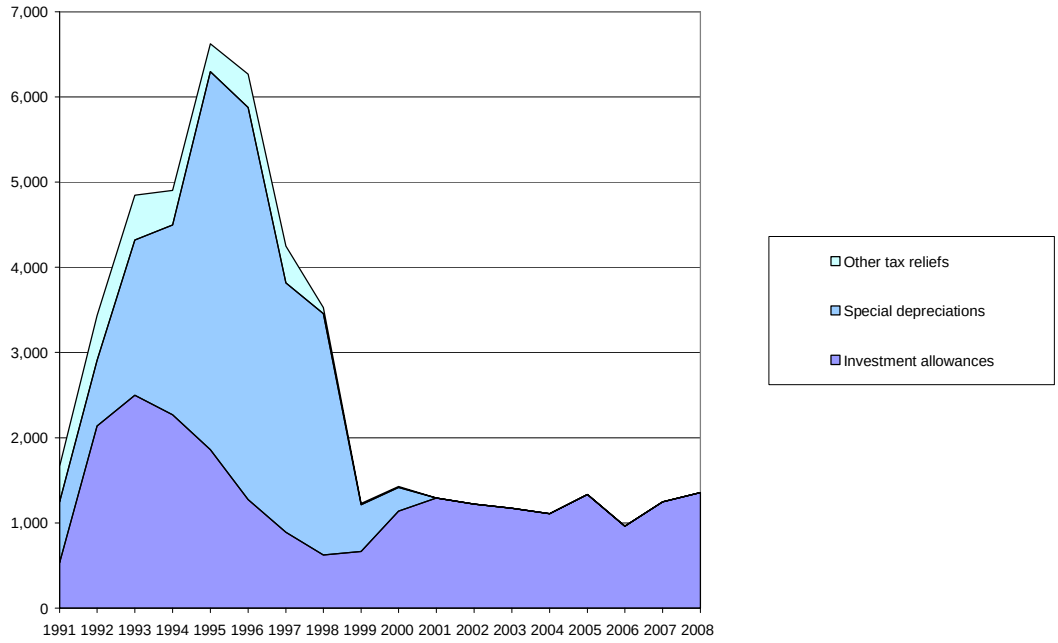
Investment allowances and special depreciation rates were initially planned for a limited period of time. However, they were extended several times and included some relevant modifications. The special depreciation rates were slightly reduced in 1996 and completely abolished in 1998. The investment allowance saw various amendments, with subsequent increases or decreases almost at a bi-annual rate. In addition, there was a gradual concentration on enterprises from manufacturing industries and production-related services. The investment allowance was amended in 2009 once again and ends in 2013.

8 "Act to promote investment and job creation in the acceding territories and to change fiscal and other laws (1991 Tax Amendment Act)" of 24.06.1991 (Federal Law Gazette (BGBL) 1991, I, p. 1322 ff.). In addition to the investment subsidies and the special depreciations, the Tax Amendment Act freed East German enterprises from paying trade capital tax. This exemption was in force until the trade capital tax was abolished in 1998.

9 The 12% supplementary allowance applied to commodities that had been purchased or produced before July 1992. For commodities purchased or produced at a later date (up to 1995), a supplementary allowance of 8% had been scheduled. The idea was that, with this chronological scale of investment subsidies, potential investors would move up their planned investments, thus contributing to a quicker stabilization of the labour market.

10 It was originally planned that the special depreciations should only be granted for a limited period of time, i.e. for commodities that had been purchased or produced between 1991 and 1994.

Figure 3.3.1:
Overall tax reductions (Federation, States, Municipalities) in favour of East Germany in million €, 1991-2008.



Source: Current reports on subsidies, BMF, 2009. Calculations made by GEFRA.

Figure 3.3.1 shows the course of tax reductions in the period 1991-2008. Total tax reductions through of investment allowances amounted to €23.59 billion, according to the calculations of the Federal Ministry of Finance (BMF). On average, the yearly revenue loss through investment allowances is about €1.31 million. For the 2000-2006 ERDF funding period, the revenue loss amounted to overall €8.23 billion or an annual average of €1.18 billion. According to the BMF, the tax reductions through special depreciation amounted to an overall sum of €21.15 billion for the period 1991–1998. Miscellaneous other tax reduction schems introduced another loss of revenue of €3.13 billion. However, since special depreciations and miscellaneous tax relief were abolished in 1998 they are not relevant for the analysis of the funding period 2000-2006.[11]

11 For the year 2000, the BMF quantified a tax relief of 0.29 billion €. When evaluating the tax losses by means of special depreciations, it has to be considered that, according to the calculating methods applied by the BMF, the deficiency in tax receipts from depreciation relief is presented in an inflated manner. As a matter of fact, deficiencies in tax receipts have only a time-lag effect on the tax burden so that, with unchanged tax regulations and a constant realization of profits, there is a positive impact on the interest rate effect only.

3.3.2 FINANCIAL ASSISTANCE: INVESTMENT GRANTS WITHIN THE FRAMEWORK OF THE GERMAN JOINT TASK PROGRAMME (GRW))

With the Unification Treaty, the law for the Joint Task Programme (GRW) was also transferred to the new German states. Along with the statutory regulations of the Unification Treaty and the 20th framework plan, all the new states in East Germany were classified as structurally-weak regions. In addition, they could grant substantially higher incentive rates for investment projects than the structurally-weak regions of West Germany.[12] The considerable preferential lead in favour of the new states resulted in a fundamental splitting of unified Germany, i.e. into a structurally-strong West German Greater Region and a structurally-weak East German Greater Region. Regional economic disparities in the East German Greater Region were secondary. As a direct consequence, the Joint Task Programme (GRW) was designated tasks that far exceeded the original assignment of creating an economic balance between structurally-weak and structurally-strong regions. Actually, the Joint Task Programme (GRW) became one of the central instruments in supporting the economic transformation in East Germany.

With the 20th framework plan, the incentive rates for industrial investments were set at 23% for new companies or branches, 20% for investments allocated in expansions, and 15% for investments made in re-organizations and rationalizations. Accumulation with other incentive means was available at a rate not exceeding 12%. These regulations remained valid up to the 24th framework plan, when a comprehensive post-reunification re-organization of the incentive regulations was undertaken. As a result, the upper limit of the incentive rates was raised to 35% of the incentive-eligible investments. In accordance with the EU subsidy framework, a 15% investment preference was introduced for small and medium-sized enterprises (SMEs). A further relevant addition was the introduction of the flexibility rule into the system of preferences so that maximum incentive rates could be fully exploited with Joint Task Programme (GRW) means or through the accumulation of other subsidies. In addition the managing authorities within the new Länder were allowed to introduce specific incentives for so-called structural “relevant” investment or a higher share of female employees. All these specific regulations had to be done within the upper limits for incentives, generally set to 35 per cent for larger enterprises and 50 per cent for SMEs.

12 20th framework, 1991, p. 4.

Table 3.3.1:
Maximum incentive rates for industrial investments in East Germany, classified according to incentive regions and types of investment within the framework plan

Period	*Incentive rates in:*	*Types of investment* *New foundations*	*(Expansions)*	*Rationalizations/ Reorganizations/ Refurbishments*
1990-1994	*standardized incentive area*	*35%*	*32%*	*27%*
1995-1996	*standardized incentive area*	*35% (50%)*	*35% (50%)*	*35% (50%)*
1997-2006	*incentive area A* *incentive area B*	*35% (50%)* *28% (43%)*	*35% (50%)* *28% (43%)*	*35% (50%)* *28% (43%)*
2007	*standardized incentive area*	*35% (50%)*	*35% (50%)*	*35% (50%)*

Source: Current framework plan. Compilation made by GEFRA.

Note: Figures in parentheses refer to maximum rates for SMEs.

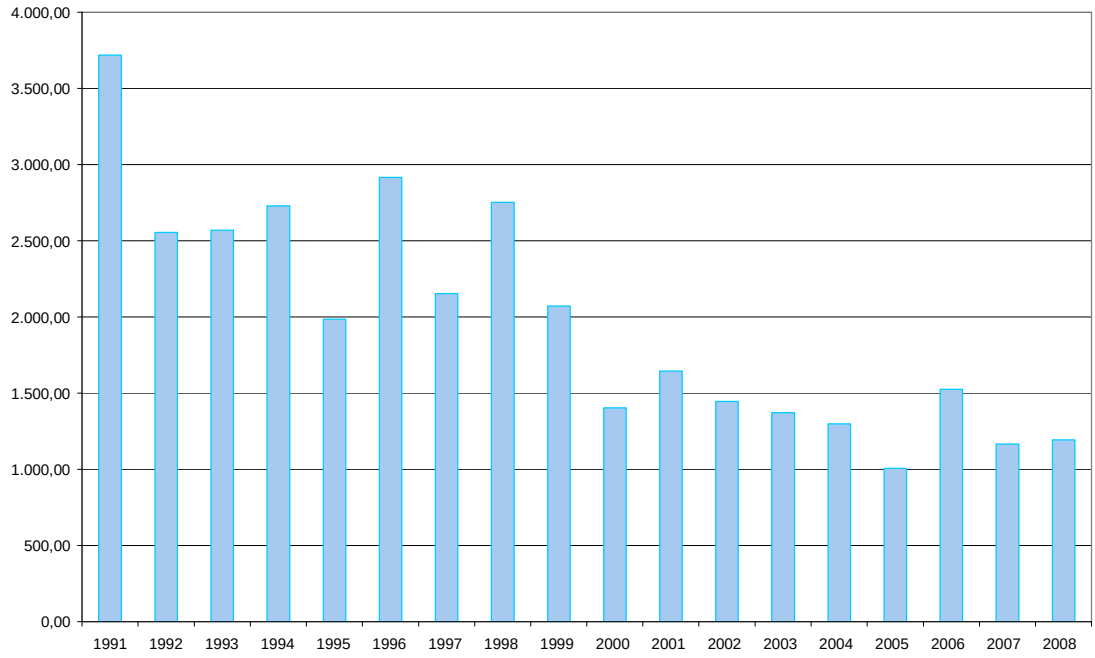
With the 27th framework of the GRW different maximum incentive rates for industrial investments were introduced to support regions in the new states. The rates were connected with the different regional economic problems. The East Geman states were classified into two different areas:[13]

- incentive area A: areas with a distinct lack of development (structurally-weakest East German regions) - 50% for small and medium-sized enterprises (SMEs), 35 % for large enterprises; and,
- incentive area B: areas with particularly severe structural problems (less structurally-weak East German regions) - 43% for small and medium-sized enterprises (SMEs), 28% for large enterprises.

13 One year later, however, this rule was relaxed under the 28th framework plan which included an opening clause dealing with maximum incentive rates for structurally-stronger regions in the new states. Following an application by their state and upon approval by the planning committee, regions that were structurally effective competitively against other similar geographic locations had the opportunity of 35% to 50% funding of the investment costs eligible for grants (incentive area B), with the exception of the city of Berlin.

The differentiation between A and B regions was abolished in the 35th framework plan. From 2007 onwards, uniform incentive rates were agreed upon for East Germany up to the year 2011. Regions in the new states affected by the so-called 'statistical effect' (Halle, Leipzig, southwest Brandenburg) might see a decrease in the maximum incentive rate (as scheduled within the framework of mandatory examination by the EU Commission) to 20%, 30%, or 40% respectively for small and medium-sized enterprises (SMEs).

Figure 3.3.2:
Investment Grants offered by Joint Task Programme in East Germany in million €, 1991-2008.



Source: Bundesamt für Ausfuhr und Wirtschaft (BAFA), 2009. Calculations made by GEFRA.

Figure 3.3.2 shows the investment grants for enterprises in the years 1991-2008. Financial means of €35.49 billion were provided by the Joint Task Programme (GRW), i.e. a yearly average of €1.97 billion. Since 1991, however, the funding followed a decreasing trend. Until 1999, the annual total of approved investment grants amounted to an average of €2.61 billion. In the 2000-2006 ERDF funding period, it the amount was around €1.38 billion and during the last two years, €1.18 billion.

If the above figures of the Joint Task Programme (GRW) are compared with the results from the monitoring of the ERDF for the period 2000-2006, it becomes apparent how important the ERDF was in the field of investment support for enterprises in the new East German states. The ERDF funds to support investments within the framework of the Joint Task Pro-

gramme (GRW) amounted to €2.59 billion in the years 2000-2006. Their share of the overall subsidies granted by the GRW was more than a quarter, i.e. 27%.

Due to dependence on the "Export Basis Concept" and the selection criteria of the comprehensive body of regulations of the Joint Task Programme (GRW), the manufacturing industry took on a superior role in investment funding for individual enterprises, while the service sector played a minor role. More than three quarters (77%) of the funded investment projects and more than four fifths of total investment (82%) can be attributed to various industrial sectors. The investment and the workplaces promoted using the Join Task Programme (GRW) represent a significant contribution toward the economic achievement of the manufacturing industry in the new states. In the 2000-2006 ERDF funding period with regard to gross value added of the manufacturing industry the share of the subsidized investment was 9.9%, with regard to total fixed asset investment it was 45.4% (see Concerning the new and safeguarded workplaces in the manufacturing industry the monitoring data of the GRW show that due to the subsidized investments during the years 2000-2006 in total 107,000 workplaces were created and 439,000 workplaces were safeguarded. In relative figures, i.e. divided by the number of employees at the beginning of the period, 105 workplaces per 1,000 employees were created and 433 workplaces were safeguarded. Thus, more than half (54%) of the workplaces in the manufacturing industry were subsidized by the GRW during the period 2000-2006. By showing the development of the created and safeguarded worklplaces between 1991 and 2008 (relative to the number of employees in manufacturing industries in the respective year) Figure 3.3.4 signals that until 1995 most of the investments created new workplaces. Thereafter safeguarding jobs dominated.

With reference to the investment grants by the GRW (a total of €6.8 billion) and the number of created workplaces in manufacturing industry (the above mentioned 107,000 workplaces) it is possible to give a rough calculation of "cost per jobs" in the ERDF funding period 2000-2006: the cost per job was approximately €64,000.

The total amount of investment undertaken by supported enterprises was €31.6 billion. Thus, on average the subsidy rate of GRW grants was 21.6%. But note that most of the supported firms received also tax allowances, so the effective subsidy rate was higher (at maximum 35% for large enterprises and 50% for SMEs) and, therefore, also cost per job with regard to all public subsidies. If one assumes a subsidy rate of 40% on average (i.e. a total leverage of 1.5) than the public "cost per job" should have been approximately €118,000.

As previously mentioned, at least every fourth Euro that was used to promote investments by the Joint Task Programme (GRW) could be attributed to the ERDF funds. However, it is meaningless to calculate separate figures of cost per job for ERDF support because of the interlinked way of awarding ERDF and GRW grants. In fact, the granting of investment subsidies from the budgets of the federal government and the states on the one side and the ERDF on the other was virtually connected to each other. All investment projects which fulfill the formal eligibility conditions were promoted with the total available funds from the GRW and ERDF.

Thus, one could assume that the ERDF contributed to the creation of nearly one fourth of the above mentioned figures of created and safeguarded workplaces. One Euro from the ERDF should have had the same impact on the investment decision of enterprises than its counterpart from the GRW. However, a very interesting finding in this case is that the relation of created and safeguarded workplaces delivered by the ERDF monitoring data to the total number of created and safeguarded workplaces by the GRW (including the ERDF workplaces) ist higher than the respective relation of ERDF grants to the total amount of investment

grants by the GRW (including ERDF grants). This is an indication of some kind of a “picking the winner strategy” in the *ex post* allocation of investment projects to ERDF support. Hence, official ERDF monitoring data with regard to their gross employment effects is severely biased and should be interpreted with caution. In addition, cost per job calculations which take into account only the ERDF means and not their “twin” GRW funds as well as other public subsidies are substantially biased downwards.

Irrespective of the question how to make a proper calculation of figures such as created workplaces or cost per job for the combined GRW/ERDF support scheme in Eastern Germany one should always bear in mind one severe shortcoming when information from monitoring data is solely used to infer impacts of public enterprise support: the lack of any credible counterfactual benchmark for the case in which the supported enterprises would not have received the public subsidy. In fact, the simple “bottom-up” aggregation of monitoring data for supported firms implicitly assumes that the total amount of investment and all of the created and safeguarded workplaces are due to the public support. Or in other words, if firms would not have received investment grants they would not have undertaken any one of their investment projects and thus would not have created and safeguarded any workplace. Of course, this assumption is highly unrealistic and is the very reason why the impacts of enterprise support should be assessed by means of counterfactual impact analysis.

Figure 3.3.3)).

Concerning the new and safeguarded workplaces in the manufacturing industry the monitoring data of the GRW show that due to the subsidized investments during the years 2000-2006 in total 107,000 workplaces were created and 439,000 workplaces were safeguarded. In relative figures, i.e. divided by the number of employees at the beginning of the period, 105 workplaces per 1,000 employees were created and 433 workplaces were safeguarded. Thus, more than half (54%) of the workplaces in the manufacturing industry were subsidized by the GRW during the period 2000-2006. By showing the development of the created and safeguarded worklplaces between 1991 and 2008 (relative to the number of employees in manufacturing industries in the respective year) Figure 3.3.4 signals that until 1995 most of the investments created new workplaces. Thereafter safeguarding jobs dominated.

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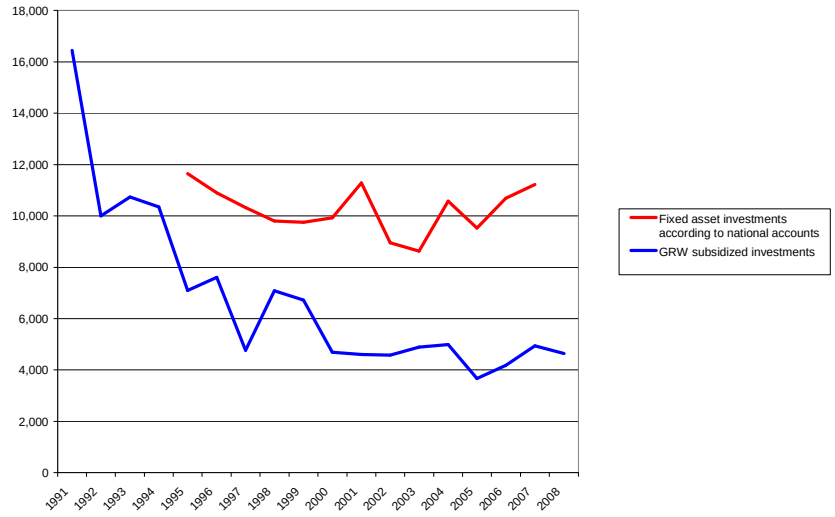
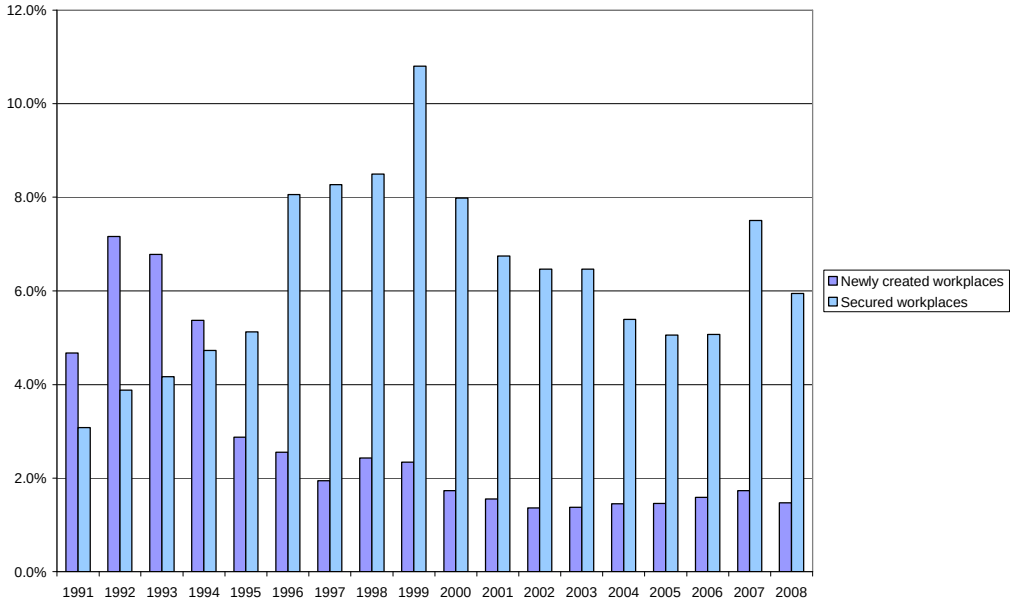
14 See GEFRA, IfS, MR (2010).

Figure 3.3.3:
Within the Joint Task Programme subsidized investment volumes and fixed asset investments in East German industry, 1991-2008, million €



Source: Bundesamt für Ausfuhr und Wirtschaft (BAFA), 2009. Calculations made by GEFRA.

Figure 3.3.4:
Within the Joint Task Programme newly created and safeguarded workplaces in East German industry in % of total employment in East German industry, 1991-2008.



Source: Bundesamt für Ausfuhr und Wirtschaft (BAFA), 2009. Calculations made by GEFRA.

3.4 SUPPORT OF RESEARCH, DEVELOPMENT AND INNOVATION

As a result of the economic and monetary union, the transformation crisis in East German industry also led to the collapse of East German research capacity. Particularly affected were the so-called “Forschungs-GmbH’s” (Research Limited Companies) which were separated from the East German state holding companies at the end of 1990 and early 1991. Consequently, the number of research and development staff dropped dramatically. In 1990, the Federal Government was putting specific subsidies at the disposal of research and development companies in East Germany in order to maintain and restructure at least part of the existing industrial research and development potential.

With the Unification Treaty in 1990, the eligibility for research and development subsidy programmes existing in West Germany was extended to include the new states, as well as East Berlin. The Federal Government increased its subsidy rates in East Germany through a bonus system and established special measures for small and medium-sized enterprises (SMEs) located in East Germany. Furthermore, East German enterprises and industrial development organizations had access to nationwide R&D support measures, some were equipped which special terms to East German enterprises. The new German states also began to support regional industrial research with state specific R&D programmes.

Subsequently, an extensive and differentiated support scheme for R&D and innovations was developed in East Germany, offering various terms and conditions for a multitude of programmes and individual measures. In parallel with subsidy measures from the Federal Government, some of the East German states supported the same R&D projects in order to increase the subsidy rate and to create a "perceptible" R&D subsidy (in fact, certain programmes allowed explicitely accumulation of subsidies). In principle, this system of R&D support has continued to exist up to the present. For programmes about to expire, follow-up programmes were frequently created and thereafter continued. While these were often given new names and were somewhat modified, they had essentially the same support targets and subject matters as before. In some instances, the spectrum of subsidies grew. While the emphasis formerly lay on "classical" support of industrial research, programmes that concentrated on networking, improving the access of technology-oriented companies to the capital market, or those supporting the set-up of new businesses were now preferred. However, the financial importance of these measures was rather small compared to direct support of private R&D projects.

Even today the new German states are enjoying a 'special status' within the framework of enterprise support for R&D and innovation of the Federal Government. This expresses itself through the existence of specific programmes for East Germany, as well as through the granting of special conditions, concerning total amount of support, incentive rates, or qualifying conditions. Apart from the numerous support measures of the Federal Government, there is also a multitude of support programmes by the individual federal states. A summary of all R&D subsidy programmes addressing the German enterprise sector in 2007 showed that 209 different programmes were simultaneously offered. Of these, 82 programmes were financed by the Federal Government, 114 by the Federal States, and 13 by the EU.[15]

The support for R&D and innovation in East Germany included, and still includes, a vast spectrum of programmes and measures for the direct support of R&D projects and the foundation and start-up of young technology-oriented firms. With the exception of tax reductions, the full range of financial subsidy possibilities is used:[16]

- direct grants for R&D and innovation expenses;
- loans with subsidized interest or with interest at reduced rates, as well as extensions for repayments;
- national co-venturing for subsidized credits and investments;
- funding of, generally, silent partnerships; and,

15 Cf. GEFRA, 2008. The core of the federal R&D and innovation economic support programmes is made up of direct financial subsidies for enterprises and external R&D organizations offering specified courses within the framework of technology-specific projects (59 technology-specific measures compared to 23 technology non-specific ones). The technology-specific support programmes are all awarded in the form of grants.

16 For the implementation of support programmes, the Federal Government refers to a choice of project-executing organisations and the state-owned banks DtA (KfW Mittelstandsbank since 2003) and KfW.

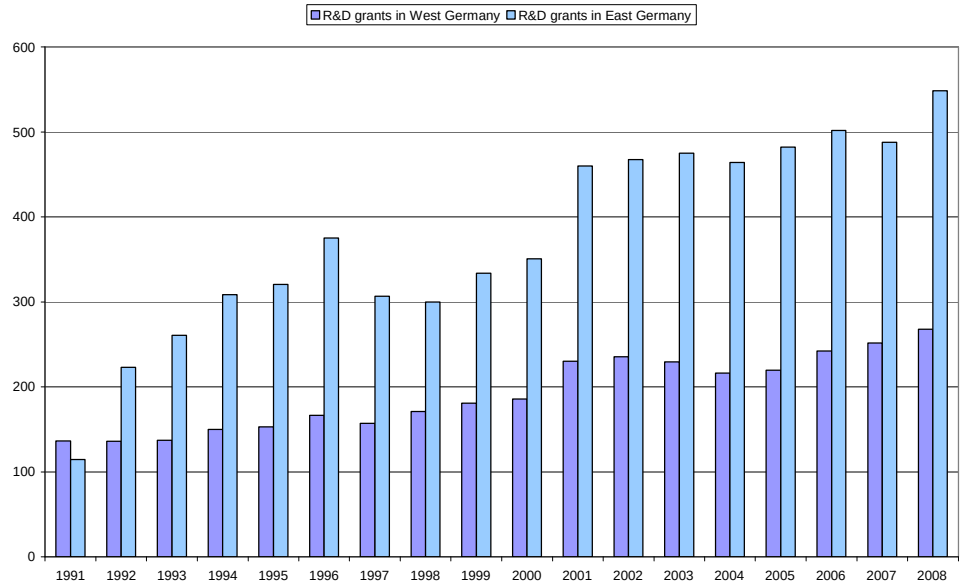
- provision of free or low-priced information and mediation services.

Contrary to the coordinated use of funds from the federal government and federal states to support private investment, there is no overall regulation for the R&D support. Consequently, an overall data source does not exist which delivers consistent figures on the amount of total R&D subsidies in East Germany. However, some data is available from the Federal Ministry of Economy and the Federal Ministry of Research on direct support for private R&D projects. This data gives at least an impression of the scale of the R&D support by national authorities complementary to the ERDF expenditure.

During the period 1991 - 2008, the federal R&D project support amounted to approximately €7.27 billion in the new states, i.e. an annual average of €404 million. As such, the R&D support by the Federal Government was approximately one fifth of the value of the investment funding by the Joint Task Programme (GRW). Within the 2000-2006 period of ERDF funding, the federal R&D subsidies amounted to €3.25 billion.

In order to determine the relative volume of ERDF subsidies, the value of €3.25 billion can be contrasted with the figures resulting from the the monitoring of the measures contained in the ERDF area 1.2 “Funding of Research, Technological Development and the Strengthening of the Information Society”. These measures were adopted to give direct R&D support to enterprises. In the years 2000-2006, public funds amounting to a total of €1.47 billion were spent on direct R&D support of firms within the framework of the ERDF funding. The ERDF funds totalled €1.02 billion. As a result of the tight state budgets, it could be assumed that the ERDF was used for the co-financing of nearly all R&D state funding measures for enterprises. Thus, ERDF funding took on a significant share of the overall direct R&D enterprise support in the years 2000-2006.

Figure 3.4.1:
Research and development project funds (R&D grants) of Federal Government per industrial employee in East and West Germany, 1991-2008 in €.



Source: Federal Ministry of Education and Research (BMBF), 2008. Calculations made by GEFRA.

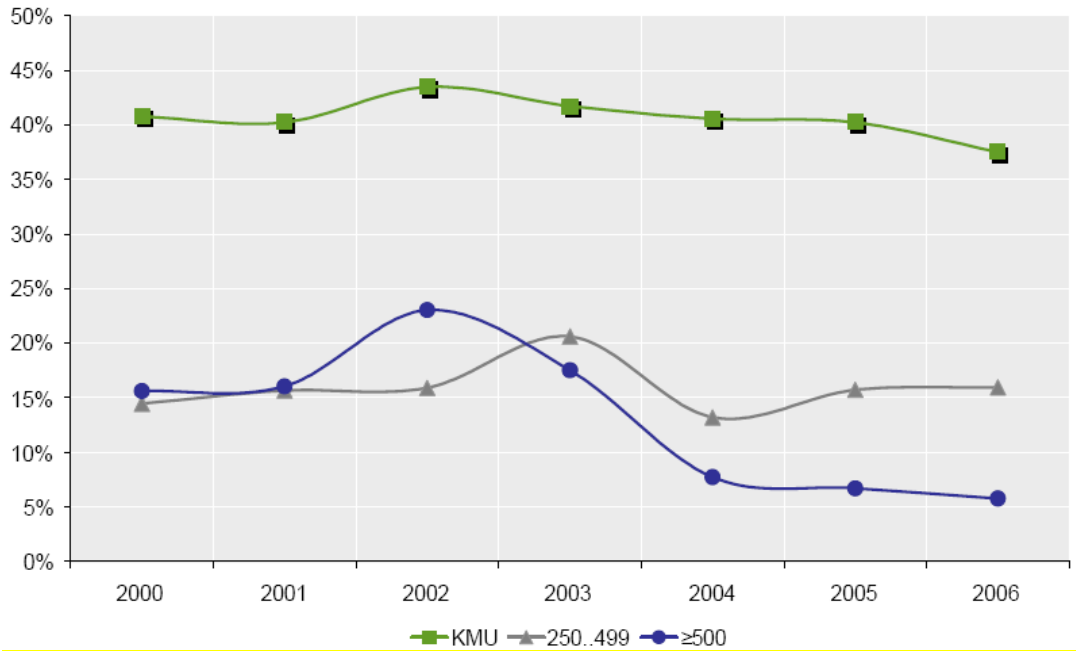
Figure 3.4.1 presents the development of the funding of private R&D projects by the federal government in East and West Germany.[17] It shows that the level of R&D subsidies, at €358 per industrial employee in East Germany, was 50% higher during the observation period than the West German average of €190.

The high level of subsidies spent on firml R&D in East Germany also becomes apparent when concentrating on the 'takers' rather than on the 'providers' of the support funds. The results of regular surveys of East German R&D enterprises showed that approximately 80% of the active R&D enterprises received R&D support. As far as drawing on the support programmes was concerned, the federal programmes reached the highest level of involvement, with almost 71% of the supported R&D firms receiving funds from the federal government in 2006. The respective share of enterprises using funds from the federal state and the EU was 62%.

17 From a sectoral viewpoint, approximately 70-75% of the R&D corporate subsidies are allocated to the manufacturing industry. The rest is primarily given to R&D service enterprises working closely together with the manufacturing industry (See Federal Ministry of Education and Research (BMBF), Research and Innovation in Germany, 2008. "Im Spiegel der Statistik, Berlin" (Statistical Reflection, Berlin)). Unfortunately, a separation of sectoral results is only available for all-German values.

A central indicator for assessing the empirical relevance of support programmes for regional R&D activities is the R&D funding quota, whereby the proportion of R&D subsidies is set in comparison to the overall R&D expenditures for continually-active R&D enterprises. Figure 3.4.2 shows a diagram of different funding quotas in East Germany in the years 2000 to 2006 depending on the size of enterprises. The diagram shows that the funding quota for small and medium-sized enterprises (SME) remained, for the most time, at a constant value of 40% during the evaluation period (approximately 37.5% in 2006). The development of the funding quota for bigger enterprises, however, was declining. The development of the funding quota in companies with 200 to 500 employees remained constant. There were, however, bigger fluctuations than with the small and medium-sized companies (SME).

Figure 3.4.2:
Funding quota by size of enterprise in East Germany (in %), 2000-2006.



Source: Konzack et al., 2007.

Note: KMU means SME, number of employees less than 250.

4

IMPACT ANALYSIS OF INVESTMENT GRANTS

4.1 DESIGN AND MODEL SPECIFICATION

Firm investment: definition of the outcome variable

The main target of the investment subsidies in East Germany is on the expansion of the entrepreneurial investment activities so that employees in subsidized companies can be equiped with improved technical (machines, devices, vehicles) and physical infrastructure. With the provision of supplementary allowances, grants, or loans at reduced interest rates, the use of physical capital, i.e. the so-called 'user cost of capital', is reduced and, as a result, incentives are created in favour of deprived regions. The rationale is that external capital from West Germany and foreign countries is planned to be directed towards the new states. Simultaneously, the capital intensity of the indigenous firms increases. The enlarged and modernized capital stock can then be regarded as a necessary stipulation for companies to increase their productivity and improve their competitiveness on a supra-regional level.

As a first step, the practice pursued within the framework of the investment incentive measures the increase in the investment quota in East German development areas. As a second step only, additional economic outcome variables, such as productivity, turnover, and employment, are being influenced. This is the reason why companies' investment activities are the key outcome variables in our analysis to assess the effects of the direct enterprise support. In order to control for the effects of different company sizes, the investment intensity (investment per employee) and the investment share (investment per sales) are used as outcome variables.

Since the mid-nineties, as shown in Chapter 3, the investment subsidies in East Germany had been focused on manufacturing industries. Approximately four fifths of the investment subsidies were allocated to manufacturing enterprises. In addition, investment allowances were gradually concentrated on manufacturing companies. Thus, whereas manufacturing firms were in general eligible for investment subsidies this was not the case for firms from the service sector. In order to ensure comparability between treated and non-treated firms with regard to their eligibility for investment subsidies the following analysis is restricted to manufacturing companies only.[18]

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18 By invoking this restricition we follow other empirical studies on the topic of investment subsidies in East Germany, e.g. Müller, 2000, Ragnitz, 2002, or Lehmann, Stierwald, 2004.

The key data source for this investigation is the IAB Establishment Panel. The IAB Establishment Panel is an annual survey of establishments and is unique in Germany, as it represents all industries and establishment sizes nationwide and can also be analysed on a longitudinal basis. This panel delivers a variety of variables (such as sales, employment, productivity, investment, innovation activities, size, industry, location) at the establishment level. The corresponding values are available for East German establishments from 1996 to 2007. In addition, information on public support of establishments which is crucial for the conduction of an impact analysis is provided by this panel (cf. for details Box 2. Furthermore, in the Appendix a comprehensive exposition of the data is given).

*Box 2: The IAB Establishment Panel**

The IAB Establishment Panel is an annual survey of the same establishments in Germany repeated every year. The panel study originally commenced in 1993 in western German and was extended to the New Federal States in 1996. Establishments in all branches and of all sizes with least one employee covered by social security are surveyed.

The establishments are selected at random from the process data of the Federal Employment Agency which contains roughly 2 million employers. This employer databank is derived from the data set containing statistics on employees, in which employers register all employees covered by social security under the code number of their establishment. For selection of the random sample, groups of economic branches are combined into 17 overall branches (up to 1999 there were 16 branches, after that 20, and since 2005 17) and the size of the establishments into 10 categories.

Through the financial participation of the eastern German states since 1996 and the western German states as of 2000 it has been possible to increase the samples to allow for regional evaluations at the level of the federal state. Close to 16,000 employers are surveyed in Germany each year.

A widely varied spectrum of questions (nearly 80 questions are asked every year) is used to gather the following information on establishments:

- Parameters of developments in employment (production, turnover, working hours, investment, capacity utilisation)
- Demand for personnel and labour expectations (vacancies, open positions, fluctuations, establishment employment policies)
- Status of and developments in technology and organisation, as well as their effects on jobs
- Determinants of productivity, e.g. technical, organisational and economic factors
- Data on the development of the establishment
- Utilisation of employment promotion measures
- Training and further training activities.

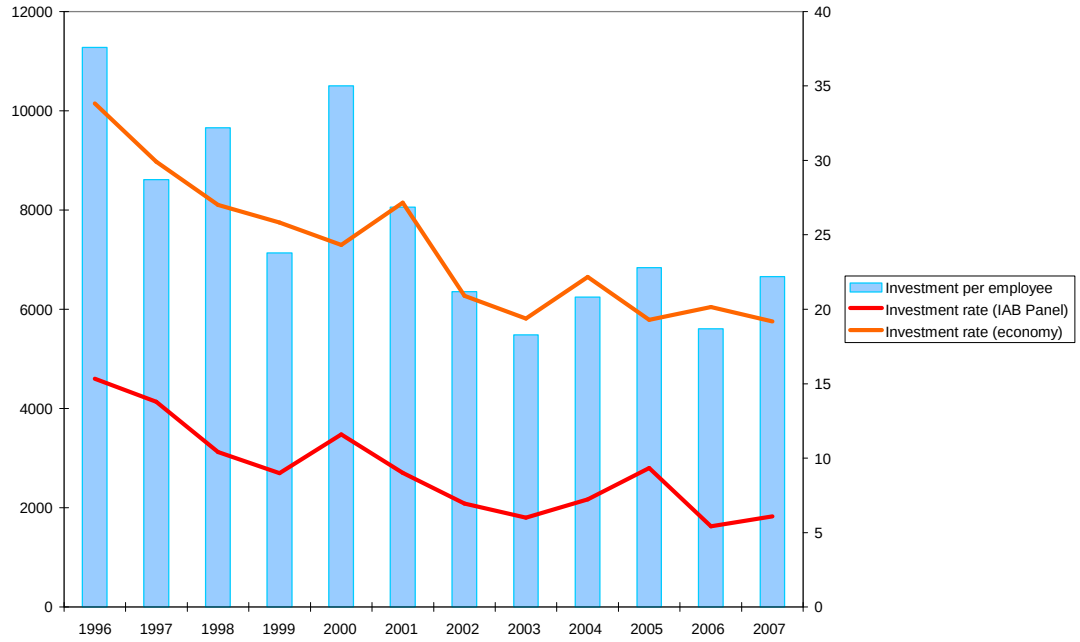
The questionnaire is revised each year and supplemented by questions of current relevance.

* For more information see the Appendix.

For the period from 1996 to 2007, Figure 4.1.1 demonstrates the development of the investment intensity and investment quota in the industry on the basis of the IAB Establishment Panel and the investment quota as specified by the national account system. The decreasing trend since the mid-nineties is obvious. The official investment quota declines from 34% to around 19%. The IAB Establishment Panel gives a representative reflection of the general

development. The difference in the level of the investment quota between the IAB Establishment Panel and the National System of Accounts can be explained with the varying defining of the denominator. In the National System of Accounts, investments are added value-related and not turnover-related.

Figure 4.1.1:
Investment per employee based on the IAB Establishmant Panel (left scale, in €1000), investment per sales based on the IAB Establishmant Panel (right scale, in %) and investment per value added based on national accounts (right scale, in %) in the manufacturing industry in East Germany, 1996-2007



Source: Statistisches Bundesamt (2009), IAB Establishment Panel (2009), own calculations.

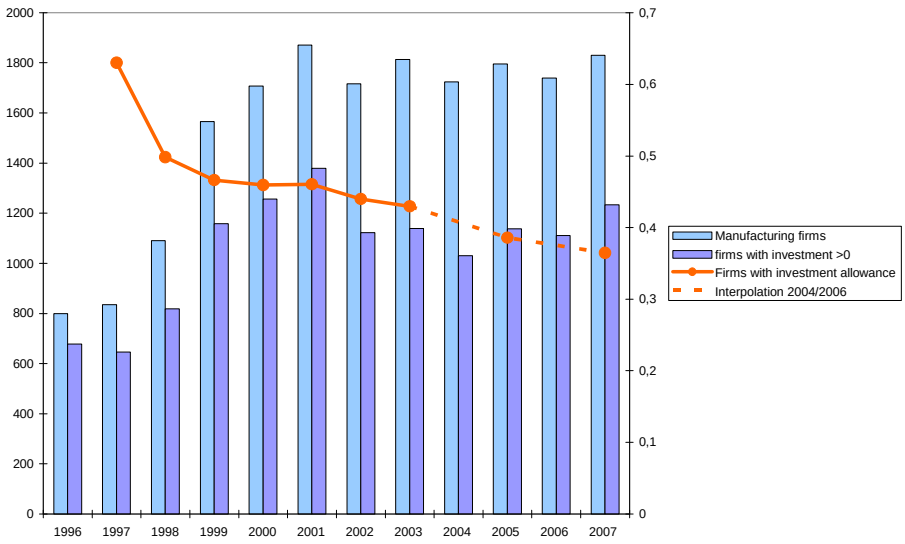
Investment subsidies: definition of the treatment variable

When determining the treatment variable, the characteristic features of the East German subsidy system have to be considered. A basic problem is that the investment allowance is coupled with a legal claim so that, in principle, all investing enterprises should have called upon this support tool. Thus, it could be assumed that all investing firms in our dataset had received investment allowances. Of course, this makes a distinction between subsidized and non-subsidized enterprises impossible. Although, in the IAB Establishment survey, some of the investing enterprises indicated that they did not received the allowance, this information

does not appear to be very reliable (see Figure 4.1.2). It can be assumed that enterprises were not adequately informed about the tax reduction facts because of their common practice of offsetting the allowance directly with the corporate income tax. An additional reason is that, owing to their industry classification, a number of enterprises were excluded from investment grants by the GRW.[19]

In contrast to this, it can be assumed that the information obtained from enterprises whether they had received specific investment programme subsidies, such as grants or loans, is much more reliable. Without specific applications, these subsidies were not available. In particular, to obtain grants from the GRW, the companies were asked to provide comprehensive information about their companies and the investment projects.

Figure 4.1.2:
Number of manufacturing firms in the sample, number of manufacturing firms with positive investment (left scale) and share of manufacturing firms which received investment allowances (right scale) based on the IAB Establishment Panel in East Germany, 1996-2007



Source: IAB (2009).

19 So-called 'sensitive sectors' (e.g. sectors of the motor vehicle industry) were excluded from the investment allowances. It was stipulated in the GRW that certain sectors in the steel and iron industry were not eligible for. Part of it might be the fact that the IAB Establishment Panel survey unit was based on a company evaluation. In the case of firms being part of a corporate group, their allowance was probably collected by the tax-paying registered office. It is, therefore, possible that consolidated companies, registered and taxable in West Germany, have received subsidies on behalf of their East German branches and because of that, these are insufficiently captured in the survey concentrating on East Germany only. Compare Ragnitz (2003) and Stierwald, Wiemers (2003).

Table 4.1.1:
Overview of recourse to different programmes for direct investment support (multiple answers possible in IAB questionnaire)

Year	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2005**	**2007**
Support (at least one of the programmes below) Number of firms	450	522	696	746	807	620	610	546	575
Thereof receiving:									
tax relief (e.g. investment subsidies or special depreciations)	429	432	573	601	655	517	511	459	467
German Common Task (Improvement of the regional economic policy)	120	171	216	251	251	190	194	162	158
Funds from the Federal Government (including Federal Government Banks)	0	79	85	94	95	66	53	41	49
Funds from programmes of the Federal States	0	70	96	92	113	72	86	76	94
Funds from the European support programmes/structural funds	0	76	66	56	63	42	56	55	65
Other funds/programmes	170	112	31	26	57	47	41	25	53
No support Number of firms	217	319	483	541	601	523	553	617	689
Total / Number of firms which provide information about support	667	841	1179	1287	1408	1143	1163	1163	1264
Total / Number of firms (with positive investment)	**678**	**849**	**1192**	**1299**	**1425**	**1156**	**1173**	**1174**	**1279**

Table 4.1.1 shows that the investment allowance was the most used investment support option. More than three quarters of the enterprises submitting information, declared they had used the investment support offer and were supported by means of investment allowances or, up to 1998, special depreciation schemes. Subsidies within the GRW framework were granted to an average of 30% of the supported enterprises. The relevance of the other options fell short of the tax relief and GRW grants.

As mentioned above, there is no point in establishing an analysis of the general effects of investment subsidies in the new states because because all firms should have received support via the investment allowance. Even if the IAB Investment Panel contained a number of investing companies that stated they had not received any subsidies, it must be recognized that, basically, all investments in the new states were tax-relieved. Hence, a differentiation between subsidized and non-subsidized enterprises is misleading, as long, at least, as the analysis is restricted to East German enterprises only. Against this background, our analysis follows the approach established by Ragnitz and others who differentiate between enterprises with higher and lower subsidies. Firms with a lower subsidy are those who have received only the investment (tax) allowance. Enterprises with a higher subsidy, therefore, have, in addition to the investment allowance, also received GRW grants and, possibly, subsidies from other programmes.

Of basic consideration is the fact that the investment incentive depends on the subsidy rate. The higher the rate, the higher the reduction in user costs of capital for the enterprises and the greater the incentive to expand investment activities. Even if all the investments in the new German states were subsidized, the aid intensity (support divided by total investment) differed, as an enterprise had asserted a claim when making the tax assessment or had applied for an additional subsidy from the GRW or other programmes. Accordingly, enterprises with higher subsidy rates should have made higher investments than firms with lower subsidy rates. The information contained in the IAB Establishment Panel about the rate of the subsidies received, does not appear to be very credible so we have to revert to a qualitative scale for the subsidy rates. This is justified, since the subsidy rates for enterprises receiving GRW grants are approximately 20 – 25% higher than the basic subsidy rate. Strictly speaking, the results stipulated hereafter relate to the effects of additional support by the Common Task.

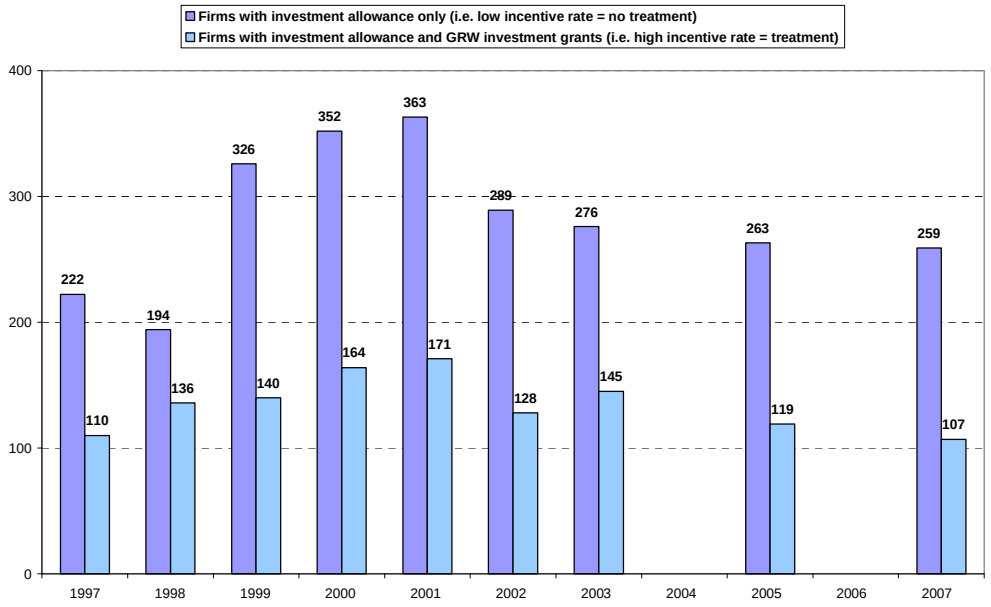
Note, that the differences in the subsidy rates measured in percentage points between treated and non-treated enterprises were roughly equal for SMEs and large enterprises. This is due to the fact that tax allowances were lower for large enterprises than for SMEs. To be concrete, large enterprises received on average a maximum subsidy rate of 35%, whereby tax allowances up to 15% are included in this figure. SMEs could be awarded a maximum subsidy rate of 50% including a tax allowance up to 25%. Thus, the proportion of grants to total investment costs was approximately 20-25% for both SMEs and large enterprises.

Figure 4.1.3 shows the development of the treatment variables which have been taken into account for the subsequent considerations. In the years 1997 – 2007, a total of 2,544 enterprises were subsidized by means of investment allowances only. In contrast, the number of enterprises receiving investment allowances and investment grants amounted to 1,220. In total, the sample provided 3,764 observations. Over the years, the number of observations has fluctuated in both categories. The ratio between enterprises “without treatment” and those “with treatment” has been more or less stable at 2:1 over a period of time. For enterprises “without treatment”, we have between 194 and 363 observations at our disposal for the same time period, and for enterprises “with treatment”, between 107 and 171.

It has to be noted that in the sample, the number of observations is not equal to the number of enterprises. The IAB Establishment Panel is a so-called 'unbalanced' panel, in that enterprises are continually asked, new ones are added, and old ones drop out. Actually, 1,825 enterprises are represented by the 3,764 observations, with an average of just over two observations made per enterprise. In the overall time period, 1,441 enterprises are not-treated and 689 enterprises are treated. This means that a small number of enterprises ((1,441+689) - 1,825=305) has received high subsidies in some years and low subsidies in others. This change in status is of particular interest for the derivation of the effects of support. It is only possible to apply a before-after or differences-in-differences estimator using this sample. Information from enterprises which have maintained their "high subsidy" status throughout the whole period is inappropriate for this methodology.

For the static models, i.e. the cross section and pooled estimation of investment functions by OLS and the propensity-score-matching, the data was adjusted for those observations in which firms initially received a high level of support, but later on only low support. Hence, firms were allowed to enter the potential control group of firms with low support only if they previously had not received high support. This procedure should help to avoid biased results due to more than one-period effects of the direct grants. By this procedure, the size of the potential control group of firms with no treatment was reduced from 2,544 to 2,226 observations.

Figure 4.1.3:
Definition of Treatment Variable: Number of firms receiving only investment allowance (i.e. low incentive rate = no treatment) versus number of firms with investment allowance and investment grants by GRW (i.e. high incentive rate = treatment) according to the IAB Panel in East Germany, 1996-2007



Source: IAB Establishment Panel (2009).

Further firm characteristics: definition of control variables

In the next two sections, we assess the effect of investment subsidies on the level of investment activity by means of a parametric estimation of an investment function and a non-parametric matching approach. Apart from the treatment variable, a set of control variables is needed. Ideally, the selection of control variables should be based on the formulation of a theoretical model by which at least of two equations could be delineated:

- a first equation should explain the determinants of the investment activity of a firm
- in a second equation the various factors determining the receipt of direct entprise support at the firm level should be modeled

Considering the modeling of an investment function a wide range of investment theories could be used. These suggest that there is a range of variables determining and explaining the investment behaviour of firms. In contrast, there are virtually no theoretical models dealing with decision-making processes within firms and public agencies when requesting and applying for public funding. Accordingly, it is very difficult to derive theory-based variables which might explain the participation probability beyond those variables already occurring in the investment equation. Therefore, empirical practice suggests that the formulation of the estimation equation for the OLS and probit regressions relies upon plausibility considerations and pure empirical aspects. The consideration of additional variables takes place mostly ad-hoc. We return to this issue in the next section. In the following, we focus on the determinants for the estimation of an investment function. As dependent variable we use the volume of investments weighted either by the number of employees or by the volume of sales in order to control for pure size effects.

In general, the selection of variables influencing the investment activities at the level of individual firms is a trade-off between investment theory-based deliberations and the availability of data. The central determinant influencing investment decisions by individual firms are their expectations about the future development of sales. The production capacities will only be enlarged if the expectations of returns are higher than the investment costs. The IAB Establishment Panel contains two short-term and one long-term forecasting variable. This is to say, that establishments are asked to assess the development of their total business volume and the development of their working staff in the coming year. In addition, the establishments are surveyed in respect of their expectation of the development of the number of employees in the next five years. These variables are, however, problematic. The time period the first two prognostic variables refer to is too short. The interpretation of the second prognostic variable is difficult because investments are related in most cases with an increase in the number of employees.

Investment costs, for instance prices of capital goods and financial charges, are also an important factor which determines the level of investment. Whereas prices of capital goods should be basically the same for all establishments and can thus be neglected in a cross-sectional analysis this is not true for financial charges. Financial charges consist on market interest rates, which again could be assumed to be equal for all firms, plus an agio for firm-specific risks. Although risk assessment depends on lenders of capital and may vary from case to case, the agio for firm-specific risk should be a function of size. Larger establishments might have advantages compared to smaller establishments in this respect. In addition, larger establishments have possibly an easier access to capital markets and better opportunities for refinancing. Firm size is, therefore, applied as a proxy variable. Furthermore, it is assumed ownership in an establishment influences strongly the investment activities at the

establishment level. It is presumed that the financial situation is more favourable in establishments with a West German or a foreign owner compared to independent East German establishments, since the latter might have more difficulties in raising capital. A positive effect of this variable is therefore suspected in the investment equation. The current profit situation of the establishment might have a similar effect. These three variables are applied as proxies for the factor investment costs.

The influence of firm age on investment activities is unclear because of different possible functional chains which may operate simultaneously. The impact of firm age on investment can thus be positive, negative or neutral.

Expectations of individual firms about their short-term development of business volume, and their long-term assessments about the development of the number of employees could not be included due to the small numbers of answers. Hence, only firm's short-term assessment on the development of their working staff in the coming year is used. This categorical variable was transformed into a set of dummy variables.

The following variables are applied as implicit proxies for investment costs.

- The total employment comprises the group of working proprietors, directors and managers as well as employees liable to social insurance and those not liable to social insurance contributions (e.g. civil servants).
- The ownership variable is a categorial variable which distinguishes whether the ownership is East German, West German, foreign or if there is any majority owner. The dummies West German and foreign ownership were affiliated to the regression analysis.
- The firm-specific assessment on the current profit situation could not be integrated into the linear regressions due to the low number of cases.

The assumed positive effects of firm size and foreign/West German ownership on investment volume per employee are to be investigated more precisely. For this reason, the following interaction terms are included into OLS regression. First, interaction terms between total employment (log)/total squared employment (log) and the treatment dummy were affiliated (interaction terms treatsize/treatsize_squared). Second, the firm sample was stratified by building firm size classes. These can be aggregated to the four firm size classes of the European Union. Then the interaction term between these firm size classes and the treatment dummy was built. Third, an interaction term between the ownership and the treatment dummy was affiliated to OLS regression.

Furthermore, the share of female employees and the share of trainees and apprentices should have an impact on the probability of firms to participate in the program. In addition, a wide range of firm-, region-, industry-specific and time-specific control variables were included into OLS regression. The Appendix 6 provides the definitions of these variables in further detail.

4.2 ESTIMATION RESULTS

4.2.1 OLS ESTIMATION

The estimation of a linear regression model is the starting point of our counterfactual impact analysis using the IAB Establishment Panel. The impact of direct investment support on investment activities and employment of East German manufacturing establishments is analysed by a pooled OLS regression which covers the years from 2000 to 2003, 2005 and 2007. Investment activities are represented by two dependent variables: investment volume per employee (investment intensity) and the quotient of investment volume and sales (investment share). Because of the right-skewed distribution of both variables we used the logarithm (in short logs) of each of these two outcome variables in the regressions.[20] For measuring employment effects we used the relative change in employment (in %) in the year following the receipt of the support as dependent variable. The analysis is confined to manufacturing firms with an absolute investment volume of at least €10,000.

This pooled regression model includes a large set of firm-, industry-, time- and region-specific control variables. To consider size effects five firm size classes are included into the model, thereof the size class of small firms with less than 20 employees build the reference category. Furthermore we differentiate firms according to three distinct ownership categories: 1. East German ownership, 2. West German ownership, and 3. Foreign ownership. Note, as mentioned before, the treatment variable (dummy) refers to firms with either a low or a high level of direct investment support. In the following, we refer only to the results for the estimated coefficents of the treatment dummy in the regressions for the alternative three outcome variables (see Table 4.2.1). Detailed results for the full set of regressors for each dependent variable (investment intensity, investment share and employment growth) are reported in the appendix (see table A 8.1.1-A. 8.1.3).[21]

The coefficient of the treatment dummy is for both investment outcome variables statistically significant at the 1%-level, for employment growth at the 5%-level. In relative terms, the treatment effect amounts to 151 percent for both the investment intensity and the investment share. Thus, investment per employee of firms with high investment support is on average 12,377 € higher than the counterfactual investment intensity if these firms would not have received high but only low investment support. With regard to the investment share the treatment effect is in absolute terms 12.6%-points. This means that the investment share of firms would have been 12.6 %-points lower without the possibility to get investment grants in addition to investment tax allowances. In addition to these impacts on investment there are also

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20 Note, that this transformation changes the interpretation of the regression coefficients. In case of such a semi-log OLS regression the coefficients of the dummy variables, such as the treatment dummy, are to be taken as semi-elasticities. After some manipulation the coefficients inform about the relative change (in %) of the dependent variable induced by a change in status of the dummy variable from 0 to 1. The formula which is applied in order to display the semi-elasticity of the dummy variables in the investment equation is explained in more detail in Appendix A.7.

21 In addition to the pooled regression models, we carried out cross-sectional regressions for every year of the observation period (2000-2003, 2005, 2007), too. These separate regressions cover all variables of the pooled regression. For both investment outcome variables the coefficient of the treatment dummy was statistically significant in all cross-sectional regressions. However, this was not the case for the outcome variable employment growth.

positive effects on firm's annual employment growth. Employment in a firm one year after the receipt of high support is 3.2%-points higher than would be the case if the firm received only low support.

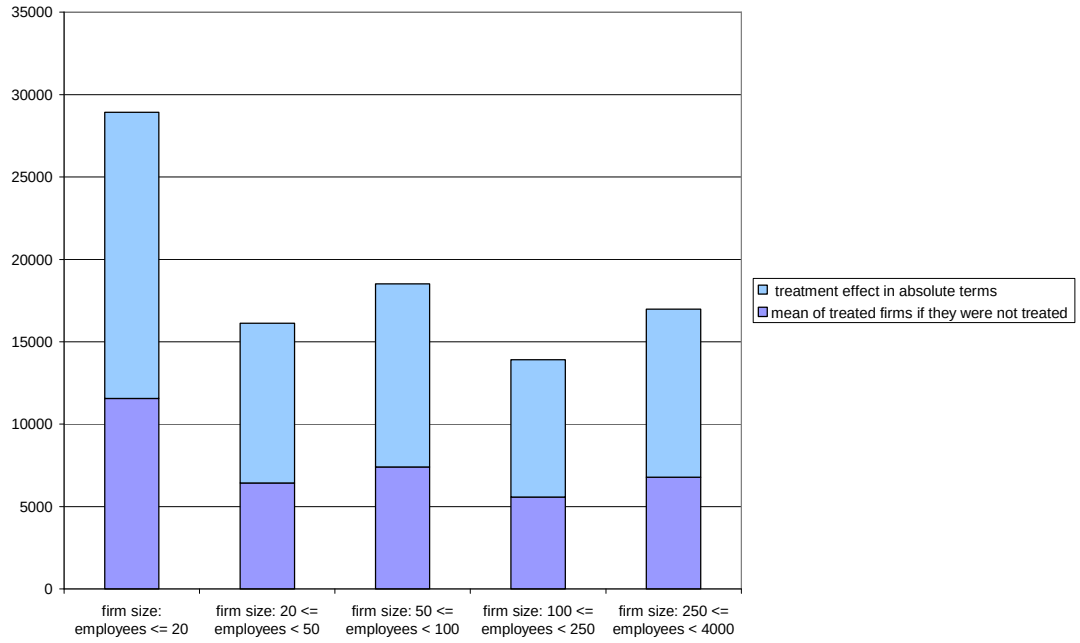
Table 4.2.1:
Overview of results from OLS estimation

Outcome variable	Treatment effect		For information	
	Relative terms	**Absolute terms**	**Regression Coefficient**	**t-value**
Investment intensity	151 %	12,377 €	0.922	13.80
Investment share	151 %	12.6 %-points	0.921	13.52
Employment growth	77 %	3.2 %-points	3.160	2.22

For information				
	Sample mean of treated firms (firms with high support)		Sample mean of non-treated firms (firms with low support)	
Investment intensity	€20,583		€8,117	
Investment share	20.99%		9.13%	
Employment growth	7.27%		4.11%	

A further step of the analysis consisted of including interaction terms into the pooled regression models to account for possible heterogeneous treatment effects. Therefore, interaction-terms between the firm size class dummies and the treatment dummy on the one side and between the ownership dummies and the treatment dummy on the other side were constructed. Then the regression models were re-estimated including these interaction-terms. However, none of these interaction-terms turned out to be significant (see tables A.8.4-A.8.6 in the appendix). It should be noted, that this finding does not mean that there are no differences in investment behaviour between different firm size classes. The negative coefficients of the simple firm size dummies in the various regression models indicate, roughly speaking, that the investment volume per employee and the investment share decline with firm size. However, once controlled for firm size the treatment effect as a percentage change remains the same – irrespective of firm size. This logic is illustrated for the case of investment per employee by Figure 4.2.1.

Figure 4.2.1:
Estimated mean values for investment per employee for treated firms and treatment effects in absoute terms according to size class



Source: IAB Establishment Panel (2009).

4.2.2 PROPENSITY SCORE MATCHING

In recent microeconometric evaluation research the matching approach is used as an alternative to the classic linear regression model. The main advantage of this non-parametric estimation method over the traditional parametric method results from the fact that the matching procedure does not rest on restrictive assumptions about the functional form of the estimation equation and the distribution properties of the error term. Therefore, as an alternative to the linear regression approach in this section we will apply the matching technique to our data from the IAB establishment panel.

The first step for the implementation of the Propensity Score Matching procedure consists of a probit estimation on the probability of receiving public funds by the joint task program. In principle, the estimation of the probit equation is carried out purely for statistical reasons. Its only objective is to balance the distribution of the control variables between treated and non-treated firms. Thus, the probit model has no behavioural interpretation and needs no

theroretical justification. In empirical practice this turns out to be very useful, since theoretical models to explain the participation of firms in public support programs do generally not exist. Therefore, most microeconometric studies lack a sound theoretical underpinning of the selection process. The choice of control variables in the probit regression for explaining the participation probability is usually ad hoc and the results of the estimation are interpreted on the basis of plausibility considerations.

The choice of control variables to estimate the probability of participation is based on those variables that were already used in the previous section to estimate the investment function simply by OLS. The reason for this approach is that – on the side of the individual firm – the demand for public investment funds should be influenced in principle by all of the variables which are also part of the investment decision. However, on the side of the supplier, the availability of grants depends in general on an unknown selection process on the part of the state authorities. By knowing at least the official rules of the joint task program one can expect that the firm size, the industry affiliation and the regional market orientation of the firm are key determinants. In addition, the share of female employees and the share of trainees and apprentices should exert an influence on the probability to participate in the program. But these variables were already considered in the investment function.

Against this background, table A.9.1 in the appendix shows the estimation results of a pooled probit regression for the period 2000-2007 (excluding the years 2004 and 2006). The results show a number of significant variables; in most cases the sign corresponds to “theoretical” expectations.

Based on this probit equation and the estimated propensity scores for each firm, the matching procedure was applied: each treated firm was assigned a non-treated firm with a similar propensity score, thus constructing a proper control group with, on average, similar firm characteristics. To verify the results, different matching procedures (nearest-neighbour matching, caliper matching, stratification matching, and kernel matching) are used:

- Nearest Neighbour-Matching
- Caliper-Matching
- Stratification-Matching
- Kernel-Matching

Due to space limitations we restrict ourselves here to the presentation of the results of the kernel matching. Application of the other matching techniques resulted in almost identical results. These are listed in the appendix. For all matching algorithms we invoked the so-called common support condition as a restriction. With this restriction imposed, all observations of treated firms with a propensity score higher than the maximum or less than the minimum propensity score of the non-treated firms were dropped.

After performing the matching procedure, no significant differences in the averages of the control variables should have remained. This is confirmed by table A.9.2, which lists the mean values of the control variables for treated and non-treated firms. On average, significant differences between treated and non-treated firms could not be detected for any of the control variables. Applying the matching procedure has therefore resulted in a group of similar non-treated firms which can now be compared to the group of treated firms.

In a next step it has to be asked, which difference is given in the outcome variables, i.e. investment intensity, investment share and employment growth, remained between the treated and non-treated firms after performing the matching procedure, and whether this difference is statistically significant. Since firms now correspond almost entirely to each other in all major (observable) characteristics and differ only with respect to their treatment status, these differences can be interpreted as the causal effect of the specific investment support by the joint task program.

To be precise, the success of investment grants delivered by the joint task is evaluated by comparing the average investment intensities (alternative: investment shares and employmewnt growth) between the groups of treated and non-treated firms. Note that in our case treated firms are those with high investment support and non-treated firms are those with low investment support. The unbiased estimator for the causal treatment effect is the difference of the means between both groups

$$A\hat{T}T = \frac{1}{N^*}\left(\sum_{i=1}^{N^*} Y_i^1 - \sum_{i=1}^{N^*} Y_{(i)}^0\right)$$

with N* indicating that the number of firms for whom a twin firm was found.

The direct investment subsidies of the joint task program have, on average, a positive impact on the investment intensity (or investment share or employment growth), if the treatment effect is significantly greater than zero. The program does not generate positive effects, if the treatment effect is statistically insignificant. Finally, firms with high investment support perform worse than firms with low investment support, if the treatment effect is significantly smaller than zero. This would mean that non-treated firms which made use only of investment allowances invest more (measured by the investment intensity or investment share) and have higher employment growth than treated firms.

The test on the significance of the mean difference, i.e. the treatment effect, is usually carried out by means of a simple t–statistic. But, the usual t–statistic would be biased upwards and misleading for making inferences, which goes back to the estimation procedure. To remove this bias, we used the method of bootstrapping as suggested by Lechner (2002). In general, bootstraping is a very popular method to estimate standard errors in case analytical estimates are biased or unavailable. Even though Imbens (2004) notes that there is little formal evidence to justify bootstrapping, it is widely applied in the matching literature to compute standards errors which take into account that the mean of the outcome variable of the control group is not the result of a random sampling. In our case we repeated the bootstrapping 500 times which led to 500 distinct estimated mean differences between treated and non-treated firms. The empirical distribution of these estimated average treatment effects served as an approximation for the sampling distribution of the population mean and was then used to calculate a standard error and, thus, an unbiased t–statistic.

Table 4.2.2 presents the estimated average treatment effects of the matching procedure and their t-values according to the subsequent boostrapping. In relative terms, the resulting causal effect is 138% with regard to investment intensity, 144% with regard to the investment share and 48% with regard to employment growth. In absolute terms and when evaluated at the sample means, the resulting causal effect is €11,946 with regard to the investment intensity, 12.4 %-points with regard to the investment share and 3.5%-points with regard to employment growth.

Thus, it turns out that after applying the matching procedure significant differences in all outcome variables remain. According to the results of the corrected two tailed t–tests, these differences are statistically significantly different from zero. Taken together, the findings of the propensity score matching are quite in line with the estimation results of the OLS regression approach.

How do our results compare with the findings in the literature? As shown in Chapter 2 most studies also find a statistically positive effect of investment subsidies on various outcome variables. However, due to the different outcome variables and different specifications used in these studies only for a subset of them an exact comparison of the quantitative magnitudes of the estimated impact coefficients is possible. One example is the work for Eastern Germany using also the IAB establishment panel by Ragnitz (2003), Stierwald, Wiemers (2003) and Lehmann, Stierwald (2004). Using a Heckman selection model, Ragnitz finds a treatment effect of €9.232 for the outcome variable investment per employee, for the investment share he estimates the treatment effect to be 11.6%. Nearly the same figures are obtained by Stierwald and Wiemers (€9.255 and 12.1%). Applying an exact matching approach Lehman and Stierwald estimate a difference in investment per employee of €8.500 between treated and non-treated firms. Thus, although they used different statistical methods and their samples have fewer observations they find quite similar impacts compared to our findings. However, this equivalence should not come as a surprise given that these studies used the same basic data. More interesting in this respect is the case that for Italy Atzeni, Carboni (2006) obtained with a matching estimator an average treatment effect on the level of total investment per worker which amounts to €14,700 per employee. Also for a sample of Italian firms Bronzini et al. (2008) estimate the impact of investment tax credits on the investment share to be in the range of 65%-134%. Thus, in general our estimated impacts on the outcome variables investment per employee and investment share are in line with the findings in the literature. With regard to (one-period) employment growth Gadd et al. (2009) report that Swedish firms which received public subsidies increased their number of employees by more than 4.7% than their matched firms in the control group. According to Pellegrini and Centa (2006) in Italy the additional annual employment growth rate was around 8 to 14 percentage points higher in subsidized firms.

In addition, one could ask how much additional absolute employment within the supported firms goes back to the investment support. From several investigations it is well known that the number of new workplaces and / or the number of safeguarded workplaces as measured by the monitoring data tends to be overoptimistic, especially where jobs safeguarded is concerned. For the East German case and the period from 2000 to 2006 the monitoring data show 107,000 new workplaces and 439,000 safeguarded workplaces. To end up with a rough measure of the net employment effect within the treated firms we did the following rough calculation: For 2004 we know the number of employees in the East German industry, namely 1,456 million.[22] Furthermore, we know that 54% of all employment is within firms that have been subsidized, i.e. a total of 760.000 and that these firms had an additional employment growth of 3.5 percent compared to non-treated firms. Assuming that in the absence of investment support the number of employees would have been 3.5 per cent lower, the total number of employed would stay at 734.300. The estimated direct employment effect amounts to 26,700 and is small compared to the above shown number of new and safeguraded workplaces. The total direct effect is somewhat higher than the number of new em-

[22] For all the other years within the period from 2000 to 2006 the numbers are roughly the same.

ployees from the HERMIN macromodels that take into account the economy wide effects.[23] Furthermore, the results are in line with our knowledge about the net effects of the support of private investment. This rough calculation shows that the direct estimated effect from the counterfactual analysis is only around one quarter of the new workplaces from the monitoring data and that the monitoring data overestimate the employment impact of the investment subsidies. Taken together with the data on investment, this underlines that the main impact of an investment grant is more likely to be a productivity increase than an employment increase.

Table 4.2.2:
Overview of results from propensity score matching

Outcome variable	**Treatment effect**		**For information**	
	Relative terms	**Absolute terms**	**Estimated Mean difference**	**t-value**
Investment intensity	138 %	€11,946	0.868 (in logs)	11.16
Investment share	144 %	12.4 %-points	0.894 (in logs)	11.33
Employment growth	92 %	3.5 %-points	3.475	2.06

For information				
	Sample mean of treated firms (firms with high support)		Sample mean of non-treated firms (firms with low support)	
Investment intensity	€20,583		€8,117	
Investment share	20.99%		9.13%	
Employment growth	7.27%		4.11%	

Our results show that East German treated firms realised on average higher investment intensities, investment shares and employment growth compared to firms with low investment support, given that the firms from both groups do not differ with respect to control variables that influence the probability of receiving public investment grants by the German Joint Task. The results confirm that investment subsidies which were afforded in addition to investment

23 Bradley, J. and G. Untiedt (2009), "Analysis of EU Cohesion Policy 2000-2006 using the CSHM: Aggregate impacts and inter-country comparisons", http://ec.europa.eu/regional_policy/sources/docgener/evaluation/expost2006/wp3_en.htm

allowances in East Germany were an important factor for increasing private investment and for subsequent (one period) employment growth. But as the results show the treatment effect on investment is around four times higher than the employment growth effect. This means that invenstment subsidies introduce preliminary productivity and capital deepening effects whereas employment growth effects arise as a second order effect. A closer look at the different sizes classes, compare for example table A.8.6 that for investment and for employment no different effects across size classes are statistically significant, i.e. we are not able to show that SMEs show a relative higher impact than bigger firms.

4.2.3 DIFFERENCE-IN-DIFFERENCES (DID)

In principle, the data of the IAB Establishment Panel should also be appropriate for carrying out a difference-in-differences (DID) estimation as for many firms information for more years should be available. But first of all, it is necessary to characterize the exact structure of the panel data in order to make sure that an adequate application of the DID-estimator is possible. However, Table 4.2.3 shows that there is only one observation per year available in the panel for more than 50 percent of the surveyed establishments. For about a quarter of the establishments the panel contains observations for two years and for 10 percent of the firms it provides observations for three different years. Altogether the number of firms that participated in several waves decreases with the time length. Only three firms participated continuously in the survey from 1997 to 2007.

Table 4.2.3:
Structure of the unbalanced panel data of the IAB Establishment Panel

Number of observation (Years) per firm	Number of firms	% of firms	% of firms cumulated	Number of observations	% of observations	% of observations cumulated
1	927	50.79	50.79	927	24.63	24.63
2	409	22.41	73.21	818	21.73	46.36
3	208	11.40	84.60	624	16.58	62.94
4	125	6.85	91.45	500	13.28	76.22
5	87	4.77	96.22	435	11.56	87.78
6	37	2.03	98.25	222	5.90	93.68
7	21	1.15	99.40	147	3.91	97.58
8	8	0.44	99.84	64	1.70	99.28
9	3	0.16	100.00	27	0.72	100.00
	1,825	100.00		3,764	100.00	

As already mentioned, a change of the support status within the survey period can only be observed for few firms. Only a small part of the 3,764 observations shows a change from a low to a high level support status between two adjacent years: only 64 of the 1,220 observations with high level of direct support (“treated”) showed up a low level of direct support in the previous year (all of the 64 observations with a change in treatment status refer to different firms). However, as shown by Figure 4.2.2 these changes refer to different years and not just to a two-period-model.

Figure 4.2.2:
Number of firms with and without a change in treatment status from low to high support between two adjacent years in the sample

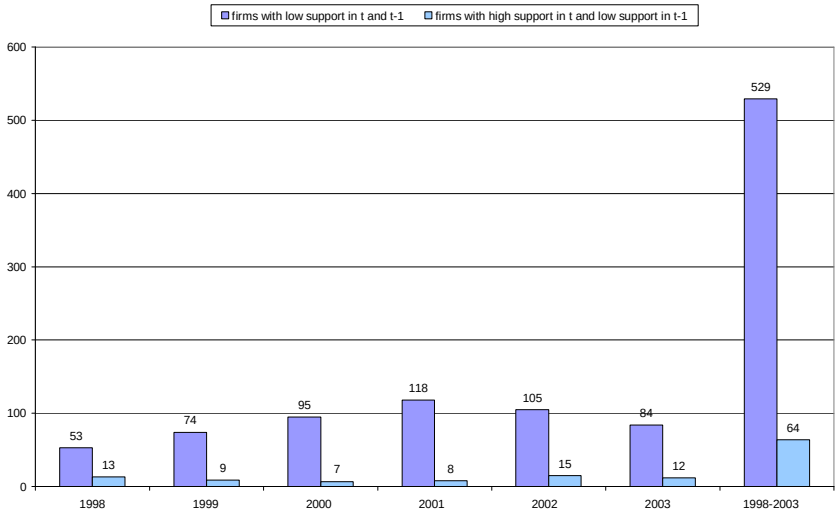
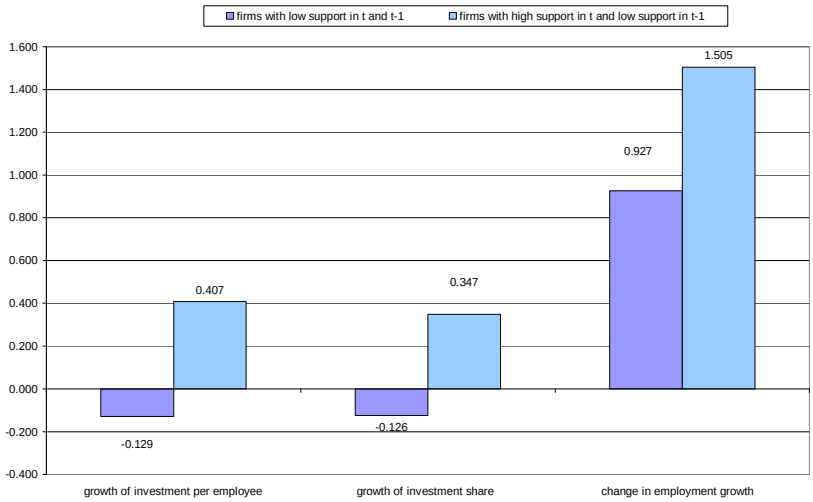


Figure 4.2.3:
Yearly growth of investment per employee, yearly growth of investment share and yearly change in employment growth for treated and non-treated firms, means for the period 1998-2003



With respect to these 64 firms, the change from a low to a high status of direct support from one year to another was accompanied also by an yearly increase of the outcome variables: the annual difference of the investment per employee (in logs) amounts to 0.407, the annual difference of the investment share (in logs) amounts to 0.468 and the annual difference in employment growth amounts to 1.504. For those establishments with an unchanged low level of direct support the annual differences in the outcome variables were lower, namely: investments per employees (in logs) -0.129, the investment share (in logs) -0.126 and employment growth 0.927 (see Figure 4.2.2). These results point out that the differences in the differences are positive. For investment per employee we calculate a treatment effect of 0.536 (in logs, or 71% in relative terms), for the investment share 0.594 (in logs, or 81% in relative terms) and for employment growth of 0.577 (%-points).

Table 4.2.4:
Yearly growth of investment per employee, yearly growth of investment share and yearly change in employment growth for treated and non-treated firms, means by years

	Number of firms		Mean of 1. difference in log of investment per employee		Mean of 1. difference in log of investment share		Mean of 1. difference in employment growth	
Year	No change in treatment status	Change in treatment status	No change in treatment status	Change in treatment status	No change in treatment status	Change in treatment status	No change in treatment status	Change in treatment status
1998	53	13	-0.433	0.029	-0.465	-0.225	7.886	3.812
1999	74	9	-0.145	0.282	-0.059	0.351	-0.090	2.307
2000	95	7	-0.026	0.255	-0.080	0.306	3.448	-0.474
2001	118	8	-0.018	0.219	-0.048	0.265	-0.002	-4.635
2002	105	15	-0.079	0.649	-0.034	0.590	-1.659	4.484
2003	84	12	-0.264	0.745	-0.248	0.662	-0.883	-0.074
1998-2003	529	64	-0.129	0.407	-0.126	0.347	0.927	1.505

But it has to be kept in mind that the first differences of the outcome variables refer to different years and not to a two-period-model. Table 4.2.4 shows the distribution of the means of the yearly changes of the (log) investment per employee, of the (log) investment share and employment growth over the years and separated by treatment status. Thus in addition to the “naïve” DID estimator we applied a linear regression models in which the yearly changes of the outcome variables were regressed on a binary dummy indicating the change in treatment status and on time dummies for each of the years from 1998 to 2003 (compare the DID estimation method in the multi-period case in Wooldridge (2002, pp. 283)). The estima-

tion results confirm our above calculations – except for employment growth. The regression models for both investment outcome variables show a positive and significant coefficient for the treatment dummy.[24] For employment growth the estimated coefficient is statistically insignificant (see tables A.10.1-A.10.3 in the appendix).

Table 4.2.5:
Overview of results from difference-in-differences estimation

Outcome variable	Treatment effect		For information	
	Relative terms	**Absolute terms**	**Regression Coefficient**	**t-value**
Investment intensity	77%	8,932 €	0.579 (in logs)	4.14
Investment share	65 %	8.3 %-points	0.511 (in logs)	3.58
Employment growth	13 %	0.93 %-points	0.934	0.15

For information				
	Sample mean of treated firms (firms with high support)		Sample mean of non-treated firms (firms with low support)	
Investment intensity	€20,583		€8,117	
Investment share	20.99%		9.13%	
Employment growth	7.27%		4.11%	

To sum up, the DID-estimation results shown in Table 4.2.5 confirm the empirical findings already revealed by the simple linear regression and the propensity score matching approach: investment intensity and the investment share are significantly higher for firms that have received high direct enterprise support compared with low support. But the estimated coefficients by DID which indicate that the mean difference are markedly lower than those obtained by standard linear regression and PS-Matching, respectively. Thus, it seems that when taking selection of unoberservables into account the impact of investment support decreases. However, the results need to be interpreted with caution because of a comparatively low number of firms which change their treatment status thoughout the observation period.

[24] The coefficient remains nearly unchanged if one includes further differences of exogeneous regressors in the model. However, the number of observations strongly decreases due to missing values.

Regarding employment growth we estimated a insignificant coefficient for the treatment variable and therefore have no direct impact on employment growth. It is possible that an impact exists with some time lag so that employment increases in the following years. But, even regression results that take a two-year period into account show insignificant coefficients and we have to conclude that no significant employment growth effect of the subisdies exists when selection of unobservables is taken into account. In this respect it seems to be the case that in a first step investment increases and employment remains unchanged. In a second step these higher investment would positively influence productivity and finally may have an employment effect. But our sample does not allow us to follow that route since the number of observations is small and the time span is to short. Again, it has to be emphasized that the results have to be viewed with caution due to the small sample size.

4.2.4 HECKMAN SELECTION MODEL

The simple linear regression of the outcome variable on the treatment variable produces - even with control of other exogenous variables - unbiased estimates only if participation in the investment support scheme can be considered as exogenous. If, however, participation depends in addition to the already included observable covariates on other unobservable variables relegated to the error term, then this is no longer the case. Under these circumstances there is a correlation between the treatment variable and the error term of the regression equation leading to inconsistent estimates by OLS. For example, management abilities are in principle unobservable. Firms with high management abilities are on the one hand more likely to apply for investment grants but on the other hand also show higher investments just for that reason. Thus, in a regression model of investment both the treatment variable and the error term are correlated with the unobservable variable management ability. Then failure to control for this correlation by estimating the investment function with OLS will yield an upward biased effect of investment support.

In this section we will try to overcome the problems of endogeneity and sample selection due to unobservables by applying a so called treatment-effects model. This model could best be grasped as a combination of the Heckman selection estimator with an instrumental variable approach (Greene (2008), Cameron, Trivedi (2009)). The basic idea of this model consists in a two-step procedure: In a first step the probability of participation in the investment support scheme is estimated using a probit model and the so-called Inverse Mills Ratio (IMR) set-up which should measure the influence of the unobservable variables in the selection process. Then, in a second step the IMR is introduced into the investment regression equation. By estimating this enhanced equation the correlation between the explanatory variables and the error terms is eliminated. Since for identification of the treatment-effects model it is highly advisable to include variables in the first stage probit equation which are not entailed in the second stage investment equation the treatment-effects model could also be seen as a variant of the more general instrumental variables method.

As instrumental variables the following four variables were used: share of trainees and apprentices, share of female employees, existence of industry-wide wage agreement and existence of company wage agreements. The results for the probit estimation show that these variables significantly add to the explanation of the probability to receive GRW investments grants (see tables A.11.2, A.11.4, and A.11.6 in the appendix). However, we assume that these variables do not have an impact on investment activity. Note that we control for wage effects in the investment equation by the average wage costs and the dummy for wages/salaries above average.

Table 4.2.6 shows the results of the ML estimation of the treatment-effects model (detailled results are reported in the appendix (table A11.1, A.11.3, and A.11.5)). If one compares the results of the estimation of the treatment-effects model with the OLS results the following points can be established: First, for both investment variables the treatment dummy remains statistically significant at the 1%-level. Second, with regard to the size of the coefficient for the treatment dummy in both investment equations the results do not change very much but are roughly the same. For investment intensity the estimated impact is somewhat smaller, for the investment share it is a bit larger. Third, the coefficient in the employment growth equation nearly doubles. However, the coefficient can only be estimated very imprecisely. Due to a large standard error the coefficient becomes insignificant.

The estimation of the treatment-effect model allows directly to test if there is a correlation between the error terms of the probit equation and the investment equation and therefore if there is an endogeneity problem. The results using a likelihood-ratio test indicate for both investment variables that the two error terms are uncorrelated cannot be rejected. Thus, it seems that OLS results are not plagued by the problem of selection on unobservables.

Table 4.2.6:
Overview of results from estimation of treatment / selection model

Outcome variable	Treatment effect		For information	
	Relative terms	**Absolute terms**	**Regression Coefficient**	**t-value**
Investment intensity	139 %	9,737 €	0.919	2.91
Investment share	191 %	10.8 %-points	1.105	4.00
Employment growth*	158 %	4.45 %-points	4.450	0.64

For information				
	Sample mean of treated firms (firms with high support)		Sample mean of non-treated firms (firms with low support)	
Investment intensity	€20,583		€8,117	
Investment share	20.99%		9.13%	
Employment growth	7.27%		4.11%	

* *Note:* The coefficent of the treatment dummy in the equation for employment growth was obtained by a more conventional two-step estimator rather than by Maximum Likelihood. Estimation by ML yielded an unplausible high coefficient value for the treatment dummy. However, ML results and two-step results for both investment outcome variables were roughly similar.

5

IMPACT ANALYSIS OF R&D GRANTS

5.1 DESIGN AND MODEL SPECIFICATION

The IAB Establishment Panel provides information on public grants for investment purposes. The various programmes and projects of direct financial support for R&D activities either funded by the federal government, the states or the EU are not covered by the IAB Establishment Panel. Hence, information on this important topic for the ERDF is not available for the programme period between 2000 and 2006 inside the IAB Panel.

With respect to the data of the indicative financial planning of the ERDF from 2000 to 2006 in East Germany the support category 1.2 “support of research, technological development and promotion of information society” accounts at least for 25 % in total public funding for enterprise support in priority 1 “support of the competitiveness, in particular for small- and medium-sized firms” of the ERDF (see GEFRA et al. 2003). Unfortunately, based on the IAB Establishment Panel it is not possible to provide empirical evidence about the impacts of various R&D programmes and projects in this area.

To be able to investigate the effect of R&D subsidies in this section we use with the GEFRA business survey 2004 to assess the impact of direct support measures for R&D and innovation during the ERDF period 2000-2006 in East Germany. The questionnaire of the GEFRA survey includes questions asking for detailed information on direct grants for R&D. Similar to the IAB Establishment Panel, the structure of the questionnaire of the GEFRA Business Survey relies implicitly on a model of a production function. Therefore, data is available not only for the competitiveness and innovativeness of the firms measured by outcome variables such as sales, labour productivity, or number of patents, but also for factor inputs of labour, intermediate inputs, and inputs of human and physical capital. And, most importantly for the purpose of impact analysis, the firms were asked whether they received funding by R&D support programmes of the federal government, the federal states or the European Union.

Box 4: The GEFRA Business Survey 2004

The GEFRA evaluated the guideline “Support of Joint Research Projects” on behalf of the Thuringian Ministry of Science, Research and Arts. This programme was co-financed by the ERDF. Thuringia is one of the six Federal States in East Germany. Amongst them, Thuringia is the third leading location for innovation activities in East Germany (after Berlin and Saxony). It accounts for 18 % of all patents. Thuringia’s shares in total R&D personnel and in total R&D investments amount to 13 % and 18 %, respectively.

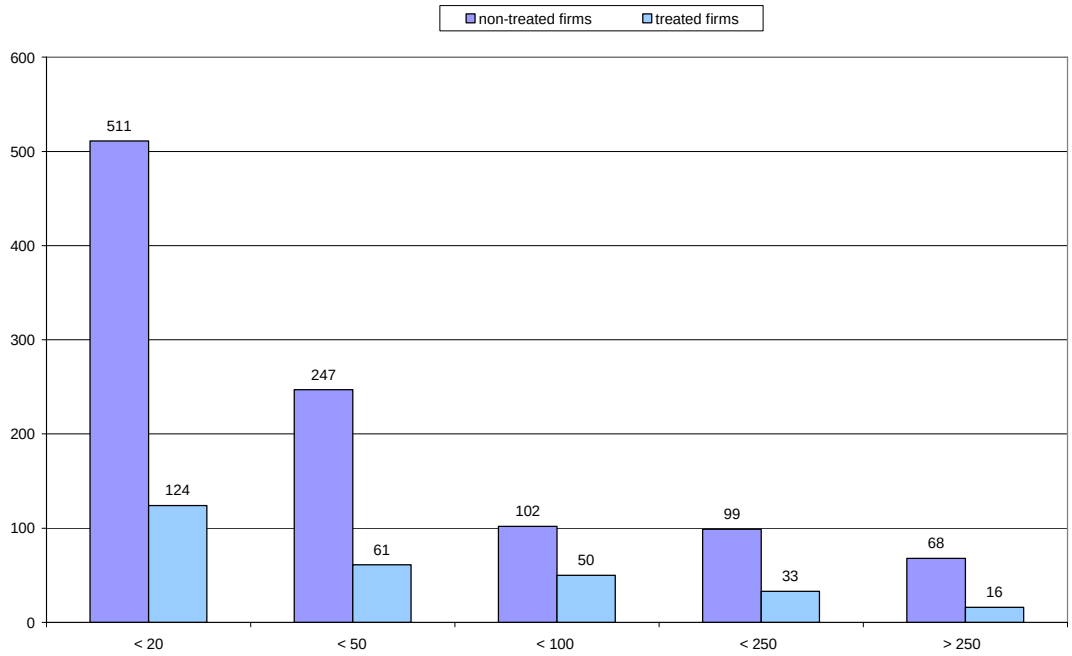
For the evaluation studiy GEFRA conducted a comprehensive survey of Thuringian firms for which a total of 6,861 enterprises within the manufacturing and production-oriented service sector have been contacted. The return rate was about 21%, so that a representative data base for manufacturing firms and business oriented services in Thuringia was generated by the survey. The database includes 1,484 firms of which 284 firms received public R&D grants. In addition to participation in R&D support programmes the survey provides information for a large set of firm-specific variables, e.g. a set of outcome and control variables. In contrast to the yearly surveys of the IAB Establishment Panel the GEFRA-Survey was carried out only for 2004. The questions in the questionnaire of the GEFRA-Survey refer to to firm-specific data for the years from 2001 to 2003. Until now the database was only used in a descriptive way, e.g. mean values etc. A micro-econometric data analysis which takes into account the participation of firms in R&D support programmes upon this data source has not yet been conducted.

In the following, the effects of public grants for R&D and innovative activities will be analyzed based upon the GEFRA Business Survey for Thuringia. This impact analysis can be seen as a complement to the analysis of enterprise support with regard to investment subsidies and the outcomes for investment behaviour based upon the IAB Establishment Panel. In this respect, it should be taken into account that empirical evidence on effects of public grants for R&D and innovation on firm performance in (East) Germany is only available on the base of the so-called Mannheimer Innovation Panel (MIP) by now. Given the limitations in our database with respect to the time dimension we focus on cross sectional matching estimators.

Since all possible R&D programmes launched by public authorities are covered by the GEFRA business survey, our approach is not restricted to a particular policy measure but reflects the effects of public R&D policy collectively. As noted by Almus and Czarnitzki (2003) the ability to identify exactly whether a firm received any subsidies for R&D projects or not could be seen as a major advantage. According to them many studies deal with only one specific public R&D scheme and cannot control for possible effects of other sources of public R&D funding. In contrast, our approach is able to construct a treatment group consisting of those firms that received subsidies at the regional, national and EU level.

In total we have information about 284 firms in the sample which received R&D grants and 1,027 firms which did not. Figure 5.1.1 shows the distribution of treated and control observations for the 5 different size classes which were used in the estimation procedure. As the figure shows, for each size class we have a sufficient number of control observations for each subsidized firm. We turn to details about the empirical operationalisation and the discussion of empirical results in the next sub-section.

Figure 5.1.1:
Distribution of treated and control firms by size class



The dataset incorporates different variables representing innovation activity at the firm level. Since information is available with respect to total R&D expenditures in line with the analysis for investment behaviour we defined a measure of R&D intensity, which relates the firms' R&D expenditure to its employment (R&D expenditure per employee). In addition we used total R&D expenditures as a share of total turnover (R&D expenditure share). Due to their right-skewed distribution in the estimation we used logarithms for both of these outcome variables.

Due to the lack of data we were not able to use employment growth as additional outcome variable. However, contrary to the case of investment grants an contemporary increase in overall employment of the supported firms could not be regarded as a immediate goal for the public support of R&D projects. It could be assumed that employment effects of successful R&D activities at the level of the firm occur only with a considerable time lag.

Table 5.1.1:
Definition of variables

Variable	Description
(log) R&D intensity	defined as R&D expenditures in relation to employment 2003
(log) R&D share	defined as R&D expenditures in relation to total turnover in 2003

In terms of finding appropriate explanatory variables to control for programme selection in the first-step binary response model estimation different suggestions have been made in the empirical literature. These typically include variables that represent (i.) firms' research activities, (ii.) the degree of firms' internationalization, (iii.) the skill structure of the workforce, as well as (iv.) standard control variables for observed firm heterogeneity such as firm size and age as well as a set of sectoral and further related membership dummies. In order to account for possible non-linearities we also tested for the effect of squared values for the set of common control variables. A full list of the various continuous and binary dummy variables used to pin down the firms' probability of receiving R&D subsidies is given in table A.12.1 in the appendix.

Among the standard firm specific control variables next to firm size measured by 5 different size classes (up to 20, 50, 100, 250, and more than 500 employees) we also include a proxy for firm age (age), which might play an important role in receiving R&D subsidies because younger firms might be more likely to receive subsidies in start-up programs to conquer their poor access to the capital market and their lack of own financial capacity. The foundation of a firm usually indicates innovative activity and young firms are expected to be faster in doing their research. Older firms however dispose of a greater experience in R&D and the application for subsidies.

We further use the capital-intensity (capint) defined as tangible assets per employee to control for the technology used in the production process and define a variable (capage) to control for the age and quality of the tangible fixed assets. The variable takes values from 1 to 4 and distinguishes among those assets being "up to date", "sufficient", "parts being obsolete" and "all being obsolete". We also test for the effect of the investment intensity defined as total investments per employee being made in 2003 (inveqmt).

As Kaiser (2004) points out, the skill structure of a firm's workforce is an important determinant of research activity and also is likely to influence a firm's ability to attract public funding in a significant way. We thus further add the share of highly educated employees (hchigh), i.e. those who have a university degree or a one of a university of applied sciences, relative to total employment at the firm level. In the empirical literature the role of competition usually is taken into account by several variables like export ratio, import ratio and market share (see e.g. Czarnitzki & Hussinger, 2004, Aertz & Schmidt 2006, Almus & Czarnitzki, 2003 as well as Licht & Stadler, 2003). We use import and export ratios (imports to sales and exports to sales) on a firm base in order to capture international activity as an indicator for competitiveness. One might assume that exporting firms are more likely to innovate and are in consequence more likely to receive R&D subsidies. Next to these standard control variables we also add several variables that have not been used in former literature like more detailed information about the share of input and sales coming from or going to the region within a close 30 km radius (labelled inregn and outregn respectively), remaining input-ouput relations within Thuringia (inthrg and outthrg), East Germany (ineast and outeast) and Western Germany (inwest and outwest).

Descriptive statistics for the continuous variables used in the empirical analysis are shown in table A.12.2.

With respect to the set of dummy variables we include the following variables: First, we define a measure for the legal form of each firm (dlbty), which turns to be 0 in the case of limited liability and 1 for the remaining legal forms (i.e. joint partnerships). Our ex-ante theoretical expectation is that firms with limited liability are more likely to receive public funding, be-

cause the government will verify the existence of an operating industrial plant. As all firms have to prove their existence and those with a liability limiting legal form in Germany have to be recorded in the trade register while other legal forms do not, and ministry officials might take risk-avers decisions, liability limiting firms might be more likely to receive public funding. Further dummy variables indicate the affliation to a parent company: Here we classify firms as belonging to a proprietary company either in West Germany (dwgroup), East Germany (deast) or abroad (dforeign) compared to self-contained firms. We assume that firms with a parent company might have better access to information and experience in applying for subsidies.

Next we specify dummy variables that indicate whether a firm is paying its employees a nominal wage that is equal to, higher of lower than the union rate (defined as dwequal, dwplus and dwminus). Either companies may be more successful and can afford to pay an efficiency wage above the union rate or those who pay less prove to be more flexible and innovative in a difficult macroeconomic environment, which may be especially relevant for East German firms. But we do not have any explicit ex-ante expectation. Finally, the existence of an R&D department (drddpmt) should reflect the absorptive capacity and R&D experience in a firm. We expect that those firms being regularly engaged in R&D activity show a higher probability to be innovative and receive R&D subsidies. The pool of binary variables is completed by a set of sector dummies.

Table A.12.3 shows descriptive statistics for the binary variables used in the empirical analysis.

5.2 ESTIMATION RESULTS

As described above, in order to estimate the policy effect as difference between the average outcome of the treated and untreated firms based on propensity score matching we first have to calculate the propensity score through a binary response model for programme participation. We choose a probit estimation to do so. The obtained linear index can then be used as input in the second step matching algorithms. Our resulting probit model for the probability of a firm to receive subsidies depending on firm specific characteristics is reported in table A.12.4 in the appendix. The first column in this table contains a probit specification with all of the potentially relevant variables defined above, in the second model reported in column 2 we choose a more parsimonious specification guided by the value of the pseudo R^2. The latter model with the smaller set of variables was also found to have superior characteristics in terms of the balancing properties of the model (based on a stratification of 7 blocks with equal score range).

As the table shows, the probability to receive an R&D subsidy is most importantly influenced by the question whether a firm is permanently engaged in R&D activity or not (proxied by the dummy indicating the existence of an R&D department; rddpmt) and by the share of high skilled workers. For both variables we get the a-priori expected significant positive effects. The inverse of the age has a significantly negative influence on the probability to receive subsidies, that is, the younger the firm the lower the probability to receive a subsidy.

Firms that buy their inputs abroad seem to be internationally integrated and thus are more likely to receive a subsidy, while those firms that buy their inputs in the region within a radius of 30 km show a slight lower probability to receive R&D subsidies. The effect of selling prod-

ucts and services to Western Germany is found to be significantly positive both in the full and the more parsimonious model. In comparison to the reference value of firms with 500 or more employees the probability to receive a subsidy is lower for all smaller firm classes. However only for firms with 250 to 500 employees the coefficient turns out to be statistically significant. Finally, the included industry dummies for various manufacturing and knowledge intensive service sectors have a strongly significant positive effect on the probability to receive an R&D subsidy indicating that the policy programmes are especially designed to target high- and medium high-tech sectors both in manufacturing as well as production oriented service sectors.

Using the fitted values from the probit specification we then run a propensity score matching routine - namely a kernel matching algorithm with common support and a bandwith of 0.06 - on both of our R&D outcome variables that might be influenced by the receipt of public subsidies: R&D intensity (R&D expenditure per employee) and R&D share (R&D expenditures relative to total firm turnover). In addition we report results from OLS-Regressions with the same set of observable variables as controls. Detailed regression results are given in tables A.12.5 and A.12.6 in the appendix.

Table 5.2.1:
Overview of results – R&D investment per employee and R&D share

Method	**Treatment effect**		**For information**	
	Relative terms	**Absolute terms**	**Coefficient / difference in logs**	**t-value**
R&D intensity (R&D per employee)				
Linear Regression	116%	€6,188	0.793	3.65
Propensity-Score-Matching	160%	€7,089	0.954	3.31
R&D share				
Linear Regression	130%	10,7 %	0.857	4.07
Propensity-Score-Matching	159%	11,6 %	0.950	2.97

For information				
	Sample mean of treated firms		Sample mean of non-treated firms	
R&D intensity	€11,531		€4,072	
R&D share	18,9%		9,8%	

As the results in table 6.1 show that for both R&D outcomes we get evidence for a significant positive difference between the R&D activities of treated and control firms. This is an important finding since R&D subsidies do not seem to lead to a complete substitution-effect, but instead subsidized firms have higher R&D expenditures relative to employment or turnover compared to the control group of non-subsidized firms.

To see whether the estimations have been successful, we then perform a mean comparison for the explanatory variables used in our sample and test for statistical significance of differences in the means of the variables based on a two-tailed t-test between the supported firms (column 2) and either firms from the potential control group (column 3) or from the selected control group (column 4). The results are reported in table A.12.7 in the appendix. As the results shows, the propensity score based matching is able to equalize differences between the treated and the controls in the progress of matching, while ex-ante the null hypothesis of equality in the means could be rejected for important determinants of the probit specification such as continuous R&D activity, high skilled workforce and internationalization activity among others.

We finally aim to check for the sensitivity of the empirical results with respect to different matching routines, which are frequently applied in empirical work. We particularly perform k = 5 nearest-neighbours matching with an additional caliper restriction in terms of one fourth of the standard error of the bounded propensity score (0.06), as well as kernel (epanechnikov based) matching with different bandwidths. Finally we used the procedure of Mahalanobis metric distance matching to include additional restrictions beyond the propensity score in the selection of matching pairs: we apply both the restriction that firms belong to the same industry and that they belong to the same industry and firm size category. All these procedures are run with the common support restriction in order to cut out observations that have non correspondent in the comparison group and vice versa. The results show that both outcome variables remain significant over the range of applied estimation algorithms. This gives additional support for the positive effect of R&D subsidies on private sector R&D activity.

Thus, our results based on the propensity score matching approach confirm the positive effect of R&D subsidies on private R&D activity already found in previous work for Germany using data from the MIP. However, with regard to the magnitude of the impact our estimated treatment effect is higher: Almus/Czarnitzki (2003) report for the innovation share of subsidized firms an average treatment effect which is equal to 4 percentage points, according to Czarnitzki (2003) the treatment effect amounts to a 5 percentage points increase in the innovation share of supported firms. In both cases these absolute effects equal in relative terms a nearly doubling of the innovation share. Further numerical examples are Czarnitzki/Fier (2002) (increase in innovation share of 5.7 percent points, in relative terms 70%) and Czarnitzki/Hussinger (2004) (increase in innovation share of 4.1 percentage points, in relative terms 66%). The reason for our higher impact estimate might be the different sample structure of the MIP and our database. The share of SMEs is markedly higher and the average size of firms is lower in our sample of Thuringian firms than in the MIP. Because the subsidy rate is much higher for SMEs, a larger fraction of their R&D expenditure is due to the R&D grants.

Although we do not have data on the total amount of R&D grants which the supported firms received from the federal government and the Thuringian state in our sample, we assume that firms in general fully exploit the maximum ceilings for aid intensity given by the commu-

nity framework for state aid for R&D and innovation which was in force in our investigation period 2001-2003. These ceilings were around 20 percentage points higher for SMEs than for large enterprises. Czarnitzki/Hussinger (2004) reports in general a subsidy rate in the range of 30 to 50% for the sample of firms in the MIP. According to the funding guideline of the Thuringian Government at that time firms could receive a proportion of their R&D project costs as a grant which amounts to 80% at a maximum. Against this background we estimate that the subsidy rate for our sample of firms was on average 60%. Now, if we assume a 50% subsidy rate and the case of exact additionality of the public R&D grant one should find a treatment effect of 100%. For a 60% subsidy rate the respective treatment effect can be calculated to be equal to 150%. Given these figures one can conclude that our estimate of the treatment effect is roughly in line with the estimates of other authors and points to the fact that public R&D grants do not lead to a crowding out of private R&D expenditures. However, on the other side R&D grants do not induce additional private funds ("crowding in").

5.3 CONCLUSION

In this section we analysed the effect of public R&D support on private R&D activity for a regional cross-section of firms in East Germany between 2001 and 2003. We use a so far unexplored database for the federal state of Thuringia from 2001 to 2003. Building upon an alternative representative dataset to the widely applied Mannheim Innovation Panel (MIP) our analysis may be seen as a crucial robustness check for earlier empirical work for (East) Germany, which relies exclusively upon the MIP data.

In the first step probit estimation for programme selection we find that the share of a highly skilled workforce and the engagement in permanent R&D activity are important determinants of the probability for receiving R&D subsidies. Both variables have the a-priori expected positive sign. Next to variables measuring the degree of internationalization and regional input-output relationships, different sectoral dummies show significant coefficient signs and indicate that especially firms in high- and medium high-tech sectors of the manufacturing and service industries are more likely to receive R&D funding. With respect to the second step matching, for our regional sample of Thuringian firms the impact on R&D intensity (defined as total R&D expenditures relative to employment) and on R&D share (defined as total R&D expenditures relative to total turnover) is found to be significant. Robustness checks for various alternative matching algorithms confirm this result indicating that the effect of public support to private sector R&D activity is significantly positive. Thus, our results based on the propensity score matching approach confirm the positive effect of R&D policy on private R&D activity already found in previous work.

Taken together, our results indicate that subsidized firms indeed show higher research activity measured in terms of R&D intensity. Our findings thus give support to earlier evidence for East Germany, which so far have been solely based on the Mannheim Innovation Panel (MIP) as the only database accessible for analyses on the role of public policy in the innovation process of (East) German firms.

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6

ASSESSMENT OF EMPIRICAL RESULTS

In addition to the empirical work based on available East German data to identify the impact of investment subsidies on private investment and R&D, a series of short interviews were performed to achieve some insights on how persons from the legal authorities assess the results of the study and how they judge the future of direct investment subsidies as well as how they regard the counterfactual evaluation methods to identify the impact of the policies under investigation. 16 Interviews with programme managers and representatives from the managing authorities of the six Eastern German states were performed. The full list interviewees is documented in Appendix A.14.

The interviews are based on an interview guide, given in Annex A.13. After a brief introduction of the research approach of the study the outcomes of the counterfactual evaluation analysis were reported and explained. Secondly, the representatives were asked to comment on the plausibility of the results and to assess the impact of the enterprise support from their perspective. Finally, the people were asked whether they perform evaluation studies for ERDF support using counterfactual methods or are planning to do so in future. Furthermore, they were asked how they judge the use of counterfactual evaluation methods.

The answers of the representatives of the managing authorities and program managers to the questions can be summarized as follows:

Concerning the General questions:

1. How important are direct investment subsidies for the development of the competitiveness of your region from your point of view?
2. How important are direct R&D subsidies for the development of the competitiveness of your region from your point of view?

The interviewed persons considered both the investment subsidies as well as the R&D support for enterprises on competitiveness of the region as highly important On a scale from 0 (no importance) to 5 (very high) in most cases values between 4 (high) and 5 (very high) were assigned to the support. Generally, differences concerning the importance between the investment and R&D support were in general not visible. Only in one case, direct investment support was classified with a value of 3 and regarded as less important than the public R&D funding with a value of 5. Overall, the programme authorities as well as the programme managers regard their programmes as significant and important. This is not an unexpected view, since the results are to some extent biased towards a positive assessment.

With respect to the specific results of the study we asked:

3. The study shows that supported firms have investments that are 2.5 times higher than those of the non-supported firms, i.e. on average €11-12,000/employee rather than €4000. Moreover, on average a given € of grant produced something like €1.50 of investment.
    a. How do you assess these results?

b. Do these estimates correspond with your experience / expectations or are you surprised that investment subsidies are that important for an individual firm?

Generally, the results for investment subsidies were classified as plausible and were in line with the experience and expectations. With regard to the program managers, they mentioned that even higher leverage effects could be plausible (In one case, a leverage effect of 1 to 5 was mentioned, documenting the high uncertainty of the real, expected impact). It was emphasized that especially for SMEs the investment grants were crucial for the realisation of the investment project at all. Without support these firms would not invest at all, which would explain the high leverage effect of investment support for enterprises. It should be noted, however, that these judgements are usually formulated on the basis of the information from the respective monitoring systems. The indicators from the monitoring systems only deliver information for supported but not for non-supported firms. The appearance of deadweight effects is a priori excluded by using only this "selected" information.

4. While the study finds that investment subsidies lead to real employment gains, these tend to be small – the main effect is on productivity. This suggests that firms are using subsidies to modernized and deepen their capital stock, rather than to increase employment.

    a. How do you assess these results?

    b. Do these estimates correspond with your experience?

Again, these results from the investigation were also classified as plausible. However, the majority of the program managers pointed to the fact that the guidelines of the Joint Task program to some extent explicitly aimed at job creation as a funding requirement. Productivity increases were seen as a natural byproduct of investing in new machinery, vehicles and buildings, but nevertheless were – at least in the past – often accompanied by an expansion of firm size and thus employment. Currently – under the impression of the economic and financial crisis – the main impact of investment activities on increasing productivity and competitiveness of firms is stressed.

5. The study detected no difference between various size classes of firms. Neither for investment nor for employment. A preferential treatment of SMEs seems not to be justified from this point of view.

    a. How do you assess these results?

    b. Do these estimates correspond with your expectations?

    c. Could you name other reasons why SME should be preferred?

The result of a statistical identical relative impact of the investment and R&D support on SMEs and large firms was viewed with scepticism, but was not generally seen as implausible. The programme managers were inclined to the view that the deadweight effects are more pronounced in large companies than in SMEs. Especially, they pointed to the need for a special support for SMEs due to capital market imperfections. Investment grants were seen as a very effective way to overcome credit constraints and to help SMEs to receive loans from their home bank, which they otherwise would not get. But, it has to be beared in mind, that the former argument does not necessarily speak against the result that there are equal *relative* effects on investment per employee by SMEs or large companies. Since the

variable investment per employee is higher for SMEs than for large companies (a fact which is confirmed by the results of the microeconometric approach) this means that the same relative impact will necessarily lead to a higher effect on investment per employee measured in absolute terms.

6. Regarding R&D-support it could be shown that supported firms have twice as high R&D spending compared to non-supported firms. But, more or less the total amount of this additional investment can be traced back to the public support.

    a. How do you assess these results?

    b. Do these estimates correspond with your experience?

The results concerning the impact of R&D subsidies were in general judged as comprehensive. Some of the program managers had the opinion that the leverage effect of the suppport must or at least should be somewhat higher. They were a little bit disappointed by the findings and stressed that actually the goal of the support is oriented towards the generation of additional private funds. However, it was also pointed to the large range of uncertainty which is associated with estimates on the basis of monitoring data which includes only infromation on supported firms. So figures derived by a contrafactual analysis were regarded as more sound.

Finally, tow specific questions concerning the methods of investigation were asked:

7. The study is based on a statistical approach that works with the comparison of groups using sophisticated statistical methods. It is connected with high data requirements and it is necessary to observe supported and non-supported firms on a regular basis over a longer period.

    a. Are there attempts to implement counterfactual data analysis in your area of responsibility?

In four of the six Eastern German states there are currently no efforts to use matching evaluation approaches to evaluate ERDF support for enterprises. In Saxony-Anhalt the evaluation will to some extent take up the the basic idea of counterfactual evaluation by a comparison of outcome variables for supported firms delivered by the ERDF monitoring system with general information on the development of firms by secondary statistical data from official sources. In Mecklenburg-Vorpommern, the application of counterfactual evaluation approaches is foreseen for a thematic evaluation of the R&D funding. In all other countries no systematic approach is given to perform counterfactual evaluation analysis.

    b. Are you interested in having more information about counterfactual methods, so that you would be able to support one or the other study in this area in the future?

All interview partners expressed their general interest in further information about methodological progress in general and about counterfactual evaluation analysis approaches in particular. However, they also pointed to the administrative burden which is related to the implementation of regular surveys of supported and non-supported firms as a prerequisite for the application of a counterfactual approach.

7

SUMMARY AND CONCLUSIONS

Support to enterprises is one of the key priorities of the Structural Funds and an essential component of the Lisbon Strategy. During the period from 2000 – 2006 about 21 percent of the ERDF Funds or approximately €45 billion were given as direct aid to enterprises and R&D across the member states. Direct aid to enterprises was mainly used to support private investment to improve the private capital stock and a smaller share was appointed for enterprise research and development (R&D). Although a considerable part of the ERDF is used to support enterprises, little is known about the impact of the direct aid at the firm level.

The core of the present investigation is to analyze the impact of direct aid to enterprise using econometric techniques on investment and R&D behaviour at the firm level and thereby supplement other work within Work Package 6 that was done during the ex-post evaluation for the period 2000 – 2006 to identify the impact of the ERDF on enterprise and innovation.

Counterfactual impact analysis at the firm level is a rarely used technique to identify the impact of investment subsidies on firm's investment behaviour in physical investment or R&D. The reason is simple in that, although the techniques are available and widely used in the area of active labour market policies or clinical trials, individual firm data that makes it possible to implement counterfactual impact methods are rare. The cause is that most available samples do not contain a mark or variable that would allow to distinct between firms whether they have received direct aid or not.

Counterfactual impact analysis rests on the assumption that it is possible to use firm data that allows to distinct between firms that have been treated, i.e. received direct aid and those who did not. Like in a clinical trial, a controlled experiment, therefore one must be able to identify different groups, namely one that received the medicine and a second one that got a placebo. The difference in the outcome variable, for example the time needed to recover from an illness, between treated and non-treated (placebo) units, can be viewed as the impact of the medicine after control for individual attributes. To perform a counterfactual analysis at the firm level and to come up with an estimate of the difference in investment of treated and non-treated firms, it is therefore necessary to have observations for firm that received direct aid and those who did not.

Depending on the structure of the database and the available enterprise information several methods were used to identify the impact of investment grants or R&D grants on the outcome variable, defined as investment per employee or R&D-expenditure per employee. The methods used range from Linear Regression over Propensity Score Matching to a more complex Simultaneous Instrument Variable Approach and Difference-in-Difference-methods that take the panel structure of the dataset into account.

To identify the counterfactual situation several control variables were used. These cover size of the enterprises (including size classes along the line of the EU classification), age of the firm, export orientation, ownership, skill structure, branch, age of capital stock and capital intensity among others. One main result for this block of control variables is that the estimated impact of investment grants on private investment and R&D is statistically not significant dif-

ferent across size classes, i.e. neither small nor medium size enterprises or big enterprises show significant differences regarding the estimated treatment effect. This seems to be contradictory to what is commonly expected, namely that SMEs have more difficulties to get capital and credits and one could therefore expect higher impacts by giving subsidies to SMEs. From a policy point of view this means that there is no hint that SMEs or big enterprises show different reactions concerning the public intervention and should be treated differently. But this result has to be treated with caution because of the limited size of the database and further investigations are urgently needed to investigate this issue before meaningful conclusions on impact by firm size can be made.

Now we are turning to the estimated effects of investment grants on investment per employee. Table 7.1 shows that the estimated differences in investment per employee between treated firms (those who received in addition to the usual benefits (tax cuts etc.) investment grants) and the non-treated firms (those who only received the usual benefits) range between about €9,000 and around €12,000 per employee, i.e. treated firms have higher investment per employee in the area of €9,000 to €12,000. On average, for non-treated enterprises investment per employee stands at €7,200, whereas treated enterprises have a mean value of €20,400. If we neglect the Difference-in-Difference estimation results due to the small sample size, the estimated effect is about €12,000, i.e. investment per employee is around 1.4 to 1.5 times higher than the investment for non-treated firms.

Table 7.1:
Investment grants – Effects on investment per employee

Method	**Treatment Effect**	
	in €	**in per cent**
Linear Regression	12,377	151
Propensity-Score-Matching	11,859	138
Treatment-Model (IV / Selection-Model)	11,866	139
Difference-In-Difference *	8,932	77
Method-of-Matching Difference-In-Difference *	10,922	115
	Mean value: Investment per employee	No. of Observations
Treated firms (firms with high support)	20,432	1,204
Non-treated firms (firms with low support)	7,202	2,188

* Note: Due to the small sample size which was available for the estimation of this model results should be interpreted with caution. The treatment effect in per cent follows directly from the estimation procedure. The treatment effect in euro is calculated as: Mean value of the treated minus mean value of the treated divided by (1 + (treatment effect in per cent / 100)).

The estimated treatment effects signal that investment subsidies are effective in inducing higher investment, but this does not mean that they are efficient. A necessity would be to have some knowledge about the size of the investment subsidies. But the IAB panel does not contain such information. To overcome this problem a rough calculation of the size of the subsidies can be performed using available data from the statistics of the German managing authority (BAFA). On average investment projects in East Germany received subsidies of around 40 per cent of the total investment sum. Given, that the total investment in a treated firm is €20,000 per employee (as shown in Table 7.1), €8,000 go back to the subsidies (i.e. 40 per cent of 20,000). The average treatment effect stands at €12,000, so that in addition to the subsidies, firms invest in addition around €4,000 per employee. Two-thirds of the additional investment over non-treated firms is explained by the subsidies and one-third is additional. So, the treatment effect is higher then the average subsidy and investment subsidies in East Germany can be seen as relative efficient.

Table 7.2 shows in a similar way the estimated effects on R&D-investment per employee by treated firms (those who reiceved R&D-investment grants) and the non-treated firms (those who did not). Since the database is only a cross-section the number of applicable methods is restricted. The treatment effect ranges between about €6,200 and around €7,100 per employee, i.e. treated firms have higher R&D investment per employee in the area of €6,000 to €7,000. On average, for non-treated firms R&D investment per employee stands at €4,000, whereas treated firms have a mean value of €11,500. R&D investment per employee is between 1.1 to 1.6 times higher than the investment for non-treated firms. Again, the estimated treatment effects signal that R&D investment subsidies are effective. Since we have no reference values for the absolute amount of R&D-subsidies we cannot make any firm statement concerning the efficiency of the subsidies using sample information. A rough calculation of the size of the subsidies can be performed using the maximium available subsidy rates for R&D investment. In Thuringia these are 70 per cent of the investment amount for small firms, to take a conservative view. Given, that the total R&D investment in a treated firm is around €11,500 per employee (as shown in Table 7.1), 8,050 euro go back to the subsidies (i.e. 70 per cent of €11,500). The average treatment effect stands at between €6,200 euro and €7,100, so that there is an additional R&D investment of 0.75 to 0.90 of the R&D investment grants. These results can be viewed as lower bounds of the impact of R&D subsidies. And they are in line with other empirical results that show impacts of R&D subsidies that are around 1. It can therefore be concluded that on average R&D investment subsidies are not completely used to replace private R&D investment.

To summarize the estimation results for investment subsidies for private investment and R&D investment show that targeted enterprises have significant higher investment per employee in East Germany. In addition, it could be shown by using an counterfactual evaluation approach hat both measures worked in East Germany and that the investment subsidies are accompanied by additional investment, increasing enterprise investment in a lagging region and that R&D investment in subsidized firms is substantially higher than in non-treated firms and R&D subsidies do not fully replace private investment. But it has also to be emphasized that the results presented are only the first in a causal chain. Second round effects, like displacement effects are not taken into account since the rest of the economy is by definition ruled out.

Concerning the employment and growth target it can be concluded that direct investment aid deepens capital intensity of the economy and boosts productivity, whereas additional employment in the short run is of second order. In the long-run however the modernised capital

stock may contribute to an enhanced regional competitiveness and thereby induce positive employment effects.

Table 7.2:
R&D investment grants – Effects on R&D-investment per employee

Method	Treatment Effect	
	in €	**in per cent**
Linear Regression	6,188	116
Propensity-Score-Matching	7,089	160
	Mean value: Investment per employee	No. of Observations
Treated firms (firms with support)	11,531	229
Non-treated firms (firms without support)	4,072	186

Note: see Table 1

Finally, it was shown that the counterfactual evaluation approach could be implemented for an Objecitive-1 region, but only while available data made it possible to distinct between treated and non-treated firms within the samples. Furthermore, it could be shown that by comparison with results from other studies, the East German results are in line with national and international evidence, so that they can be viewed as a hint how these measures work and have impact at the firm level. It can well be the case to transfer the exercise to other recipient countries and regions as long as data is made available. This could contribute to a growing understanding how public interventions work. But the actual experience shows that only few samples are available to perform this evaluation approach. To perform counterfactual evaluation it seems necessary to set-up regional or national data samples that contain the relevant data. The best way to do this is by using scientific knowledge from the beginning and before a programme or measure is implemented.

A

APPENDIX

A.1 KEY DATA SOURCE: IAB ESTABLISHMENT PANEL

A.1.1 GENERAL INFORMATION

The key source for data in this study is the IAB Establishment Panel. The following information on the IAB Establishment Panel refers to a range of publications of authors of the Institute of Employment Research which is situated in Nuremberg (e.g. Kölling 2000; Bellmann 2002; Fischer et al. 2009). This is the Research Department of the Federal Agency for Employment in Germany.

The IAB Establishment Panel is an annual survey of establishments and is unique in Germany, as it represents all industries and establishment sizes nationwide and can also be analysed on a longitudinal basis.

This survey began in West Germany in 1993, with the aim of building up a representative information system for continuous analysis of labour demand. It has been carried out in East Germany since 1996, making it a nationwide survey. The IAB Establishment Panel is conceived as a longitudinal survey, i.e. a large majority of the same establishments are interviewed every year. Consequently, it enables both analysis of developments across time through comparison of cross-sectional data on different points in time, and also longitudinal studies of individual establishments.

Now in the IAB Establishment Panel approximately 16,000 establishments are surveyed on a large number of employment policy-related subjects. The survey also includes varying focal topics every year. Nearly all the German federal states (Bundesländer) currently contribute regional extension samples to the IAB Establishment Panel. This firstly enables evaluations at the federal state level, and secondly results in a total range of samples that significantly widens the evaluation options at the nationwide level.

A.1.2 SAMPLE DESIGN

The survey unit of the IAB Establishment Panel is the establishment rather than the company. The population of the IAB Establishment Panel consists of all establishments with at least one employee liable to social security as of 30 June of the previous year. The basis for sampling is the Federal Employment Agency establishment file which contains some two million establishments. This is the only data source in Germany that covers all industries and establishment sizes. Establishment numbers for the IAB Establishment Panel sample are drawn from this establishment file. The establishments receive an establishment number for these notifications from the respective Employment Agency responsible for the establishment, as of 2007 from the BA's central establishment number service. These establishment

numbers are compiled centrally in the BA establishment file. The establishment number is the relevant unit for the sampling and weighting processes.

These establishment numbers form the basic survey units for the IAB Establishment Panel. Not every establishment number, however, represents a suitable unit for surveying. The IAB Establishment Panel is based on a disproportionately stratified sample according to establishment size, industry and federal state (Bundesland). Weighted data must be used to make representative descriptive statements on the population.

A.1.3 THE PARTIAL SAMPLES OF THE IAB ESTABLISHMENT PANEL

The longitudinal character of the IAB Establishment Panel is reflected in the sample. Firstly, the IAB attempts to survey as many establishments as possible over an extended period. Secondly, the IAB Establishment Panel sample must also depict the dynamics of establishment closures and "new" establishments. The annual gross sample thus consists of four respective partial samples:

1. responding establishments from the previous year ("continuers sample"),
2. non-respondents from the previous year willing to being surveyed again,
3. "new" establishment numbers,
4. extension sample.

These partial samples are necessary to depict continuity and change in the establishment population. Sample 1, the responding establishments from the previous year, consists of the establishments that are part of the existing stock of establishments from one year to the next. This sample ensures the longitudinal character of the IAB Establishment Panel. The non respondents from the previous year (sample 2) raise the number of cases in cross-sectional terms. In a survey of establishments over an extended period of time such as the IAB Establishment Panel, a concentration solely on the establishments continuing to exist from one year to the next would lead to selection effects. Establishments that have existed over an extended period differ in many operative characteristics from newly founded establishments. In order to depict this dynamic, "new" establishment numbers (sample 3) are added to the IAB Establishment Panel sample every year. These establishment numbers had at least one employee liable to social security as of the reference date, but not in the previous year. Such an establishment number does not necessarily denote a newly founded establishment – as explained above in the description of establishment number allocation. It can also be a "dormant" establishment number or an establishment that has existed for some time, but has only recently taken on an employee liable to social security.

In addition to the samples described above, it is sometimes necessary to add further existing establishments as of the reference date, in order to make up for losses and achieve the required number of cases in the individual federal states (sample 4). Up to the 2001 wave, all establishment numbers ever contained in the gross sample in any of the waves that did not participate or no longer took part in the survey were blocked for all further waves. That is, they were no longer available for the sampling process. As of the 2002 wave, establishment numbers that have already been included in the gross sample, but became non-respondents in the meantime, can be included again after a certain period of time. The reason for this decision was that the population in certain industries or federal states was almost exhausted in the upper establishment size classes, causing problems in filling the cells in the stratification

matrix. The intervening period is determined based on the need for extension establishments. An artificial identification number (idnum) is allocated for processing in the dataset. For organisational reasons, the establishments added back into the gross sample receive a new identification number.

A.1.4 THE QUESTIONNAIRE

The questionnaire consists firstly of one block of questions asked in identical form every year. These questions are supplemented by subject areas that are repeated at regular intervals. For longitudinal analyses, users should pay attention to the precise formulation of the questions, as some deviations occur. There are also questions on specific focus subjects, which vary every year. The survey is generally carried out in the form of face-to-face interviews, with written postal surveys also taking place in some federal states (Bundesländer).

All in all, the IAB Establishment Panel has good response rates for surveys of this kind. However, there are differences depending on the partial sample type and the survey method: "continuer" establishments have a higher response rate than establishments included for the first time, and establishments surveyed in face-to-face interviews have a higher response rate than establishments surveyed by post. In order to enhance the data quality, the data are checked and errors are corrected in the course of an extensive editing process.

The IAB Establishment Panel questionnaire contains numerous questions that are asked in every wave, so as to depict changes consistently over time. This basic programme of questions is generally identical over the years. Several questions, however, have had to be changed at some point. Users should bear these changes in mind for longitudinal analyses.

Up to the 2007 wave, this basic programme consisted of the subject blocks, including employment development, business policy and business development, investment activities, innovations in the establishment, public funding, personnel structure, vocational training and apprenticeships, new and exiting personnel, recruitment, wages and salaries, working times in the establishment, further training and general data on the establishment. In addition, specific subject blocks are also regularly included in the questionnaire at certain intervals, e.g. subjects such as further training, working time, public funding and innovations.

In 1997, two questions were included in the questionnaire of the IAB Establishment Panel to obtain information on firm subsidies. In a first question, the establishments are asked whether they received public grants for investment and equipment (see Box 3 for this question, taken from the IAB Establishment Survey in 2007). The respondent can choose from a range of different sources of public grants listed below the question; one of these sources is Support by European Programmes/Structural Funds. Since the answer is either *yes* or *no*, it does not give any information about the specific amounts of investment grants the establishments have received from the EU or from other institutions. Instead, they are asked in a second question to specify their total amount of overall public funding.

The structure of these two questions has, in principle, not changed over the course of time.[25] However, the survey does not provide information on public funding for each year of the ob-

[25] Between 1997 and 1998 some of the response categories have changed slightly. In addition, in 2001 a response category was added, but these minor changes can be disregarded.

servation period, since the establishments were surveyed on this specific topic only from 1997 to 2003, and in 2005 and 2007.

Concerning the possible answers to the question about different investment subsidies, we consider it important to note that specific programmes or measures in the realm of enterprise support schemes are not listed there – except for the Joint Task „Verbesserung der regionalen Wirtschaftsstruktur“ (GRW) and tax reliefs. Instead, the answers indicate the source of funding, i.e. whether the establishments have taken advantage of funds of the Federal Government, the Federal States or the EU. Here, it has to be taken into account that in Germany it is quite common for different programmes and measures of enterprise support to be funded by the Federal Government and the Federal States at the same time. This is especially true for the GRW, which – being a Joint Task programme by definition – is funded by the Federal Government and the States. Since the German reunification means of the ERDF are especially used in East Germany in order to co-finance the GRW. It cannot be concluded that the funds of the Federal Government, the Federal States and the EU are less relevant as source for direct enterprise support due to the fact that the establishments referred only rarely to these sources of funding in the IAB Establishment Panel compared to a great occupancy of the GRW. It is for the very reason that the first named sources for direct enterprise support finance the GRW.

Due to the inadequate form of response categories in the questionnaire and against the background of the extensive system of investment support in East Germany it is not as easy as it may seem to make a sensible definition of treatment for the impact analysis. Here we would just like to point out that the definition of the treatment variable was possible only as a binary dummy variable on the basis of the qualitative answers of question no. 79 (Box 3). Unfortunately, the total sum of public grants received by a firm could not be used as a variable for measuring the political impulse, because answers to question no. 80 proved implausible in many cases.

Box 3: Extract from the questionnaire of the IAB establishment panel in 2007:

Question No. 79

Which of the following grants for investment and equipment has your establishment/your department received in 2006?

- ☐ funds of the German Common Task “Verbesserung der regionalen Wirtschaftspolitik”
- ☐ funds of nationwide programmes, including the “Deutsche Ausgleichsbank (DtA)” or the “Kreditanstalt für Wiederaufbau (KfW)” or the new “Mittelstandsbank”
- ☐ funds of programmes of the Federal States (German “Bundesländer”)
- ☐ funds of the European Support Programmes/Structural Funds
- ☐ tax reliefs (e.g. investment subsidies or special depreciations)
- ☐ other funds
- ☐ any of it

Question No. 80

What was the whole amount of these grants for investments and material expenses in 2006?

- ☐ €

A.1.5 NON-RESPONDENTS AND QUESTIONS

The response rate to the surveys has varied between 63% and 73%. The variations in the response rates are mainly due to differing sizes of the extension samples. As the response rates among establishments surveyed for the first time are significantly lower than those of continuer establishments, the total response rate is much lower in the years with large extension samples. The response rates for the orally interviewed continuer establishments, however, are stable at between 81% and 84%.

To judge the survey quality, one must look at the non-responses to specific questions as well as the non-responses to the entire survey. Questions with high non-response rates are either hard to understand, hard to answer, or participants frequently refuse to respond to them. These values are registered as “no response” and coded “-9”. Across the waves of the IAB Establishment Panel, the sensitive variables such as business volume, total wages & salaries, share of advance performance and cost of debt in total sales and total investment grants, always have the highest non-response rates, but these are relatively stable. In the written survey, the “no response” rates are considerably higher than in the oral interviews. The lower rate of non-response items and the higher response rates in the face-to-face interviews underline the data quality arising from the survey method applied.

A.1.6 CROSS-SECTIONAL AND LONGITUDINAL WEIGHTING

A random sample, disproportional with regard to the size and branch of the economy of the establishments, is drawn for the IAB Establishment Panel from the establishment file. For this reason, large establishments have a higher probability of being drawn and are thus overrepresented in the sample. In order to balance out this disproportional approach, an extrapolation factor of the IAB was calculated in correspondence with the distribution of establishments in the population. Extrapolation factors enable statements on the population of all establishments with employees liable for social security contributions.

Two weighting procedures can be distinguished in this process: cross-sectional and longitudinal weighting. The possibility of longitudinal weighting is of significance for the panel dataset. Using this process, data from different waves may be linked, provided the same establishments were constantly surveyed. In contrast, cross-sectional weightings have been produced for the individual survey years and are thus independent of one another.

The focus of our analysis will probably not rely on such weighting processes. However, our datasets will provide the before mentioned two different kinds extrapolation factors for every year.

A.1.7 CONSTRUCTION OF A PANEL DATASET

As mentioned above, the IAB Establishment Panel enables us to conduct longitudinal analysis. The availability of panel data will enhance the set of feasible methods we will apply in order to assess the impacts of establishment support.

We will proceed as follows in order to construct a panel dataset:

1. It is necessary to process the required variables from every individual wave of the IAB Establishment Panel. There are variables that are present in every wave, but

also variables that have been sampled at regular or irregular intervals. The majority of variables are subject to change over the course of time. This means that questions may have been modified over the course of time, for example by alterations in the response categories. For this reason, the variables for our panel dataset will be processed in a way that they remain constant over the survey years. Changes of categories can be figured out by checking the variables for alterations in the yearly Questionnaires and Codebooks. In addition, the FDZ Datenreport No. 5 describes the alterations of the respective variables. We also take into account variables that are only surveyed in specific years, e.g. research and development indicators such as the number of R&D-employees within an establishment, because these data may be of additional importance for comparative cross-sectional tabulations of funded and non-funded establishments.

2. In the original dataset of each wave, the variable names refer to the wave (in alphabetical order: “a” corresponds to 1993, etc.) and the question number in each questionnaire (a 02 is the name of question 2 in the 1993 questionnaire). Therefore, the variables will be named by standardized names. Then, it will be necessary to create a new annual variable stating the year of the wave in which the establishment was surveyed. After processing the variables for every dataset, the waves will be brought together by establishment number. This will result in a panel dataset, which may contain several lines for every establishment, depending on the frequency of the establishment’s participation in the survey.
3. Finally, the characteristics covering a specific period, e.g. two years, will be extended to the corresponding previous year(s). Time-series can be completed by means of extending characteristics (e.g. legal form of the establishment). Nevertheless, the period of the variables must always be taken into account for interpretation purposes.

Furthermore, we will take into account changes in the industrial classification system and in the separation of East and West Germany while building the panel dataset.

In the case of industry analysis, it should be beared in mind that the change in the system of classification of economic activities (in particular from WS73 to WZ93) means that data can only be compared over time to a limited extent. Comparative industry analyses can be carried out from 1993 to 1999 and from 2000 up to the most recent available data.

The change in the system of classification for economic sectors from WZ93 to WZ2003 does not restrict comparability of industries, as the changes took place below the level of classification used in the IAB Establishment Panel.

Up to 2006, separate samples were drawn for each federal state and for West and East Berlin. It is, however, no longer possible to allocate establishment geographically precisely to West or East Berlin in the establishment file. Since 2007 Berlin has thus been treated as a single entity since 2007. This affects the definition of West and East Germany. Up to and including 2006, East Germany included East Berlin and West Germany included West Berlin. To overcome this issue a dummy variable will be introduced to make sure that all Berlin establishments will be part of the East German database for the whole sample period.

A.2 EXPOSITION OF MICROECONOMETRIC METHODS

This section draws heavily on Caliendo and Hujer (2005).

A.2.1 ESTIMATION OF TREATMENT EFFECTS AT THE FIRM LEVEL – A PRIMER

The need to evaluate the performance of (direct) enterprise support more rigorously is not questioned any longer. This is especially valid since EU Member States spend significant shares of the EU Structural Funds on these measures and no clear results about the impacts are visible (see further the literature overview in Chapter 4). An ideal evaluation process can be looked at as a series of three steps (Fay, 1996):

- The impacts of the measures on the individual firm should be estimated (micro-econometric evaluation).
- It should be examined if the impacts are large enough to yield net social gains if all spillover effects and side-effects are taken into account (macroeconomic evaluation).
- It should be examined if this is the best outcome that could have been achieved for the money spent (effectiveness- or cost-benefit analysis).

In this section the focus solely is on the first step; steps two and three are well beyond the scope of this investigation (for step two and three compare Bradley et al., 2006; Bradley and Untiedt, 2007). The main issue in micro-econometric evaluation is if the outcome for a firm is affected by the participation in a supporting programme or not. At issue is the difference between the value of one or more firms' target variables in the actual situation and the value of the target variables if they had not participated. A fundamental problem arises because it is never possible to observe both states (participation and non-participation) for the same enterprise at the same time, i.e. one of the states is counterfactual. Therefore finding an adequate control group is necessary to make a comparison possible. This is not an easy task because firms receiving funds usually differ in more aspects than just participation from non-participants and a (naïve) comparison of the average from participants and non-participants will usually lead to a selection bias and therefore does not deliver any useful information about the impact of the measures.

Experimental and non-experimental methods

For a long time a micro-econometric evaluation at the firm level was hardly possible, since the available data was not rich enough or data protection did not allow the use of large firm level data sets. However, in recent years there has been made some progress enabling researchers to use administrative data for evaluation purposes. The evaluation strategy differs according to the data at hand. Ideally, the researcher can plan the evaluation as an experimental one at the outset of the programme. The basic idea of this approach is to assign firms randomly to the participant group and the control group. Both groups then differ only with respect to participation and the differences in the outcomes can be taken as treatment effects. However, this approach – to the best of our knowledge – has not been implemented within the European Union so far and experimental data are not available. Therefore any re-

searcher has to rely on non-experimental data and must choose among non-experimental evaluation estimators.

A lot of methodological progress has been made to develop and justify non-experimental evaluation estimators which are based on econometric and statistical methods to solve the fundamental evaluation problem (see e.g. Heckman and Robb (1985b), Heckman and Hotz (1989) or Heckman, LaLonde, and Smith (1999)). In non-experimental studies, the data are not derived in a process that is completely under the control of the researcher. Instead one has to rely on information about how firms actually performed after the intervention. That is, the observable outcomes are with treatment for participant firms and without treatment for non-participant firms. The objective is to use this information to restore the comparability of both groups by design

The aim of the following is to review some relevant evaluation approaches and to provide a non-technical overview. The different estimators can be classified with respect to two dimensions. The first dimension is the required data for their implementation, where a distinction can be made between panel and cross-sectional methods. The second dimension concerns the handling of selection bias, where two categories arise. The first category contains approaches that rely on the so-called "unconfoundedness" or selection on observables assumption, like matching and regression models. If one believes that the available data is not rich enough to justify this assumption, one has to rely on the second category of estimators which explicitly allows selection on unobservables, too. Heckman's selection model as well as the difference-in-differences estimator will be presented for that situation.[26]

A.2.2 THE EVALUATION FRAMEWORK

Potential outcome approach and the fundamental evaluation problem

Inference about the impact of a treatment on the outcome (say growth, employment, investment) of a firm involves speculation about how this firm would have performed, had it not received the support. The framework for the empirical analysis of this problem is the potential outcome approach, the Roy-Rubin-model (Roy 1951, Rubin 1974). The main ingredients of this model are individual firms, treatment (participating in a programme or not) and potential outcomes, which are also called responses. Within the basic model there are two potential outcomes $(Y^1; Y^0)$ for each firm, where Y^1 indicates a situation with treatment and Y^0 without. To complete the notation, variables, mainly firm characteristics, that are unaffected by treatments are denoted by $\mathrm{X} = (x_1, x_2, \cdots, x_k)$. The firm characteristics (variables) X are assumed to be exogenous (Holland, 1986). In addition, a binary classification indicator D is defined, indicating whether a firm *i* actually received subsidies or not:

$$D_i = \begin{cases} 1 \; if \;\; firm \; i \; received \;\; subsidies \\ 0 \; if \;\; otherwise \end{cases} \tag{1}$$

[26] A much more detailed and rigorous treatment is given by Imbens and Wooldridge (2008). It contains a review of the latest statistical and econometric developments in this area of research, but this is well beyond the scope of this primer.

The treatment effect for each firm *i* is then defined as the difference between its potential outcomes:

(2) $$\Delta Y_i = Y_i^1 - Y_i^0.$$

The fundamental problem of evaluating this individual treatment effect arises because the observed outcome for each individual is given by:

(3) $$Y_i = D_i Y_i^1 - (1 - D_i) Y_i^0.$$

The consequence is that for those firms who participated Y^1 is observed and for those who did not Y^0 is observed. Unfortunately, Y^1 and Y^0 can never be observed for the same firm simultaneously and therefore (2) cannot be estimated directly. The unobservable component in (2), be it Y^0 or Y^1, is called the counterfactual outcome.

An important implication of the concentration on a single firm is that the effect of the policy intervention on each firm is not affected by the participation decision of any other firm, this means that the treatment effect ΔY_i for firm *i* is independent of the other firms, whether they are treated or not. In the statistical literature this is referred to as the stable unit treatment value assumption and guarantees that average treatment effects can be estimated independently of the size and composition of the treatment population (Rubin, 1974).

Treatment effects and selection bias

Since there will never be an opportunity to estimate individual effects in (2) directly, estimations must concentrate on population averages of impacts from treatment. Two treatment effects are most frequently estimated in empirical studies. The first one is the (population) average treatment effect (ATE), which is simply the difference of the expected outcomes after participation and non-participation:

(4) $$\Delta Y_{ATE} = E(\Delta Y) = E(Y^1) - E(Y^0).$$

This measure answers the question which would be the effect if firms in the population were randomly assigned to treatment. But, Heckman (1997) notes, that this estimate might not be of importance to policy makers because it includes the effect for whom the support was never intended. Therefore, the most important evaluation parameter is the so called average treatment effect on the treated (ATT), which concentrates solely on the effects on those for whom the programme is actually introduced. It is given by:

(5) $$\Delta Y_{ATT} = E(\Delta Y \,|\, D = 1) = E(Y^1 \,|\, D = 1) - E(Y^0 \,|\, D = 1).$$

In the sense that this parameter focuses directly on those firms who participated, it determines the realised gross impact from the programme and can be compared with its costs, helping to decide whether the programme is successful or not (Heckman, LaLonde, and Smith, 1999). Given equation (5), the problem of selection bias is straightforward. The second term on the right hand side of equation (5) is unobservable as it describes the hypothetical outcome without treatment for those firms who received treatment.

Only if the condition $E(Y^0 \mid D=1) = E(Y^0 \mid D=0)$ holds, which means that the outcome and behaviour of treated and non-treated firms are not affected by participation, the non-participant firms can be used as an adequate control group. This identifying assumption is likely to hold only in randomised experiments. With non-experimental data it will usually not hold. Consequently, estimating the average treatment effect in (5) by the difference in sub-population means of participants $E(Y^1 \mid D=1)$ and non-participants $E(Y^0 \mid D=0)$ will therefore lead to a selection bias. Selection bias arises because participant firms and non-participant firms are selected groups that would have different outcomes, even in the absence of the programme.

Concerning investment subsidies firms are not randomly applying for subsidies and / or are not chosen randomly by the authorities. The assignment to the group of participants and non-participants might be caused by observable factors, like age of firms, profitability, or industrial branch, or unobservable factors like motivation of the entrepreneur, future prospects of the firm or the decision made by some authority when deciding about an application.

Non-experimental evaluation methods

The discussion in the previous section has made clear that the problem of selection bias is a severe one and cannot be solved with more data, since the fundamental evaluation problem will not disappear. Hence, some identifying assumptions must be applied to to draw inference about the hypothetical population based on the observed population. In the following a selection evaluation approaches are introduced to address this problem. Each approach invokes different identifying assumptions to construct the required counterfactual outcome within a sample of individual firms. The following discussion starts with two estimators (matching and regression) that are based on the selection on observables assumption. Afterwards two estimators that allow for selection on unobservables, too, namely Heckman's selection model and difference-in-difference estimators, are introduced. Finally a few remarks on which estimator to choose will be given.

Matching estimator

Matching is based on the identifying assumption that conditional on some variables *X*, the outcome *Y* is independent of *D*, i.e. being a member of the participants or the non-participants. This is the identifying "unconfoundedness" assumption. It means, that conditional on *X*, non-participant outcomes have the same distribution that participants would have experienced if they had not participated in the programme and vice versa (Heckman, Ichimura, and Todd, 1997). Similar to randomisation in a classical experiment, matching balances the distributions of all relevant, pre-treatment characteristics *X* in the treatment and comparison group. Thus it achieves independence between the potential outcomes and the assignment to treatment. Hence, if the mean exists, the conditional and unconditional means for participants and non-participants are identical, and the missing counterfactual means can

be constructed from the outcomes of non-participants and participants. Furthermore, assuming that the probability of participation (D=1) for some *X* is in the interval 0 and 1 prevents *X* from being a perfect predictor in the sense that it is possible to find for each participant a counterpart in the non-treated population and vice versa. The mean impact of treatment on the treated can be written as:

$$\Delta Y_{ATT}^{M} = E(\Delta Y^{1} \mid X, D=1) - E_{X}\left(E(Y^{0} \mid X, D=0) \mid D=1\right). \tag{6}$$

where the first term can be estimated from the treatment group and the second term from the mean outcomes of the matched comparison group. The outer expectation is taken over the distribution of *X* in the treated population. The method of matching can also be used to estimate the average treatment effect at some points *X* = *x*, where *x* is a particular realisation of *X*. Before considering the next type of estimator, two things should be briefly mentioned. First, it should be clear that conditioning on all relevant covariates is limited in case of a high dimensional vector *X*. For that case Rosenbaum and Rubin (1983) suggest the use of so-called balancing scores to overcome this dimensionality problem. One possible balancing score is the propensity score and matching procedures based on this balancing score are known as propensity score matching. Second, there are several different matching algorithms suggested in the literature, e.g. kernel or nearest-neighbour matching, and the choice between them is not trivial since it involves a trade-off between bias and variance. For an overview see Smith and Todd (2005).

Linear regression approach

Even though regression and matching both rely on the unconfoundedness assumption, there are some key differences between both approaches which are worth discussing. One key difference is that matching, due to its non-parametric nature, avoids functional form assumptions which are implicit in linear regression models. Basically, linear regression makes the additional assumption that simply conditioning linearly on X suffices to eliminate selection bias. Hence, the potential outcomes in a linear regression framework can be written for those who participate as $Y^{1} = X\beta_{1} + U^{1}$ and for the non-participants as $Y^{0} = X\beta_{0} + U^{0}$. The average treatment effect is then defined as:

$$\Delta Y_{ATT}^{R} = E(Y^{1} - Y^{0} \mid X, D=1) = X(\beta_{1} - \beta_{0}) + E(U^{1} - U^{0} \mid X, D=1). \tag{7}$$

The identifying assumption needed to justify regression under unconfoundedness is analogue to those for the matching approach (see Smith 2000).

Selection Model

This method is also known as the Heckman selection estimator (Heckman, 1978) and is based on the assumption that the participation in a programme may be determined by some observed and unobservable factor(s). The procedure consists of a two-stage process. Suppose, that, in a first stage a decision is made whether a firm receives subsidies or not and that participation is a function of observed variables *Z* and unobserved variables *V*:

(8) $$IN_i = f(Z_i) + V_i$$

and attendance in the Programme *D* is given by:

(9) $$D_i = \begin{cases} 1 \ if \ \ IN_i > 0 \\ 0 \ otherwise \end{cases}$$

The basic idea of this estimator to measure the impact of participation is to control directly for the correlation of the participation dummy variable D with the unobservable error term *U* in the outcome equation via $\hat{\lambda}$, the so called Mills-Ratio, estimated usually by a Probit- or Logit-model in a first stage. The second stage consists of estimating

(10) $$Y_i = X_i\beta_o + \alpha D_i + \rho\hat{\lambda}_i + U_i$$

using Ordinary Least-Squares (the algorithm underlying standard linear regression). Under the assumption where U and V are assumed to follow a joint normal distribution, the conditional outcome expectations as:

(12) $$E(Y \mid D_i = 1) = \beta + \alpha + \rho \frac{\phi(Z_i\gamma)}{\Phi(Z_i\gamma)}$$

and

$$E(Y \mid D_i = 0) = \beta - \rho \frac{\phi(Z_i\gamma)}{1 - \Phi(Z_i\gamma)}$$

and the impact of the participation can be constructed easily.

Difference-in-Differences Estimator

The difference-in-differences (DID) estimator requires access to panel data and can be seen as an extension to the usual before-after estimator. Whereas a before-after estimator compares outcomes of firms who participate after they participate in the programme with their outcomes before they participate, the DID estimator eliminates common time trends by subtracting the before-after change in non-participant outcomes from the before-after change for participant outcomes. The DID-estimator forms simple averages over the group of participants and non-participants between pre-treatment period t_0 and post-treatment period t_1, that is, changes in the outcome variable *Y* for treated individuals are contrasted with the corresponding changes for non-treated individuals (Heckman, Ichimura, Smith, and Todd, 1998):

(13) $$\Delta Y^{DID} = (Y_{t1}^1 - Y_{t0}^0 \mid D = 1) - (Y_{t1}^0 - Y_{t0}^0 \mid D = 0)$$

The identifying assumption of this method is:

(14) $$E(Y_{t1}^0 - Y_{t0}^0 \mid D = 1) = E(Y_{t1}^0 - Y_{t0}^0 \mid D = 0)$$

The DID estimator is based on the assumption of time-invariant linear selection effects, so that differencing the differences between participants and non-participants eliminates the bias.

Which estimator to choose?

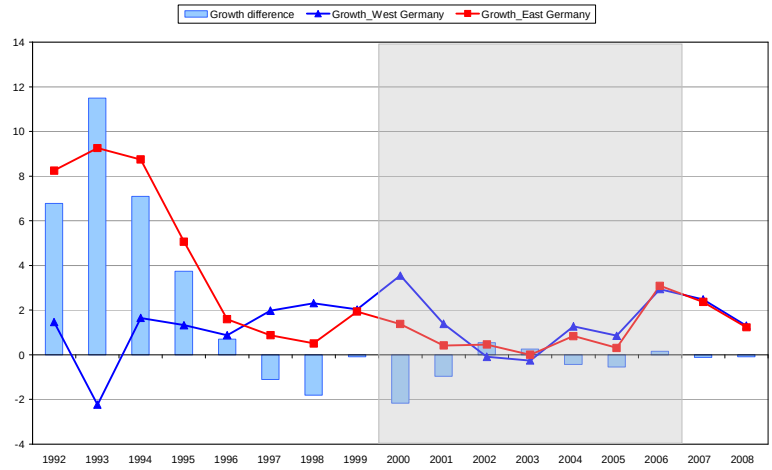
Above a selection of different estimators to identify the impact of a policy intervention has been presented. Finally, the question to be answered is: Which strategy should be chosen to evaluate direct investment subsidies for firms? Unfortunately, there is no clear answer to this question. As outlined, the estimators need different identifying assumptions and also require different kinds of data for their implementation. When the assumptions hold, a given estimator will provide consistent estimates of certain parameters of interest (Smith, 2004). The literature provides some guidance for making the right choice, based either on experimental datasets to benchmark the performance of alternative evaluation estimators or Monte-Carlo simulations.

The different estimators can be classified with respect to two dimensions. The first dimension is the required data for their implementation. Except the DID estimator, the presented methods for the evaluation framework require only cross-sectional information for the group of participants and non-participants. The second dimension concerns the handling of selection bias. Two estimators are based on the "unconfoundedness" assumption. Clearly, the most crucial point for these estimators is that the identifying assumption is in general a very strong one and they are only as good as the used control variables X (Blundell, Dearden, and Sianesi, 2004). If the assumption holds, both matching and regression analysis, can be used. For the situation where there is selection on unobservables, too, two alternative strategies exist. Whereas selection models try to model the selection process completely, DID methods erase a time-invariant selection effect by differencing outcomes of participants and non-participants before and after treatment took place. The crucial assumption for the latter approach is that the selection bias is time invariant.

Taken together, the description of the possible estimators has shown that each non-experimental estimation strategy relies on identifying assumptions and has to be justified case-by-case.

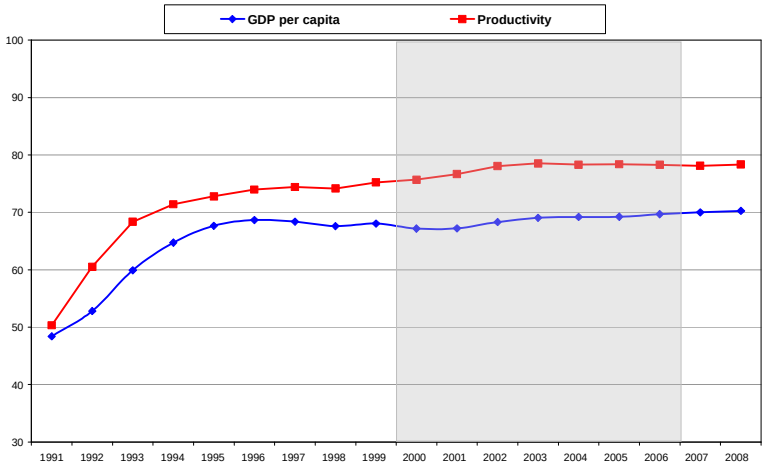
A.3 DESCRIPTION OF CONTEXT INDICATORS FOR EAST GERMANY

Figure A.1:
Real GDP growth in East and West Germany 1991-2008, in %



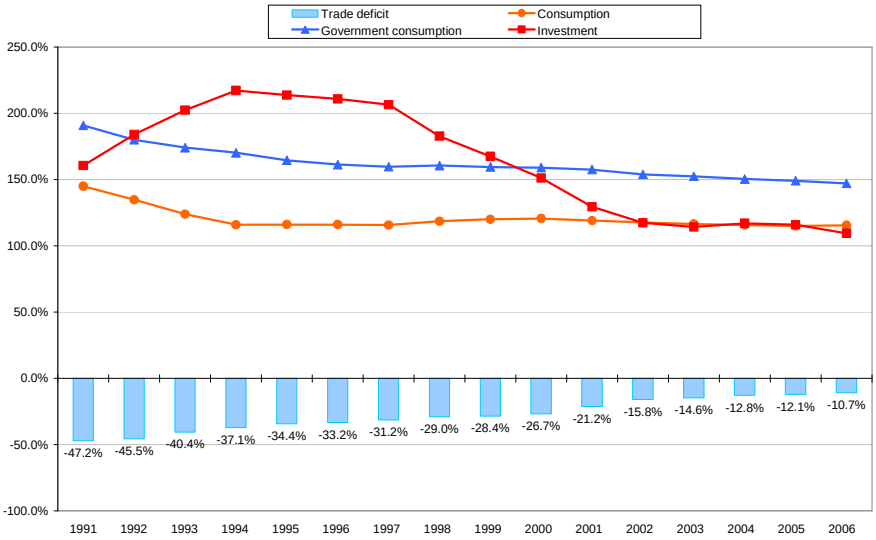
Source: Statistisches Bundesamt (2009).

Figure A.2:
Relative Productivity and GDP per capita in East Germany 1991-2008 (West Germany=100)



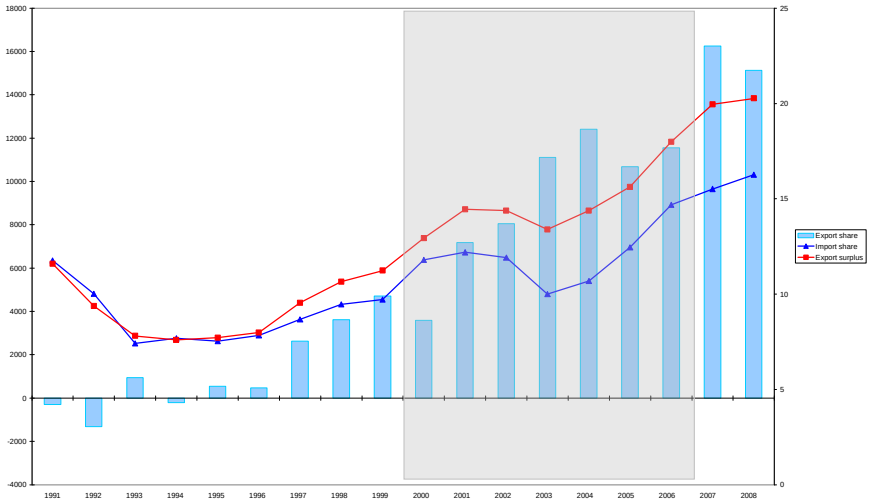
Source: Statistisches Bundesamt (2009).

Figure A.3:
Ratio of consumption and investment rate in East and West Germany (West Germany = 100) and „trade deficit“ (difference of regional absorption minus regional output in % of GDP) 1991-2006



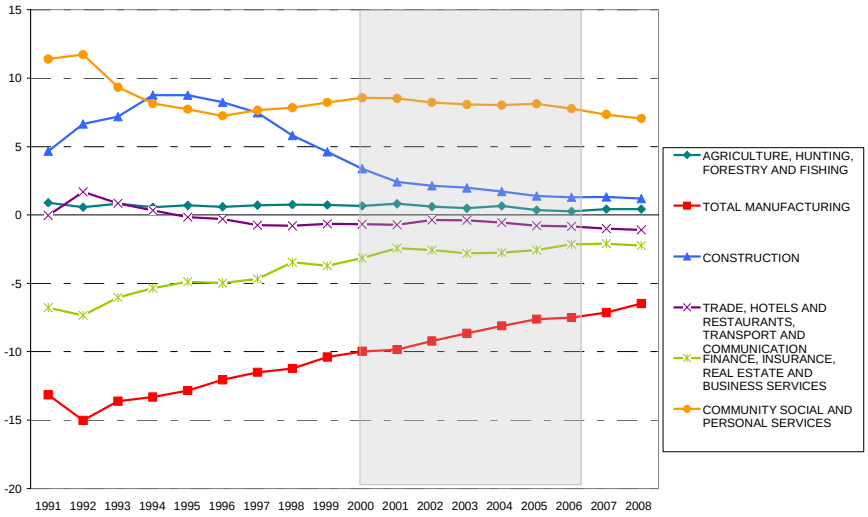
Source: Statistisches Bundesamt (2009).

Figure A.4:
Export und import share (in % of GDP) in East Germany and export surplus 1991-2008



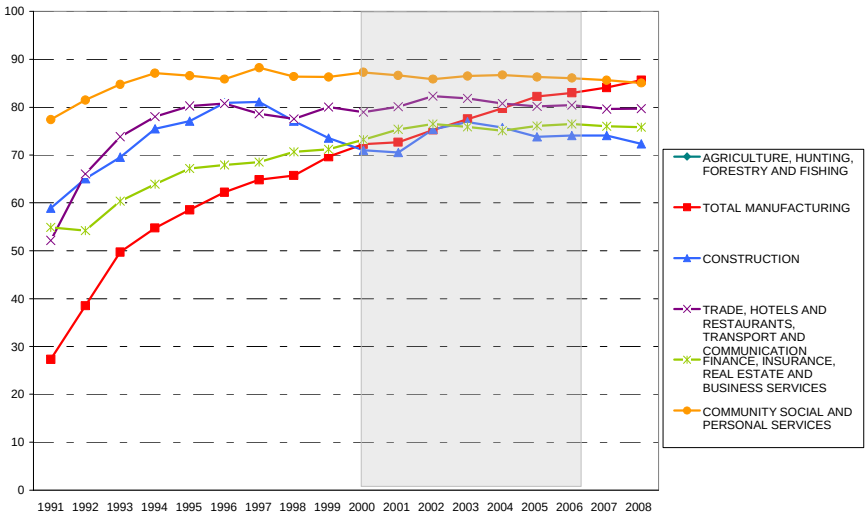
Source: Statistisches Bundesamt (2009).

Figure A.5:
Differences of sectoral shares of value added between East and West Germany 1991-2008, in %



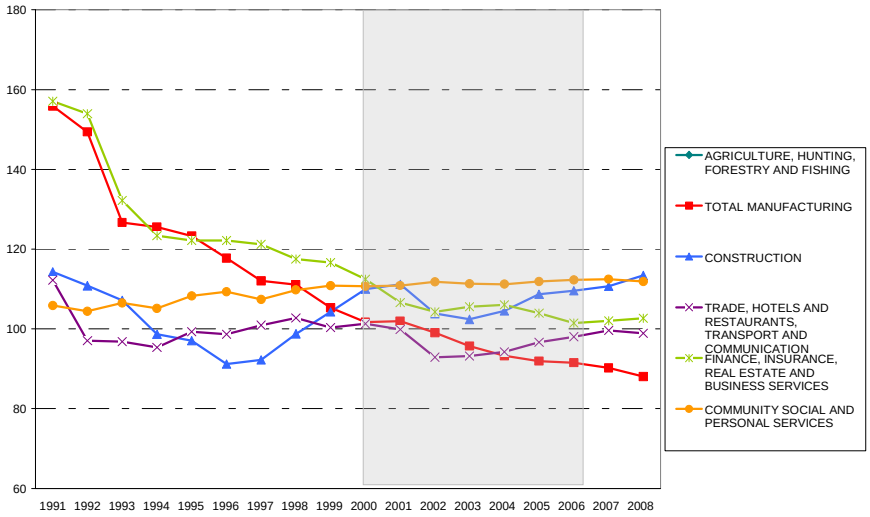
Source: Statistisches Bundesamt (2009).

Figure A.6:
Relative productivity at sectoral level in East Germany 1991-2008 (West Germany=100)



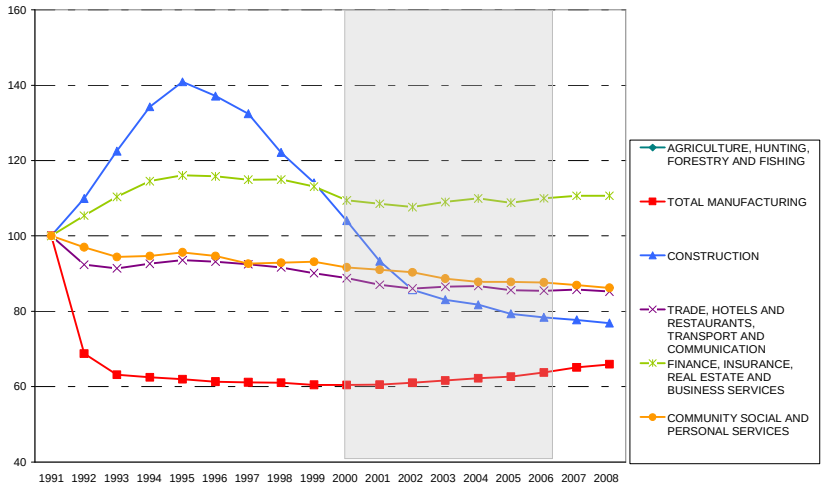
Source: Statistisches Bundesamt (2009).

Figure A.7:
Relative real unit labour costs at sectoral level in East Germany 1991-2008 (West Germany=100)



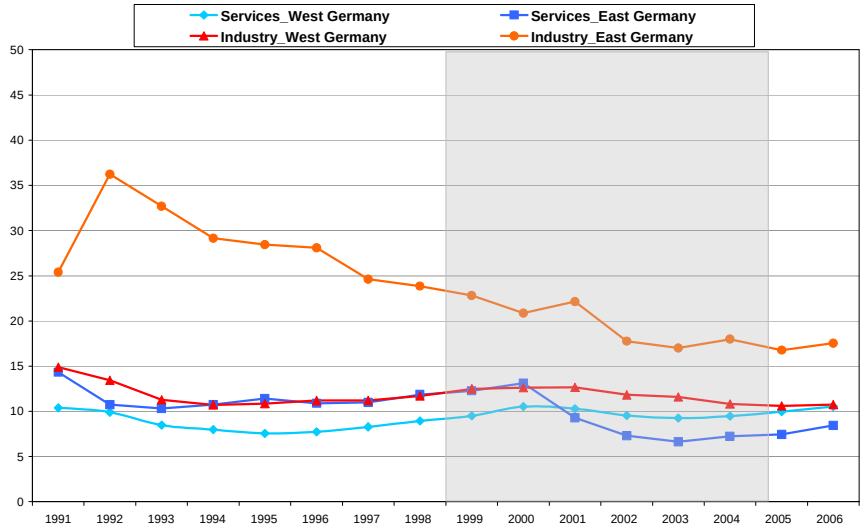
Source: Statistisches Bundesamt (2009).

Figure A.8:
Ratio of employment indices at sectoral level in East Germany 1991-2008 (1991=100, West Germany=100)



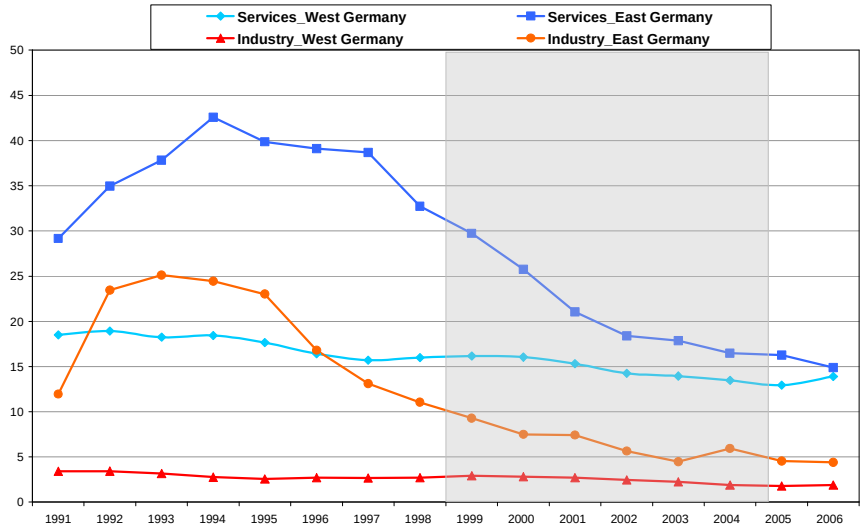
Source: Statistisches Bundesamt (2009).

Figure A.9:
Equipment investment rate in manufacturing industry and services 1991-2008 in East and West Germany



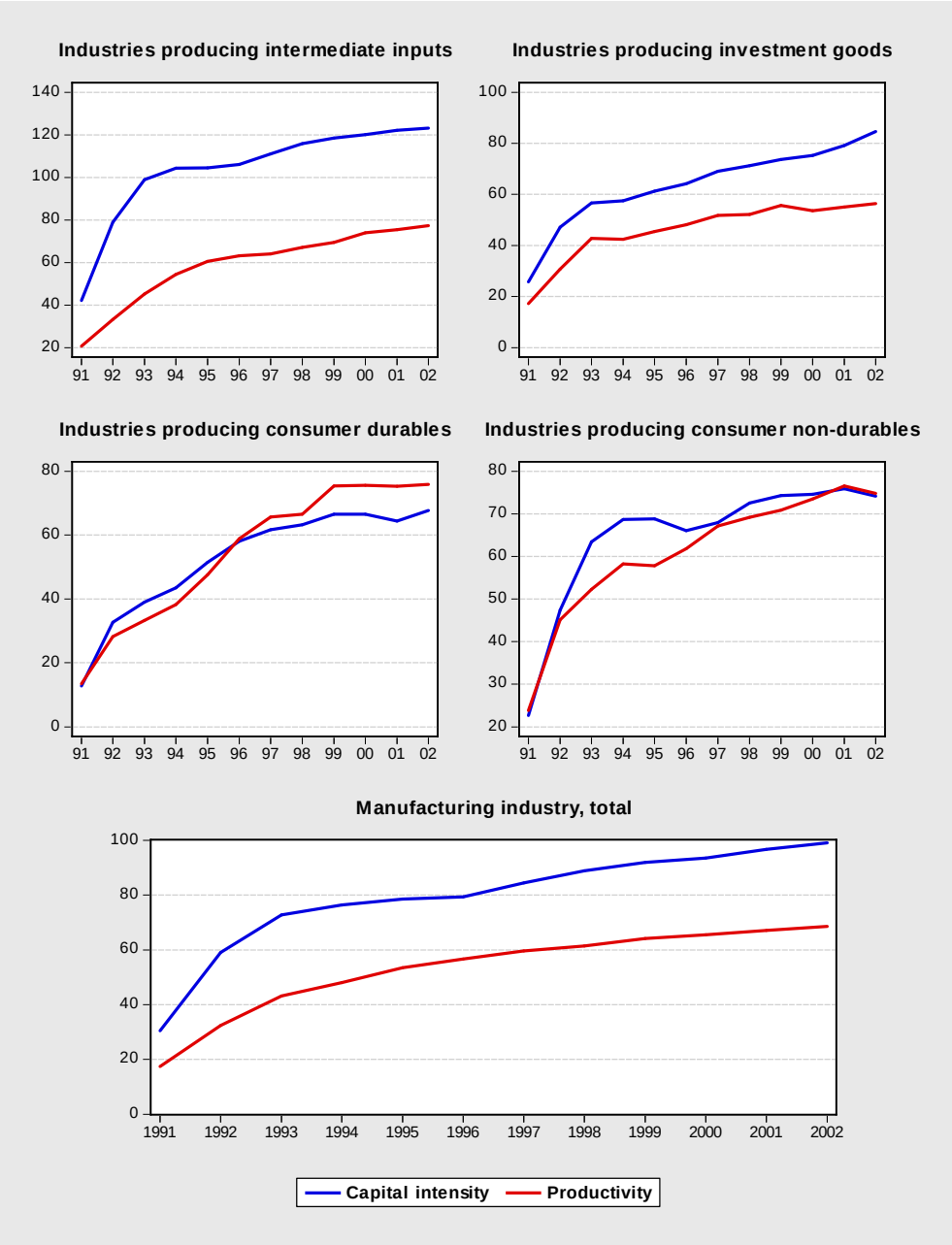
Source: Statistisches Bundesamt (2009).

Figure A.10:
Construction investment rate in manufacturing industry and services 1991-2008 in East and West Germany



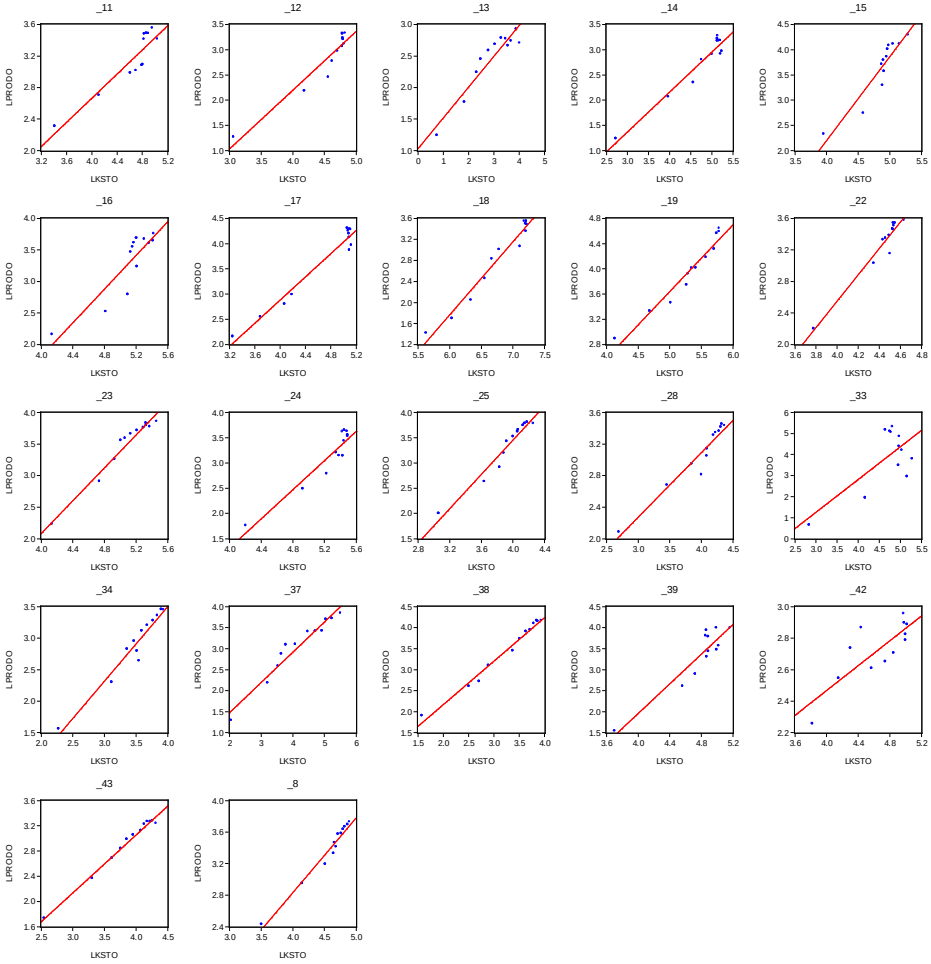
Source: Statistisches Bundesamt (2009).

Figure A.11:
Relative productivity and capital intensity 1991-2002 in manufacturing industries in East Germany (West Germany=100)



Source: DIW (2003).

Figure A.12:
Capital intensity and productivity in 22 branches of manufacturing industry 1991-2002 in East Germany



Source: DIW (2003).

A.4 OVERVIEW OF THE FINANCIAL SUPPORT SCHEMES

A.4.1 INTRODUCTION

In Germany there exists a long and well-established enterprise support system by which numerous incentives for enterprises are given. Funds are provided by the German government, the individual federal states, and the European Union (EU) - in most cases regardless of whether enterprises are from Germany or not. A variety of incentive programmes is available, designed to fit the needs of diverse economic activities at different stages of the business process. Support ranges from cash incentives for new firm foundation to labor-related, and incentives for research and development (R&D). In general, the incentive programmes can be grouped into two overall packages:

- the investment incentives package which includes different measures to reimburse investment costs
- the operational incentives package to subsidize expenditures after the investment has been settled

Figure A.13:
Different Incentive schemes

Each package consists of a different number of programmes. Investment incentives can be made up of cash incentives, interest-reduced loans, and public guarantees. Operational incentives package components include labour-related incentives and R&D incentives. In most

cases, investment incentives and operational incentives can be combined. Since labour-related incentives are not subject of funding by the ERDF in what follows we will concentrate on investment incentives and R&D incentives.

A.4.2 INVESTMENT INCENTIVES

Investor production facility set-up and expansion costs can be significantly reduced using a number of different measures from the investment incentives package. Cash incentives provided in the form of non-repayable grants make up the main components of this package. Public loan programmes and guarantees round off investment project financing.

There are two major programmes directing the allocation of cash incentives:

- The "Joint Task for the Support of Industry and Trade" or "Joint Task" (Gemeinschaftsaufgabe, GRW)
- A special cash incentives programme to promote investment activities in East Germany called the "Investment Allowance" (Investitionszulage, IZ)

The Joint Task Programme

The Joint Task programme is issued by the Ministry of Economics and Technology. It regulates the distribution of non-repayable grants for investment costs throughout Germany. Money available through this programme is usually distributed in the form of cash payments. The amount granted is calculated depending on either investment costs or assumed wage costs (of the future operating business). Foreign investors are subject to exactly the same conditions available to German investors.

The actual incentives amount granted varies from region to region subject to economic development level. Regions with the highest incentives rates, so called A Regions, offer grants of up to 30 percent of eligible expenditures for large enterprises, up to 40 percent for medium-sized enterprises, and up to 50 percent for small enterprises respectively. Regions in East Germany are with the exemption of Berlin all A Regions.

Berlin and several regions within West Germany are also designated incentives regions, but at a lower incentive rate level than their eastern counterparts. In these regions, large enterprises can receive subsidy rates of up to 15 percent, medium-sized enterprises up to 25 percent, and small enterprises up to 35 percent of eligible project costs respectively. As could be seen from Figure 15, incentive regions in Western Germany are mainly situated at the former internal border.

It is important to note that beside investment project location and company size the Joint Task Programme also defines industries eligible for funding. Whereas enterprises in manufacturing industries are nearly completely eligible, only enterprises in certain service sectors such as business oriented services or tourism could apply for investment grants.

The Joint Task Programme is administered by the German states. Each state is free to determine individual ceilings, but is bound to the maximum incentives level prescribed by its respective location. Furthermore each state can restrict the set of industries eligible for funding. Company size is determined according to the classification system of the European Un-

ion in which enterprises are categorized as being small, medium-sized or large according to their staff headcount, annual turnover or annual balance sheet total.

Table A.1:
Overview of cash incentive rates

Type of Region	Small Enterprises[1]	Medium-sized enterprises[2]	Large enterprises
A Region[3]	50%	40%	30%
A Region in Transition[4]	50% (until end 2010) 40% (from 2011 on)	40% (until end 2010) 30% (from 2011 on)	30% (until end 2010) 20% (from 2011 on)
C Region	35%	25%	15%
D Region	20%	10%	max. €500,000 within 3 years[5]
C/D Region	35%/20%	25%/10%	15% / max. €500,000 within 3 years[5]

The bonus of 20% for a small company and of 10% for a medium-sized enterprise is not granted to large investment projects with eligible investment costs above €50 million.

Notes:

1 Includes a bonus of 20%,

2 Includes a bonus of 10%,

3 Lower level of incentives provided in Dresden and Leipzig,

4 The areas of south-west Brandenburg, Halle, Leipzig, Lüchow-Dannenberg and Uelzen will be reviewed by the EU Commission in 2010 and could be reduced to the lower level from 2011 on,

5 “De-minimis-rule“; max. €500,000 until 31 December 2010 possible

Investment Allowance (Investitionszulage/IZ)

The Investment Allowance is a special incentives programme created to promote investment activities in East Germany. As such, the programme is only open to investment projects settling in the states of Berlin, Brandenburg, Mecklenburg- Vorpommern, Saxony, Saxony-Anhalt, and Thuringia.

The Investment Allowance usually takes the form of a tax-free cash payment but can also be allotted in the form of a tax credit. The programme is based on the Investment Allowance Act 2010 and is effective since 2009. Investors automatically receive Investment Allowance funding (subject to all eligibility criteria being satisfied) when investing in East Germany – without having to go through general incentives programme application procedures.

The Investment Allowance can be combined with investment grants received under the auspices of the Joint Task programme. However, the overall sum received from the two programmes combined may not exceed the maximum possible Joint Task incentive rate of the respective region.

For example, if a large company invests €11 million in a Joint Task incentives region with the maximum possible incentives rate of 30 percent, it will receive 12.5 percent from the Investment Allowance automatically and 17.5 percent from Joint Task funds (application must be submitted).

In Table A.2 similarities and differences of the two major programmes for cash investment incentives are summarized.

Table A. 2:
Cash incentive Programme terms and Conditions

	Joint Task	**Investment Allowance**
Eligible Industries	Most manufacturing industries Certain service industries	Most manufacturing industries Certain service industries
Eligible Projet Costs	Direct investment costs Expenditures for buildings, machinery, and equipment Or Future Operating Costs Wage costs for two years	Direct investment costs Expenditures for buildings, machinery, and equipment
Maximum Eligible Investment Amount	Up to €500,000 per job created (not exceeding the maximum total investment costs)	No limits set
General Programme Requirements	The investment project must create long-term jobs. The subsidized equipment must remain at the investment location for at least five years.	The subsidized equipment must remain at the investment location for at least five years.

Interest reduced loans and public guarantees

Public loan and guarantee programmes round off enterprise support for investment project financing. Investors can access a variety of publicly subsidized loan programmes in Germany. These programmes usually offer loans at below current market value interest rates in combination with attractive grace periods. These loans are provided by so-called development banks: publicly owned and organized banks which exist at the national and state level. Each financial tool or programme offered by such banks is accessible to foreign investors subject to the same conditions available to investors from Germany.

- German KfW Banking Group Loan Programmes: The KfW Banking Group (Kreditanstalt für Wiederaufbau - KfW) is the nationally operating development bank of the Federal Republic of Germany. It makes available a number of different financing tools such as loan programmes, mezzanine financing, and private equity. The most important institution for investment project financing is the KfW Mittelstandsbank which offers a number of loan programmes for investment projects including the Entrepreneur Loan (Unternehmerkredit) and Entrepreneur Capital (ERP Unternehmerkapital).
- State Development Bank Loan Programmes: In addition to the KfW, each German state has its own development bank financing projects within the respective state. They offer own loan programmes, especially targeted at start-ups and growing companies. Compared to KfW programmes, state development bank loans are generally tailored to meet the requirements of small and medium-sized enterprises (according to the EU Commission's SME definition).
- Loan Programmes of the European Investment Bank (EIB): At the European level, the European Investment Bank (EIB) finances investment projects in cooperation with private banks. The EIB provides loans below general market conditions, offers long-term repayment periods, and is a host of other favorable conditions. EIB loan programmes are open to large enterprises as well as SMEs. The main financing tools are intermediated loans. Credit lines to banks and financial institutions help them to provide financial means to SMEs with eligible investment programmes or for projects costing less than €25 million.
- Public Guarantees to Secure Bank Loans: Public guarantees can replace absent recoverable, customary banking securities, making funding by banks possible. Commitments vouched for within public guarantees are normally subject to intensive individual examination by external assessors. Public guarantees are available through individual state governments, sometimes in combination with the Federal Government.

Investors profit from interest reduced loans as they are a means of acquiring capital in a cost effective way during the investment phase, thus easing financial longterm planning. Small and medium-sized enterprises in particular can profit from interest reduced loans.

Interest reduced loans constitute a subsidy and can usually be combined with other public funding. However, it is important to note that the total amount of cash incentives available is usually reduced when combined with loan and guarantee programmes.

A.4.3 R&D INCENTIVES

R&D projects can count on numerous forms of financial support. There are many programmes allocating R&D grants, interest-reduced loans, and special partnership programmes. Financing is provided by the German government, the individual German states, and the European Union (EU).

- German Federal Government R&D Grants: Most research programmes financed by the German federal government focus on specific industry sectors with a high dependency on ongoing high-tech research and development (so called Fachprogramme). Each defined industry sector consists of a number of different R&D programmes which support specific R&D projects by non-repayable project grants. Grant rates can reach up to 50 percent of eligible project costs. Higher rates may be possible for SMEs or projects settling in East Germany. Cooperation between project partners, especially between enterprises and research institutions, is usually required. The federal government periodically calls for R&D project proposals followed by a competition of best project ideas. In addition, a number of national programmes without a specific technological focus also exist. These programmes are usually targeted at SMEs. Application for incentives available under these programmes is possible at all times, without any prior calls for proposals or application deadlines.
- German Federal State Funding: In addition to programmes run by the federal government, each German state has R&D grant programmes in place. Some states put particular focus on specific industry clusters, but programmes without specific technological focus also exist. Cooperation between project partners is not always necessary. industrial research (research with a specific practical objective aimed at improving existing products, processes, or services)
- EU R&D Incentives: The EU's Research Framework Programmes offer financial support to R&D projects at the European level. Support is allocated in the form of grants covering up to 75 percent of project expenditures for small and medium-sized enterprises (SMEs). Support is usually provided to R&D projects working on a transnational level with different project partners. The EU usually issues a call for proposals announcing the research area, eligibility guidelines, and the available budget.

R&D incentives programmes generally provide money for R&D project personnel expenditure. Other costs for instruments and equipment may also be eligible if they can be clearly assigned to the relevant R&D project (if such instruments and equipment are used beyond the lifetime of the R&D project, only the depreciation costs for the duration of the R&D project are considered eligible).

To participate in R&D funding programmes, companies must define an R&D project with clear objectives and a fixed time line. The project application should highlight the innovative character of the project and the technological risks involved.

An application for R&D funding also has to set out a commercialization plan, detailing how research results will be transformed into products, processes or services which generate additional turnover and/or employment in the region where the R&D project is located.

The total amount of incentives a project may receive depends on the size of the company (small, medium-sized, or large), whether the project is conducted in cooperation with other companies or research institutes, and the research category of the project. The research

category expresses the scope of the intended project. There are three basic research categories:

- fundamental research (experimental or theoretical work aimed at gaining new knowledge)
- industrial research (research with a specific practical objective aimed at improving existing products, processes, or services)
- experimental development (research aimed at producing drafts, plans, and prototypes)

R&D loans can be an alternative to R&D grants and entail several specific advantages: they are usually not attached to a specific technology field, application is possible at all times (no deadlines), and they can cover higher project costs. R&D loans are provided by different governmental programmes. For instance, the ERP Innovation Programme offers 100 percent financing of eligible R&D project costs up to EUR five million. Public (silent) partnerships are offered by both the KfW Banking Group and state-owned venture capital companies to technically oriented companies. Direct shareholding by a public investment company is also possible. Conditions are negotiated on a case-by-case basis.

A.5 REVIEW OF THE LITERATURE

Table A.3: **Overview of selected empirical contributions for impact analysis of private sector investment support schemes (studies are listed in alphabetical order)**

Author	Area (Source of data)	No. of obs., Sample Period, Aggregation Level (Macro / meso / micro)	Estimated Specification	Empirical Method used for quantitative analysis	Results
Atzeni and Carboni (2006)	Italy: Evaluation of the impact of subsidies on ICT adoption	Two waves: 1998 – 2000; 1995 – 1997 N= 2290 Micro: Survey of Manufacturing Firms (SMF) by Capitalia	Ad-hoc specification Outcome variable: log of ICT investment per worker	Matching procedure (average treatment effect)	Receiving the subsidy has a positive effect on the treated firms. Without the subsidy the treated firms would have invested less. Moreover, grants improve ICT investments by 25% in the South and 20% in the North. Hence, investment schemes are more effective in the South. There exist crowding out effects for medium-large firms.
Bergés (2009)	*Hungary*: Evaluation of the performance of assisted domestic small and medium sized enterprises compared to those not receiving the investment support schemes	N= 65,000 2004 – 2006 Micro*:* two datasets form the basis of the analysis i) dataset of the Ministry for Justice and Law Enforcement ii) dataset of the National Development Agency	Ad-hoc specification to investigate the effect of being assisted on growth (dependent variable absolute growth of tangible assets one year before grant was approved)	1.DID estimator without matching 2. DID estimator with (propensity score) matching	The two main conclusions derived from the analysis are that investment support schemes caused additional investments by the assisted firms These investments did not trigger a faster growth (at least in the short run).

Author	Area (Source of data)	No. of obs., Sample Period, Aggregation Level (Macro / meso / micro)	Estimated Specification	Empirical Method used for quantitative analysis	Results
Bergström (1998)	*Sweden:* Evaluation of the effect on total factor productivity (TFP) of public capital subsidies to firms	1987 – 1993 *Micro:* panel data covering subsidised and non-subsidised firms	Ad-hoc specification to evaluate the effect of subsidization on growth; capital-augmenting production function model is used to estimate the performance of supported firms; dummy for being assisted or not (dependent variable growth of value added)	OLS estimation based on White's adjustment for heteroskedasticity	The study concludes that subsidization is positively correlated with growth of value added. There is evidence that in the first year after support productivity of subsidised firms increase. However, in the long run the estimates suggest that the more subsidies a firm has received the more TFP has decreased. Subsidization can lead to less efficient enterprises.
Bronzini et al. (2008)	*Italy:* Evaluation of investment tax credits (ITC) on business investments	Ministry of Industry dataset:: 2001 – 2004 (identification of who has received ITC) Cerved data: 1998 – 2004 (Augmention for information on investments) N= 634	Ad-hoc specification Outcome variable: investment per firm per region	Difference-in-difference approach	Results suggest that the programme stimulate investments.
Devereux et al. (2006)	UK: Treated unit new plants with "Regional Selective Assistance" (RSA) in specific UK regions both set up by foreign owned MNEs as well as UK-owned firms	1986 - 1992 Micro: Plant-level data on greenfield entrants from the population of plants for each year for the 64 counties and Scottish regions within the UK (of which are 38 an assisted area)	Location Choice model; goal: Specify a conditional Logit model of firm location and include as explanatory variable the expected grant available to each firm in each location, conditional on making an application in that location Due to unobservable variables the operational form comprises two	Both empirical specifications are subject to a bias in the opposite direction (overestimation in i), underestimation in ii)). However, the authors assume that the bias in i) is smaller than in ii); the model also aims to determine whether agglomeration effects play a role in the location of new plants by adding a agglomeration measure such as total	With respect to capital subsidies the RSA grants are found to have a significant effect in attracting plants to specific locations, though the effect is small. As the authors report the estimated elasticity of the probability of choosing to locate in a particular region with respect to the expected grant offer ranges between 0.04 –

Author	Area (Source of data)	No. of obs., Sample Period, Aggregation Level (Macro / meso / micro)	Estimated Specification	Empirical Method used for quantitative analysis	Results
			alternatives for the Grant offer regression: i) using only data on grants offered to estimate expected grants conditional on applying and being made an offer, ii) using grants offers matched to plant level data to estimate unconditional expected value of the grant (via a Tobit model); a special focus is also given to the role of agglomeration in the firm's choice of location	number of industry plants in previous periods to the location choice model	0.13. Thus, the RSA is found effective in terms of bringing further dynamic benefits to particular regions by increasing the probability that a new plant will locate there. The results also show that agglomeration effects influence location choice; plants in more agglomerated industries choose to locate near to other plants within the same industry; new foreign-owned plants choose to locate near to other foreign-owned plants within the same industry.
Gadd et al. (2009)	*Sweden:* Evaluation of the effect of subsidization on performance	Micro*:* using data on Swedish stock companies	Multilevel logit estimation to estimate the probability of being assisted or not; matched pairs approach to evaluate the effect of subsidization on performance (dependent variable difference in employees and return on total assets in 1 and 3 years, respectively)	Propensity score matching (with caliper=0,001)	The study shows that both firm characteristics and regional context matter with respect to the probability of receiving firm support. Concerning profitability, measured as return on total assets, there are no significant differences between supported and non-supported firms.
Girma et al. (2007)	*Republic of Ireland:* Evaluation of the effect of government grants on plant level productivity (TFP)	1992 – 1998 N=4,251 *Micro:* plant-level data for manufacturing industries	TFP calculated by using the semi-parametric approach of Levinsohn and Petrin (2003); ad-hoc specification to estimate the effect of supporting schemes on TFP	GMM regression (Blundell and Bond (1998)); validity of the instruments tested by Sargan-type test	The study suggests that only age has a significant influence on TFP, namely that older plants have a higher probability to be productive than younger. Productivity will increase if firms

Author	Area (Source of data)	No. of obs., Sample Period, Aggregation Level (Macro / meso / micro)	Estimated Specification	Empirical Method used for quantitative analysis	Results
					face higher financial constraints. There is a turning point in which financial constraints do not increase productivity further.
Haapanen et al. (2005)	Finland: Treated unit assisted firms with both national funding as well as from the European Regional Development Fund (ERDF); focus on investment subsidies	2001 – 2003 (N = 1836) Micro: plant-level data for 1,836 investment projects of private firms	Goal: study whether the investment subsidy is a prerequisite for project implementation; thus the dependent variable of the (ad-hoc) model is the necessity of investment subsidy which is specified in a binary way (1=investment subsidy is a necessary requirement for the project implementation, 0=otherwise)	Due to the binary nature of the dependent variable a Probit framework is chosen, the vector of explanatory variables contains project costs, turnover of firm, relative intensity of investment aid as well as various dummies for industry and regions	The results show that the necessity of the investment subsidy varies significantly between investment projects: i) for project implementation the investment subsidies are much more crucial for distant regions compared to central locations; ii) investment subsidies are less important for firms with large overall turnover; iii) necessity of investment subsidy increases significantly with the size of the investment project and intensity of aid
Harris and Robinson (2005)	UK: treated unit: Plants with capital subsidy of the Regional Selective Assistance (RSA) relative to non-assisted plants (both in total UK as well as assisted areas only)	1990 – 1998 Micro: plant-level data for UK manufacturing, special regional focus on regions with assisted plants	First step: Analysing characteristics of RSA-assisted plants; Second step: analyse of the survival rates for RSA-assisted and non-assisted plants using the hazard function model; Third step: Sources of productivity growth in assisted and non-assisted areas	Probit models in step one and two; production function approach to measure TFP in step three, aggregation of TFP results at the plant level to industry averages; finally decomposition of labour and total factor productivity at the industry level into various components that represent the impact of resource allocation across surviving plants as well as impact on productivity of entry and exit of plants	First step: Larger plants, older plants and foreign-owned plants have a higher probability of being RSA aided, industries as metal goods, electrical and electronic engineering, motor vehicles, other transport equipment and leather goods are more likely to receive assistance, there is also a regional concentration both regarding total UK as well as within assisted areas itself; Second step: RSA-assisted

Author	Area (Source of data)	No. of obs., Sample Period, Aggregation Level (Macro / meso / micro)	Estimated Specification	Empirical Method used for quantitative analysis	Results
					plans lower the hazard rate of closure both for new as well as established firms. The effect for the latter is somewhat bigger; Third step: In terms of labour productivity RSA-assisted plants make a significant contribution to national productivity growth, however in terms of TFP RSA-assisted firms experience negative growth (further industry and regional effects – not reported here)
Harris and Trainor (2004)	Northern Ireland: Treated unit firms with capital subsidies based on various aid programmes collectively termed "Selective Financial Assistance" (SFA)	1983 – 1998 (436 plants) Micro: plant-level data with sectoral restriction to manufacturing sector	"Policy on/Policy off" Model: TFP estimates based on plant-level production function of Cobb-Douglas type in a panel data framework augmented by policy variables in form of investment aid (one step approach)	Baseline specification: Linear static production function model with a set of exogenous variables, time dummies to control for business cycle effects and a 0/1-dummy for SFA assistance; From the baseline specification SFA-plants are allowed to interact with exogenous variables in the model through various ways such as: i) composite dummy effects (multiplication of the SFA-dummy with employment, capital stock etc.) to accept that SFA plants might operate using different technologies compared to non-assisted plants, ii) interaction terms between SFA-assistance and plant age, ownership structure, as well as iii) disaggregation of SFA into capital grants and all further	The results show that for manufacturing real gross output would have been up to 10% per year lower for the observation period if SFA had not been in operation (in a sectoral basis this effect is especially in order for Metals & Chemicals; Drink and Tobacco sectors and somewhat smaller for Footwear and Clothing as well as Paper and Printing); in terms of total aggregate volume the output-spending ratio is considerably above 1 (for the whole period around 10); the authors also find that capital grants are more likely to have a positive impact on TFP compared with other forms of grant-aid; finally, the impact of SFA aid was stronger towards the end of the

Author	Area (Source of data)	No. of obs., Sample Period, Aggregation Level (Macro / meso / micro)	Estimated Specification	Empirical Method used for quantitative analysis	Results
				SFA assistance (plus application of i) and ii) to disaggregated effect) Estimator: System GMM to account for possible endogeneity of capital, employment, intermediate inputs and SFA	sample period from 1990 - 1998
Head et al. (2004)	USA: Treated unit Japanese foreign direct investment in US states subject to labour and capital subsidies, lower taxes and foreign trade zones	1980 - 1992 Micro: plant-level data for 760 Japanese manufacturing establishments (in 225 different 4-digit industries)	Location Choice model where heterogeneous investors choose locations among the 50 US-states, specifying the probability that a state yields the highest profits for a particular investor; next to agglomeration effects also investment-support policies play a crucial part	Conditional Logit model with dependent variable: Probability that investor j chooses state s; exogenous variables account for market size, labour costs, policy instruments and regional fixed effects as well as agglomeration forces (both within-state and adjacent-state)	The results show that next to agglomeration effects (the primary focus of the study) also investment-support policies significantly increase the investment inflow to the respective state. Further, the timing for investment support schemes may be of importance: The authors find that with endogenous agglomeration effects, a state that adopts pro-investment policies first can retain an advantage even after the policy change is emulated by rivals
Institute for Small Business & Entrepreneurship (isbe, 2008)	*Finland:* Evaluation of deadweight spending	2003 – 2003 N=5,744 *Micro:* data set contains private sector business projects that were granted direct business subsidies	Ad-hoc specification controllong for project, firm and regional level factors	Ordered Probit Model	Deadweight is smaller for recently established firms. Deadweight is of smaller influence in regions with lower economic development. Deadweight spending is higher during the beginning of the programme period.

Author	Area (Source of data)	No. of obs., Sample Period, Aggregation Level (Macro / meso / micro)	Estimated Specification	Empirical Method used for quantitative analysis	Results
Lehmann and Stierwald (2004)	*Germany:* Analysis of the influence of the investment support scheme "Verbesserung der regionalen Wirtschaftsstruktur" (GA) on the investment behaviour of East German enterprises	No. of obs. depends on the considered time periods (1999, 2000, 2001) in the sample; it varies from n=98 till n=216 *Micro:* IAB-plant level data covering East German manufacturing firms (quota sample)	Ad-hoc specification of the effect of subsidization on additional firm level investment (dependent variable investment per employee), dummy for being assisted or not	The paper includes two specifications: i) Matched-pairs approach: CDID estimator (conditional difference-in-difference estimator) with three different matching algorithms in order to demonstrate whether the results are independent and stable with respect to the selected variables ii) Heckman estimator	The paper investigates with respect to the matched-pairs approach that the investment support schemes have significant positive influence on the amount of investments of East German enterprises. The investment subsidies cause a more than 100% increase in additional investments by the supported firms. There is no complete deadweight. The results with respect to the Heckman estimator are not considered to be meaningful because the goodness of fit of the regression model is very low.
Pellegrini and Centra (2006)	Italy: Treated unit firms assisted by law 488/92 in form of a capital subsidy, only in the Mezzogiorno area (Objective 1); control group: firms which applied for the capital subsidy, but were not elected	Not explicitly documented (subsidies started before 1999) Micro: plant-level data with the additional regional restriction to the Mezzogiorno area (Obj. 1)	Ad-hoc specification of different performance indicators as turnover, employment etc. as a function of different covariates in a panel setting with individual and time-effects, dummy for being assisted or not	Derivation of a conditional difference-in-difference (CDID) estimator as a combination of a standard difference-in-difference estimator and the (single index) matching estimator. The advantage of the CDID is that it allows for temporally invariant differences (individual fixed effects and trend effects) in performance between subsidized and non subsidized firms	Evaluation indicates that growth in turnover, employment and fixed assets has been more dynamically in subsidized firms, achievement of policy goals: subsidized firms have invested more than usual, increased the number of employees more than firms in control group; regarding the output and substitution effect of the investment aid, the output effect is found to dominate the substitution effect; however in turn labour productivity in subsidized firms is found to grow slower than in non-assisted

Author	Area (Source of data)	No. of obs., Sample Period, Aggregation Level (Macro / meso / micro)	Estimated Specification	Empirical Method used for quantitative analysis	Results
					firms. Thus, the analysis finds a trade-off between employment and turnover and labour productivity: The higher the reduction in capital cost, the higher is additional investment, which leads to production and employment growth, but also lowers the firm's labour productivity growth.
Ragnitz (2003)	Germany: Treated unit assisted firms in East Germany with respect to the private sector investment support schemes (GA "Verbesserung der regionalen Wirtschaftsstruktur")	1997 – 2001 Micro: IAB plant-level data with further sectoral restriction: manufacturing; as well as regional restriction: East Germany	Ad-hoc specification of subsidization effects on the firm level investment function (dependent variable either investment per plant or employee), corrected for unobservable individual heterogeneity	First step: Probit regression for the propensity to participate in investment programme to correct for unobserved individual heterogeneity in the sample, dependent variable: probability of being assisted (since it is not possible to define an adequate control group due to the institutional design of the investment support scheme) Second step: The first step correction factor (Mills ratio) is included in the linear investment function which specifies investment ratios based on an eclectic set of exogenous determinants augmented by the policy variable (investment aid)	Capital subsidies have a substantial effect on the investment level (per employee) of assisted firms, which is about three times higher than the corresponding level for non-assisted firms The studies find deadweight effects of funding (however they are considerably lower compared to other results for East Germany – about one third of total investment); A separate analysis of substitution effects is not possible in the chosen empirical framework
Stierwald and Wiemers (2003)	*Germany:* Evaluation investigates the impact of the investment support scheme "Verbesserung der regionalen	1999-2001 N= 3,254 *Micro:* IAB-plant level data covering East German manufacturing firms (quota	Ad-hoc specification of the effect of subsidization on firm level investment corrected for unobserved heterogeneity (dependent variable either investment per turnover unit or employee)	Heckman estimator *First step:* Calculating Mills Ratio *Second Step:* Estimation of the investment function including Mills Ratio and explanatory variables	Investment support scheme (GA) has a positive influence on assisted enterprises. GA supported firms invest more than non-GA supported firms.

Author	Area (Source of data)	No. of obs., Sample Period, Aggregation Level (Macro / meso / micro)	Estimated Specification	Empirical Method used for quantitative analysis	Results
	Wirtschaftsstruktur" (GA) in relation to other investment support schemes	sample)			The paper investigates an average deadweight of 35% (investment per employee) respectively 28% (investment per turnover unit).
Tokila et al. (2007)	*Finland:* Evaluation of investment subsidies with respect to deadweight effects	2001 – 2003 N=3,423 Micro*:* micro level data on investment projects by private sector firms	Ad-hoc specification including variables with respect to firm characteristics (turnover, age of the firm, etc.) and regional dummies (location of the subsidised firms) and industry dummies (metal, wood, etc.) Dependent variable: dummy equals 1 if the project would have been abounded in the absence of the investment sudsidy (i.e. deadweight is zero) and 0 otherwise.	Homoskedastic probit model (tested for heteroskedasticy by using Likelihood Ratio (LR))	Probability of being assisted is higher in the peripheries than in central areas. Investment-bearing capacity with higher responsibility for deadweight effect of investment subsidy than the mere size of the enterprise. The effect of deadweight is smaller for new firms than for old. The effect of deadweight declines with the degree of the investment project.

Table A.4: **Overview of selected empirical contributions for impact analysis of public funding on private R&D and innovation effort (studies are listed in alphabetical order)**

Author	Area (Source of data)	No. of obs., Sample Period, Aggregation Level (Macro / meso / micro)	Estimated Specification	Empirical Method used for quantitative analysis	Results
Aerts and Schmidt (2006)	*Germany and Belgium*: survey based analysis (CIS III & IV) with regards to information about firms innovation activity and funding	Two waves from the Flemish and German CIS (III: 1998-2000; IV: 2002-2004), ca. 3,900 firms Germany, 1,500 for Belgium Macro and meso perspective: No regional disaggregation for German data, while a regional perspective is chosen for Belgium (Flanders as NUTS2 region)	Eclectic R&D model with a focus on identification of variables that affect both the profitability to receive R&D subsidies and R&D expenditure; the main focus of the paper lies on the econometric specification	Two empirical specifications: non-parametric matching estimator and conditional difference-in-difference estimator with repeated cross-sections; the model is estimated in a stepwise manner, where the matching estimator is used to estimate the additionality effect of subsidies that were granted to Flemish and German companies, while the diff-in-diff estimator is used in the 2.stage to control for unobserved heterogeneity	Main conclusion from both estimators: Funded firms are significantly more R&D active than non-funded firms (between 76-100% in the case of German firms, 64%-91% for Flemish firms), in turn this result is then interpreted as empirical support for rejecting the crowding-out hypothesis between public R&D subsidies and private spendings, the authors also find that the additionality effect seems to have the same structure although the funding systems in Flanders and Germany are rather different
Almus und Prantl (2002)	*Germany:* Impact of subsidies on survive and increase of employment of young firms	1990 – 1993 N= 3,996 (960 supported firms) *Micro:* Mannheimer innovation panel (ZEW Mannheim) DtA – support data	Ad-hoc specification Outcome variable: rate of survive and increase of employment Treatment variables: support of equity and support of start-ups by KfW/DtA	Nearest Neighbour-Matching	Subsidization leads 14,41% higher rate of survive Annual rate of increase of employment of treated firms 6,9% higher
Almus und Czarnitzki (2003)	*Germany:* Impact of public R&D support on private financing of	Three waves: 1995, 1997, 1999 Micro: Mannheim innova-	Ad-hoc specification Outcome variable: R&D intensity (R&D expenses in relation to turn-	Caliper-Matching	R&D intensity of treated firms by 4% higher

Author	Area (Source of data)	No. of obs., Sample Period, Aggregation Level (Macro / meso / micro)	Estimated Specification	Empirical Method used for quantitative analysis	Results
	innovation projects in East Germany	tion panel N= 925 of East German manufacturing sector (622 supported firms)	over) Treatment variable:		
Busom (2000)	Spain: R&D subsidies given by the Spanish ministry of industry (more than 1/3 of total public R&D budget)	1988, Cross-section analysis of 154 firms Macro perspective based on firm-level micro data for Spain (no further regional and/or sectoral disaggregation)	Structural (latent variable) model of participation in a public R&D programme and private R&D effort in a multiple equation setup with endogenous variables as: i) firm's expected profitability of applying for R&D subsidy relative to not applying, ii) value for government of funding a particular project, iii) total R&D spendings for funded firms, iv) total R&D spendings for non-funded firms	1) Univariate Probit model interpreted as a reduced form model, where coefficients of explanatory variables capture net effects of each variable on programme participation as the endogenous (binary) variable; basic assumption: group membership (participation, non-participation) is random 2) Estimating R&D effort for participants and non-participants relaxing the assumption of random group membership: i) OLS without sample splitting, ii) OLS with sample splitting, iii) Heckman 2-step procedure to correct for endogenous sample selection, iv.) ML	Cross-section estimates show that 1) small firms are more likely to obtain a subsidy than large firms, 2) mixed empirical results of substitution effects: For about 2/3 of all subsidized firms, the R&D subsidies increase private funding of R&D by approx. 20%; however, for the remainder firms there would be a complete crowding out of private fundings by R&D subsidies; empirical results point at the importance of heterogeneity in evaluation rather than just averaging over all positive and negative effects
Clausen (2007)	Norway: Survey based analysis (CIS III) using detailed information about firms innovation activity and funding	1999 – 2001: ca. 3900 firms, very high response rate of 93% for the Norwegian part of CIS III Macro perspective based on firm-level micro data for Norway (no further regional and/or sectoral disaggregation)	Data availability on monetary values for R&D subsidies in Norwegian firms, this allows for a more profound analysis of substitution effects of private and public R&D funding; eclectic R&D model with R&D outcome as dependent variable and special focus to control for non-randomness of subsidy allocation among firms	Structural single equation model estimated by instrumental variables technique	Results show that "far from the market subsidies" (high technological uncertainty) stimulate private R&D spending, mainly by increasing expenditures on research activities; this type of subsidy was also found to have a positive impact upon the quality of R&D done at the firm level and upon firms' future commitment to R&D; on the contrary "close to the

Author	Area (Source of data)	No. of obs., Sample Period, Aggregation Level (Macro / meso / micro)	Estimated Specification	Empirical Method used for quantitative analysis	Results
					market" subsidies were found to crowd-out private R&D spending
Czarnitzki (2001)	*Germany:* Investigation of the impact of public support schemes on private financing of innovation projects for East German enterprises	Two census waves: 1997 and 1999 N=640 of East German manufacturing industry (448 supported firms) *Micro:* Mannheimer innovation panel (ZEW Mannheim)	Ad-hoc specification of the impact of public enterprise support on innovation intensity; depenten variable defined as expenses of innovation / turnover (innovation intensity)	Non-parametric matching estimator	Results support positive effects of public investment schemes on innovation activity of East German manufacturing firms Supported firms have 5% higher innovation intensity compared to the non-supported firms Public support is a complement to private financing
Czarnitzki and Fier (2002)	*Germany:* Measuring the effect of R&D support on innovation intensity of service sector firms	Two census waves: 1997, 1999 N=1,084 firms of the service sector (210 supported firms) Micro. Mannheim innovation panel	Ad-hoc specification Outcome variable: innovation intensity (innovation expenses in relation to turnover) Treatment variable: innovation support of Bund, Bundesland and European Union	Nearest Neighbour-Matching	Treated firms have a 5,7% higher innovation intensity
Czarnitzki and Fier (2003)	*Germany:* Measuring the effect of R&D cooperating support on patent behaviour	Three census waves: 1993, 1997, 2001 N= 2,473 non-cooperating firms, 1,564 cooperating firms from the manufacturing industry and the service sector (356 supported firms) Micro. Mannheim innovati-	Ad-hoc specification Outcome variable: amount of patent registration Treatment variable: R&D cooperation and network support of the Bund	Matching procedure (Kernel regression and propensity score)	Amount of patent registrations is significantly higher for public supported R&D cooperating firms

Author	Area (Source of data)	No. of obs., Sample Period, Aggregation Level (Macro / meso / micro)	Estimated Specification	Empirical Method used for quantitative analysis	Results
		on panel			
Czarnitzki and Licht (2006)	Germany: survey based data Mannheimer innovation panel (ZEW Mannheim) complemented by the German data base for patent registrations (German department for patents), disaggregation into East and West German macro regions encompasses data on R&D- and innovation activity	Four waves: 1994, 1996, 1998 and 2000; for each regional unit about 700 firms included (treated as well as support group) N= 6,462	Eclectic empirically driven R&D model to estimate the impact of R&D subsidies on R&D input Ad-hoc specification with two different estimations: Estimation 1 control group consits of all non-supported firms independent of R&D activities. Estimation 2 control group consists only of those firms with R&D activities (dependent variable: dummy being 1 for supported firms and 0 otherwise)	Propensity score matching The empirical model employs a matching estimator in step 1, which regresses the endogenous variable (private R&D investment) on the policy instrument in focus and a variety of other exogenous control factors such as firm size, industry, region, human capital etc.; using the output of the matching estimation in a 2.step productivity differences between government funded R&D and private spendings are analysed, the endogenous variable in this 2.step is the firm's innovation output, regressors are public R&D subsidies and R&D expenditures induced by public funding among other controls	Results point toward a large degree of additionality in public R&D grants with regard to innovation input measured as R&D expenditures and innovation expenditures, as well as with regard to innovation output measured by patent applications; while input additionality is found to be larger in East Germany during transition, R&D productivity is still larger for the established West German innovation system; based on these findings the authors suggest that the use of regional redistribution of public R&D subsidies may improve the overall innovation output of the German economy
Duguet 2003	France: Overall R&D subsidies to firms having at least one full-time person working on R&D, based on the R&D survey of the French Ministry of Research	1985 – 1997 Macro perspective based on firm-level micro data for France (no further regional and/or sectoral disaggregation)	Building a theoretically based R&D model including variables that both influence the probability of getting public support and the investment in private R&D; among the key variables are: line of business, firm size, private R&D to sales ratio, debt to sales ratio, past public support	Two step estimation based on a Logit approach to estimate the determinants for R&D and a 2. step matching regression based on the Nadaraya-Watson (non-parametric) estimator, where for each treated firm the difference between its own performance and a local weighted average of the performances of its non-treated neighbours are computed. Weights are given on the basis of the propensity score	First step estimation: Probability of being subsidized is increasing with firm size, debt ratio and the importance of privately funded R&D; 2. step matching estimation: on average, public funds add to private funds, so that there is no significant crowding out effect in the matching method estimation, in line with related empirical findings the effect of

Author	Area (Source of data)	No. of obs., Sample Period, Aggregation Level (Macro / meso / micro)	Estimated Specification	Empirical Method used for quantitative analysis	Results
				method allowing to compare firms that have the same probability of being treated within a specific group, this gives a random distribution of treated and non-treated firms which can be estimated empirically, key parameter: propensity score probability distribution	subsidies is found to be heterogeneous (meaning that the effect on the treated unit may differ from the non-treated unit, mainly because of identified 1.step determinants of subsidy grants)
Engel (2001)	Germany: Impact of venture capital on increase of employment of young firms	1991 – 1998 N=15,772 (222 with venture capital cooperation) *Micro:* Mannheimer innovation panel (ZEW Mannheim)	Ad-hoc specification Outcome variable: increase of employment Treatment variable: investment through venture capital	Matching procedure	Treated firms have a 17,8% higher rate of staff growth
Engel (2002)	Germany: Impact of venture capital on increase of employment of young firms	1991 – 1998 95,571 (632 with venture capital cooperation) *Micro:* Mannheimer innovation panel (ZEW Mannheim)	Ad-hoc specification Outcome variable: increase of employment Treatment variable: investment through venture capital	Matching procedure	170 percentage points higher rate of increase of employment
Fier (2002)	*Germany:* Impact analysis of direct R&D project support	1992 – 1998 N= 3,136 of the manufacturing industry (297 supported firms) Micro. Mannheim innovati-	Ad-hoc specification Outcome variable: R&D intensity (R&D expenses in relation to turnover) Treatment variable: direct project	Propensity score matching	R&D intensity of treated firms by 3,3% higher

Author	Area (Source of data)	No. of obs., Sample Period, Aggregation Level (Macro / meso / micro)	Estimated Specification	Empirical Method used for quantitative analysis	Results
		on panel	support of BMBF		
Hussinger (2003)	*Germany:* Impact of public R&D support on private financing of innovation projects in East Germany	Census waves from 1992 – 2000 N= 3,744 innovative firm from manufacturing industry (723 supported firms) Micro: Mannheim innovation panel	Ad-hoc specification Outcome variable: R&D expenses (net, i.e. without support) Treatment variable: direct project support of BMBF	Heckit estimator	Significant positive effects Effects because of functional form not explicit
Kaiser (2004)	Denmark: survey based analysis from the Danish Ministry of Economics and Business affairs	2001, cross-section of firms (268 in service sector, 847 in manufacturing) Macro perspective based on firm-level micro data for Denmark (no further regional disaggregation, sectoral classification into services and manufacturing)	Eclectic R&D model to estimate the average effect of a bundle of support programmes, no identification of exact support scheme, only those firms are included in the analysis that receive treatment; included sets of variables: i) firms' research activity ii) skill structure of the workforce, iii) firms' internationalization degree, iv) firm size and other controls	Two alternative estimation setups: 1) Fully-parametric two-step regression and 2) matching methods (propensity score matching approach): Ad 1) baseline idea is to control for potential endogeneity of treatment on private R&D by IV type regression; combination of Probit model for probability of receiving R&D subsidies and OLS with controls for heterogeneity; Ad 2) Propensity score matching to correct estimation of treatment effects by controlling for existence of non-random selection into support programmes	Alternative estimation techniques do not find a statistically significant effects of R&D subsidies on private R&D intensity (defined as R&D expenditures scaled by sales) both for joint specification as well as for disaggregated services and manufacturing sample, which suggests that R&D stimulating and free-ridings effects just balance out one another; next to statistical insignificance the estimation results are also very small in absolute magnitude
Licht and Stadler (2003)	Germany: survey based data (Mannheim Innovation Panel), encompasses	1992 – 2000, data on almost 8000 firms (around 15% received public funding) Macro perspective based	Starting point is a theoretically derived oligopoly model that includes the firm's decision about its R&D budget in a two stage strategic competition game, where R&D	Three-step empirical implementation: In a first step theoretically derived potential determinants of private sector R&D activities are estimated in a standard panel data single equation model (Fixed-Effects and	The results of the different estimation methods show that public R&D funding has a positive effect on private R&D activity, public and private spendings are found to complement

Author	Area (Source of data)	No. of obs., Sample Period, Aggregation Level (Macro / meso / micro)	Estimated Specification	Empirical Method used for quantitative analysis	Results
	data on R&D- and innovation activity combined with official data from the federal government (Förderdatenbank BMBF)	on firm-level micro data for Germany (no further regional and/or sectoral disaggregation)	budgets are determined independently in advance of production capacities; the model includes spill-over-effects between the firms R&D activity, as well as public funding of private R&D; based on this stylised model the authors derive testable hypothesis with regards to determinants of R&D activity (incl. public funding)	Random-Effects alternatives), in a second step the authors endogenize the participation in public funded R&D programmes via treatment models (as an alternative to IV regression methods since no adequate IV for public subsidies were found by the authors), in a final step the effects of public R&D funding are elaborated via different matching methods including propensity score distribution as well as other matching variables such as industry, firm size etc. (balancing score)	each other so that substitution effects are rejected by the empirical model; the authors also compare the likely effects of different institutional R&D subsidy designs: Based on international evidence on indirect funding via tax credits, the authors conclude that the direct R&D funding practise in Germany is supposed to have higher effects with regards to private R&D spendings (abstracting from resource reallocation as well as administrative costs)

A.6 DEFINITION OF CONTROL VARIABLES

Outcome variables will be needed for the impact analysis: e.g. number of employees, productivity, investments. Furthermore, exogenous control variables, such as the share of high-qualified personnel in total workforce, the share of intermediate inputs, the technical status of capital stock and, the legal form and industry of the establishment, will be included in the impact analysis. In addition, we will test whether the different East German federal states show different results by introducing a dummy variable approach for the federal states.

Firm age: This variable was transformed into a categorical variable which distinguishes between four groups: foundation of the establishment before 1990, foundation of the establishment between 1990 and 1997, 1998 and 2003, 2004 and 2007.

Firm size classes: It is distinguished between five different size classes: < 20 employees, ≥ 20 to < 50 employees, ≥ 50 to < 100 employees, ≥ 100 to < 250 employees, and ≥ 250 to < 4000 employees.

Ownership: This variable informs whether the firm is owned by West German, East German or foreign owners. The categorical variable was transformed intor dummies.

Type of enterprise: single-enterprise company, branch/branch office, headquarters/head office and intermediate instance. This categorial variable was transformed into dummies.

Legal form: It is distinguished between the following legal forms of an establishment: The category individual enterprise includes companies with full liability of a single individual. The second type of legal form comprises partnerships including the German business forms KG, OHG, GbR. The third type refers to corporate enterprises such as limited liability companies covering the legal forms AG, KGaA and GmbH. The fourth category contains other legal forms (e.g. public foundations and institutions).

Collective wage agreement: An establishment might be bounded by a collective wage agreement or not. It is differentiated whether an establishment abides either by an industry-wide wage agreement or a company agreement, and or if the polled firm is not obligated to such an an agreement.

Work council: It is distinguished whether the establishment has got a work council or not.

Insourcing/Outsourcing: The variables insourcing and outsourcing cover whether organisational changes were made. The first named variable addresses the integration of establishments or of parts of establishments. The variable outsourcing informs whether establishments or parts of establishments were closed, outsourced or whether new companies were formed.

Membership in a Chamber of Industry and Commerce

Status of technical equipment: In the surveys, the establishments are asked for evaluating the status of their technical equipment compared to other establishments in the respective industry of the economy. The establishments can tick in the questionnaire one out of the following categories: quite new, state of the art, medium, quite old/completely out of date.

Wages and salaries: Another variable addresses whether wages and salaries are paid above the collectively agreed level in the enterprise surveyed.

Wage costs

Regional/extra-regional market orientation: The spatial market orientation is reflected by the share of exports to East Germany/ to foreign countries in total volume of exports.

Share of intermediate inputs in total business volume

Shares of skilled labour in total workforce

Share of unskilled labour in total workforce

Share of trainees and apprentices

Share of female employees

Expected development in the number of employees in the next year: This variable is a short-term assessment of the firms whether they expect an increase, a decrease or a stable development of their working staff in the coming year or whether this development is unknown by the firms.

Regional dummies at the level of the six States (so-called "Länder") in East Germany enable us to analyze whether the local environment in which the establishment is situated affects its investment activities.

Industrial dummies: We built two sets of industrial dummies due to a change of the industrial classification system between the IAB Establishment Surveys in 1999 and in 2000.. In addition, the industrial classification adopted in 2000 contains two additional manufacturing industries. A frequency analysis revealed small numbers of supported establishments in a range of manufacturing industries (e.g. recycling). Therefore, we aggregated the single manufacturing industries to six groups of industries (dummies).

Time-dummies: A dummy for each year of the observation period is included into analysis.

A.7 SEMI-ELASTICITIES IN SEMI-LOG OLS REGRESSION

In the case of dummy variables, the percentage change in y, from y_0 to y_1, for a discrete change in dummy D_j from 0 to 1, is usually calculated as [p = [exp(c_j)-1]x100] by which ŷ D_j = 1 differs from ŷ with a D_j = 0 by keeping the control variables constant (ceterus paribus). However, statistical literature on displaying semi-elasticities in semi-log OLS regression suggests that the use of this formula for percentage change *p* results in a biased estimator (Kennedy 1981). When the error term in the typical semi-log model is assumed to be normally distributed then the ordinary least squares (OLS) estimator of $\hat{c}$, is efficient and unbiased (van Garderen, Shah, 2002). Then, it could be concluded that the expected value of exp ($\hat{c}$) is exp (c+½V($\hat{c}$)), with V($\hat{c}$) is the variance $\hat{c}$. Then $\hat{p} = 100(\exp(\hat{c} - \frac{1}{2}\hat{V}(\hat{c})) - 1)$ (Kennedy, 1981).

A.8 OLS REGRESSIONS

Table A.5:
Investment per employee – Pooled OLS Regression 2000-2003, 2005, 2007

	Coefficient	Robust Std. Error	t-values	Significance
Treatment	0.922	0.067	13.8	0.000
firm size: 20 <= employees < 50	-0.626	0.097	-6.48	0.000
firm size: 50 <= employees < 100	-0.658	0.121	-5.44	0.000
firm size: 100 <= employees < 250	-0.690	0.133	-5.19	0.000
firm size: 250 <= employees < 4000	-0.588	0.159	-3.7	0.000
nonmetallic mineral product manufacturing, woodworking industry	0.027	0.133	0.2	0.840
iron, steel & metal manufacturing industry	-0.311	0.103	-3.01	0.003
manufacture of machinery and equipment	-0.441	0.109	-4.05	0.000
manufacture of automobiles and automobile parts, miscel-lanous vehicle construction	-0.362	0.147	-2.46	0.014
Electrical engineering, manufacture of medical, precision and optical instruments, watches	-0.461	0.109	-4.24	0.000
paper & printing, publishing houses, textile & clothing, food, furniture, jewellery, recycling	-0.093	0.107	-0.88	0.381
West German ownership (yes)	0.095	0.075	1.28	0.203
foreign ownership (yes)	0.266	0.121	2.19	0.029
branch office (yes)	0.126	0.107	1.18	0.240
capital company/corporation (yes)	-0.326	0.100	-3.25	0.001
Foundation of establishment before 1990	-0.107	0.161	-0.66	0.507
Foundation of establishment 1990-1997	-0.107	0.155	-0.69	0.489
industry-wide wage agreement (yes)	-0.045	0.087	-0.52	0.606
Company wage agreement (yes)	-0.090	0.096	-0.94	0.350
work council (yes)	0.274	0.087	3.16	0.002
Member of chamber of industry and commerce (yes)	0.266	0.108	2.45	0.014
insourcing (yes)	-0.304	0.209	-1.45	0.147
outsourcing (yes)	-0.238	0.184	-1.29	0.196
technical equipment: quite new	-0.523	0.079	-6.66	0.000

technical equipment: medium	-0.868	0.088	-9.87	0.000
technical equipment: quite old/completely old	-1.173	0.215	-5.45	0.000
wage costs (log)	0.189	0.118	1.61	0.108
wages/salaries above average (yes)	-0.088	0.105	-0.84	0.403
share of exports to East Germany in sales	-0.001	0.001	-1.05	0.293
share of exports to foreign countries in sales	0.001	0.002	0.8	0.422
share of intermediate inputs in sales	-0.001	0.001	-0.36	0.719
share of unskilled staff in total staff	-0.079	0.162	-0.49	0.627
share of apprentices and trainees	-0.005	0.005	-1.01	0.312
share of female employees	-0.006	0.002	-3.28	0.001
expectation: increase in number of employees	0.171	0.075	2.28	0.023
expectation: decrease in number of employees	-0.046	0.097	-0.48	0.633
expectation: unknown develoment of number of employees	-0.160	0.131	-1.21	0.225
State: Berlin	0.146	0.135	1.08	0.278
State: Brandenburg	-0.124	0.095	-1.31	0.191
State: Mecklenburg-Vorpommern	0.032	0.119	0.27	0.789
State Sachsen	-0.013	0.078	-0.17	0.868
State Sachsen-Anhalt	-0.090	0.084	-1.08	0.282
year dummy 2001	-0.051	0.097	-0.52	0.600
year dummy 2002	0.055	0.093	0.58	0.559
year dummy 2003	-0.059	0.105	-0.57	0.570
year dummy 2005	-0.080	0.107	-0.75	0.456
year dummy 2007	0.039	0.115	0.34	0.735
_cons	8.930	0.947	9.43	0.000
R-squared = 0,332 / Number of observations = 1302 / heteroscedasticity robust standard errors are reported				

Table A.6:
Investment share – Pooled OLS Regression 2000-2003, 2005, 2007

	Coefficient	Robust Std. Error	t-values	Significance
Treatment	0.921	0.068	13.52	0.000
firm size: 20 <= employees < 50	-0.567	0.097	-5.85	0.000
firm size: 50 <= employees < 100	-0.662	0.121	-5.46	0.000
firm size: 100 <= employees < 250	-0.658	0.134	-4.92	0.000
firm size: 250 <= employees < 4000	-0.560	0.159	-3.53	0.000
nonmetallic mineral product manufacturing, woodworking industry	0.182	0.129	1.41	0.160
iron, steel & metal manufacturing industry	-0.019	0.102	-0.19	0.853
manufacture of machinery and equipment	-0.171	0.111	-1.54	0.123
manufacture of automobiles and automobile parts, miscel-lanous vehicle construction	-0.260	0.148	-1.75	0.080
electrical engineering, manufacture of medical, precision and optical instruments, watches	-0.298	0.106	-2.81	0.005
paper & printing, publishing houses, textile & clothing, food, furniture, jewellery, recycling	-0.037	0.105	-0.36	0.721
West German ownership (yes)	-0.058	0.074	-0.78	0.438
foreign ownership (yes)	-0.009	0.128	-0.07	0.944
branch office (yes)	0.052	0.108	0.48	0.629
capital company/corporation (yes)	-0.343	0.099	-3.45	0.001
Foundation of establishment before 1990	-0.193	0.160	-1.21	0.228
Foundation of establishment 1990-1997	-0.278	0.154	-1.81	0.070
industry-wide wage agreement (yes)	-0.084	0.087	-0.96	0.336
company wage agreement (yes)	-0.072	0.097	-0.74	0.459
work council (yes)	0.191	0.088	2.17	0.030
Member of chamber of industry and commerce (yes)	0.075	0.107	0.7	0.484
insourcing (yes)	-0.380	0.216	-1.76	0.079
outsourcing (yes)	-0.197	0.169	-1.16	0.245
technical equipment: quite new	-0.410	0.078	-5.28	0.000
technical equipment: medium	-0.667	0.089	-7.51	0.000
technical equipment: quite old/completely old	-0.862	0.282	-3.06	0.002
wage costs (log)	-0.409	0.112	-3.66	0.000

wages/salaries above average (yes)	-0.225	0.110	-2.05	0.041
share of exports to East Germany in sales	-0.002	0.001	-1.77	0.078
share of exports to foreign countries in sales	-0.002	0.002	-1	0.317
share of intermediate inputs in sales	-0.010	0.002	-6.37	0.000
share of unskilled staff in total staff	0.109	0.160	0.68	0.496
share of apprentices and trainees	-0.002	0.005	-0.48	0.632
share of female employees	-0.002	0.002	-1.03	0.305
expectation: increase in number of employees	0.227	0.075	3.02	0.003
expectation: decrease in number of employees	0.002	0.099	0.02	0.984
expectation: unknown develoment of number of employees	-0.155	0.137	-1.14	0.256
State: Berlin	0.205	0.134	1.53	0.127
State: Brandenburg	-0.226	0.101	-2.25	0.025
State: Mecklenburg-Vorpommern	-0.113	0.119	-0.94	0.345
State Sachsen	-0.024	0.079	-0.3	0.761
State Sachsen-Anhalt	-0.162	0.086	-1.88	0.061
year dummy 2001	-0.116	0.099	-1.17	0.242
year dummy 2002	-0.050	0.095	-0.52	0.603
year dummy 2003	-0.119	0.104	-1.15	0.251
year dummy 2005	-0.147	0.109	-1.35	0.178
year dummy 2007	-0.150	0.113	-1.32	0.186
_cons	2.729	0.922	2.96	0.003
R-squared = 0,325 / Number of observations = 1283 / heteroscedasticity robust standard errors are reported				

Table A.7:
Employment growth – Pooled OLS Regression 2000-2003, 2005, 2007

	Coefficient	Robust Std. Error	t-values	Significance
Treatment	3.160	1.424	2.22	0.027
firm size: 20 <= employees < 50	-6.441	2.316	-2.78	0.006
firm size: 50 <= employees < 100	-4.106	3.405	-1.21	0.228
firm size: 100 <= employees < 250	-6.668	2.760	-2.42	0.016
firm size: 250 <= employees < 4000	-7.505	3.202	-2.34	0.019
nonmetallic mineral product manufacturing, woodworking industry	1.146	3.152	0.36	0.716
iron, steel & metal manufacturing industry	1.151	2.108	0.55	0.585
manufacture of machinery and equipment	3.511	2.328	1.51	0.132
manufacture of automobiles and automobile parts, miscellanous vehicle construction	2.408	2.699	0.89	0.372
electrical engineering, manufacture of medical, precision and optical instruments, watches	1.088	2.414	0.45	0.652
paper & printing, publishing houses, textile & clothing, food, furniture, jewellery, recycling	1.608	2.479	0.65	0.517
West German ownership (yes)	-3.387	1.543	-2.19	0.028
foreign ownership (yes)	-1.930	1.723	-1.12	0.263
branch office (yes)	-0.640	1.495	-0.43	0.668
capital company/corporation (yes)	0.912	1.958	0.47	0.642
Foundation of establishment before 1990	-17.397	5.260	-3.31	0.001
Foundation of establishment 1990-1997	-15.264	4.891	-3.12	0.002
industry-wide wage agreement (yes)	-0.609	1.431	-0.43	0.671
company wage agreement (yes)	-1.159	1.164	-1	0.320
work council (yes)	-0.834	1.353	-0.62	0.538
Member of chamber of industry and commerce (yes)	1.897	2.587	0.73	0.463
insourcing (yes)	-19.894	5.006	-3.97	0.000
outsourcing (yes)	-10.702	2.579	-4.15	0.000
technical equipment: quite new	-5.945	2.520	-2.36	0.018
technical equipment: medium	-6.926	2.611	-2.65	0.008
technical equipment: quite old/completely old	-8.976	5.932	-1.51	0.130
wage costs (log)	3.555	3.117	1.14	0.254
wages/salaries above average (yes)	-1.045	1.278	-0.82	0.414

share of exports to East Germany in sales	0.018	0.036	0.5	0.614
share of exports to foreign countries in sales	-0.019	0.027	-0.69	0.488
share of intermediate inputs in sales	0.037	0.030	1.22	0.224
share of unskilled staff in total staff	22.455	11.207	2	0.045
share of apprentices and trainees	0.110	0.125	0.88	0.381
share of female employees	-0.026	0.065	-0.41	0.684
expectation: increase in number of employees	4.615	1.521	3.03	0.002
expectation: decrease in number of employees	-2.727	1.472	-1.85	0.064
expectation: unknown develoment of number of employees	-3.088	3.179	-0.97	0.331
State: Berlin	-5.038	2.780	-1.81	0.070
State: Brandenburg	2.533	2.564	0.99	0.323
State: Mecklenburg-Vorpommern	-0.805	1.619	-0.5	0.619
State Sachsen	1.156	1.605	0.72	0.472
State Sachsen-Anhalt	0.282	2.009	0.14	0.889
year dummy 2001	-1.894	1.863	-1.02	0.310
year dummy 2002	-2.102	1.425	-1.47	0.141
year dummy 2003	-1.275	2.731	-0.47	0.641
year dummy 2005	-5.097	1.660	-3.07	0.002
year dummy 2007	-0.374	2.545	-0.15	0.883
_cons	35.820	30.801	1.16	0.245
R-squared = 0,141 / Number of observations = 1307 / heteroscedasticity robust standard errors are reported				

Table A. 8: ,
Investment per employee – Pooled OLS Regression 2000-2003, 2005, 2007 with interaction terms

	Coefficient	Robust Std. Error	t-values	Significance
Treatment	0.919	0.164	5.61	0.000
Treatment * Firm size class ≥ 20 to < 50 employees	0.099	0.204	0.48	0.628
Treatment * Firm size class ≥ 50 to < 100 employees	0.353	0.220	1.6	0.109
Treatment * Firm size class ≥ 100 to < 250 employees	-0.007	0.227	-0.03	0.977
Treatment * Firm size class ≥ 250 to < 4000 employees	-0.066	0.250	-0.27	0.791
Treatment * West German ownership (yes)	-0.269	0.144	-1.87	0.062
Treatment * foreign ownership (yes)	0.125	0.229	0.55	0.585
Firm size class ≥ 20 to < 50 employees	-0.652	0.108	-6.02	0.000
Firm size class ≥ 50 to < 100 employees	-0.809	0.146	-5.56	0.000
Firm size class ≥ 100 to < 250 employees	-0.670	0.158	-4.23	0.000
Firm size class ≥ 250 to < 4000 employees	-0.523	0.178	-2.94	0.003
nonmetallic mineral product manufacturing, woodworking industry	0.034	0.134	0.25	0.800
iron, steel & metal manufacturing industry	-0.296	0.104	-2.85	0.004
manufacture of machinery and equipment	-0.420	0.109	-3.84	0.000
manufacture of automobiles and automobile parts, miscellanous vehicle construction	-0.358	0.148	-2.42	0.015
electrical engineering, manufacture of medical, precision and optical instruments, watches	-0.441	0.109	-4.03	0.000
paper & printing, publishing houses, textile & clothing, food, furniture, jewellery, recycling	-0.089	0.107	-0.83	0.406
West German ownership (yes)	0.209	0.108	1.94	0.052
foreign ownership (yes)	0.221	0.173	1.28	0.201
branch office (yes)	0.126	0.110	1.15	0.252
capital company/corporation (yes)	-0.334	0.100	-3.32	0.001
Foundation of establishment before 1990	-0.109	0.159	-0.69	0.492
Foundation of establishment 1990-1997	-0.104	0.154	-0.68	0.500
industry-wide wage agreement (yes)	-0.041	0.088	-0.47	0.638
company wage agreement (yes)	-0.081	0.095	-0.85	0.395
work council (yes)	0.285	0.088	3.25	0.001
Member of chamber of industry and commerce (yes)	0.262	0.110	2.38	0.017

insourcing (yes)	-0.297	0.209	-1.42	0.157
outsourcing (yes)	-0.240	0.185	-1.29	0.196
technical equipment: quite new	-0.528	0.079	-6.72	0.000
technical equipment: medium	-0.877	0.088	-9.96	0.000
technical equipment: quite old/completely old	-1.168	0.211	-5.53	0.000
wage costs (log)	0.191	0.118	1.62	0.107
wages/salaries above average (yes)	-0.104	0.106	-0.99	0.323
share of exports to East Germany in sales	-0.001	0.001	-1	0.319
share of exports to foreign countries in sales	0.001	0.002	0.63	0.530
share of intermediate inputs in sales	0.000	0.001	-0.28	0.781
share of unskilled staff in total staff	-0.066	0.165	-0.4	0.686
share of apprentices and trainees	-0.004	0.005	-0.84	0.399
share of female employees	-0.006	0.002	-3.25	0.001
expectation: increase in number of employees	0.176	0.075	2.36	0.018
expectation: decrease in number of employees	-0.060	0.097	-0.61	0.539
expectation: unknown develoment of number of employees	-0.143	0.132	-1.08	0.280
State: Berlin	0.145	0.136	1.07	0.287
State: Brandenburg	-0.089	0.097	-0.92	0.359
State: Mecklenburg-Vorpommern	0.019	0.120	0.16	0.872
State Sachsen	-0.005	0.079	-0.06	0.949
State Sachsen-Anhalt	-0.080	0.084	-0.96	0.337
year dummy 2001	-0.045	0.098	-0.45	0.650
year dummy 2002	0.054	0.094	0.57	0.567
year dummy 2003	-0.056	0.105	-0.53	0.593
year dummy 2005	-0.082	0.107	-0.77	0.441
year dummy 2007	0.039	0.115	0.34	0.735
_cons	8.869	0.953	9.3	0.000
R-squared = 0,339 / Number of observations = 1302 / heteroscedasticity robust standard errors are reported				

Table A.9:
Investment share – Pooled OLS Regression 2000-2003, 2005, 2007 with interaction terms

	Coefficient	Robust Std. Error	t-values	Significance
Treatment	0.964	0.170	5.68	0.000
Treatment * Firm size class ≥ 20 to < 50 employees	-0.043	0.208	-0.21	0.836
Treatment * Firm size class ≥ 50 to < 100 employees	0.244	0.226	1.08	0.280
Treatment * Firm size class ≥ 100 to < 250 employees	0.028	0.233	0.12	0.904
Treatment * Firm size class ≥ 250 to < 4000 employees	-0.136	0.250	-0.54	0.587
Treatment * West German ownership (yes)	-0.227	0.146	-1.55	0.122
Treatment * foreign ownership (yes)	0.114	0.239	0.47	0.635
Firm size class ≥ 20 to < 50 employees	-0.554	0.109	-5.09	0.000
Firm size class ≥ 50 to < 100 employees	-0.777	0.147	-5.28	0.000
Firm size class ≥ 100 to < 250 employees	-0.671	0.160	-4.2	0.000
Firm size class ≥ 250 to < 4000 employees	-0.476	0.179	-2.66	0.008
nonmetallic mineral product manufacturing, woodworking industry	0.192	0.130	1.47	0.141
iron, steel & metal manufacturing industry	-0.008	0.103	-0.08	0.937
manufacture of machinery and equipment	-0.153	0.112	-1.37	0.172
manufacture of automobiles and automobile parts, miscel-lanous vehicle construction	-0.259	0.149	-1.74	0.083
electrical engineering, manufacture of medical, precision and optical instruments, watches	-0.282	0.107	-2.63	0.009
paper & printing, publishing houses, textile & clothing, food, furniture, jewellery, recycling	-0.026	0.105	-0.25	0.802
West German ownership (yes)	0.040	0.105	0.38	0.701
foreign ownership (yes)	-0.047	0.187	-0.25	0.803
branch office (yes)	0.058	0.111	0.52	0.604
capital company/corporation (yes)	-0.355	0.100	-3.56	0.000
Foundation of establishment before 1990	-0.197	0.158	-1.25	0.213
Foundation of establishment 1990-1997	-0.277	0.153	-1.81	0.070
industry-wide wage agreement (yes)	-0.084	0.088	-0.96	0.337
company wage agreement (yes)	-0.064	0.096	-0.67	0.504
work council (yes)	0.198	0.089	2.23	0.026

Member of chamber of industry and commerce (yes)	0.078	0.108	0.72	0.474
insourcing (yes)	-0.381	0.218	-1.75	0.080
outsourcing (yes)	-0.197	0.168	-1.17	0.243
technical equipment: quite new	-0.415	0.078	-5.3	0.000
technical equipment: medium	-0.676	0.089	-7.59	0.000
technical equipment: quite old/completely old	-0.863	0.282	-3.06	0.002
wage costs (log)	-0.406	0.112	-3.61	0.000
wages/salaries above average (yes)	-0.238	0.111	-2.15	0.032
share of exports to East Germany in sales	-0.002	0.001	-1.75	0.081
share of exports to foreign countries in sales	-0.002	0.002	-1.19	0.233
share of intermediate inputs in sales	-0.010	0.002	-6.33	0.000
share of unskilled staff in total staff	0.116	0.162	0.71	0.475
share of apprentices and trainees	-0.001	0.005	-0.31	0.760
share of female employees	-0.002	0.002	-1.02	0.308
expectation: increase in number of employees	0.233	0.075	3.09	0.002
expectation: decrease in number of employees	-0.006	0.098	-0.06	0.951
expectation: unknown develoment of number of employees	-0.151	0.138	-1.09	0.277
State: Berlin	0.210	0.135	1.56	0.120
State: Brandenburg	-0.203	0.103	-1.97	0.049
State: Mecklenburg-Vorpommern	-0.127	0.120	-1.06	0.290
State Sachsen	-0.021	0.079	-0.27	0.788
State Sachsen-Anhalt	-0.156	0.086	-1.81	0.070
year dummy 2001	-0.111	0.100	-1.11	0.267
year dummy 2002	-0.049	0.095	-0.51	0.609
year dummy 2003	-0.118	0.104	-1.14	0.254
year dummy 2005	-0.150	0.109	-1.37	0.170
year dummy 2007	-0.150	0.113	-1.32	0.186
_cons	2.679	0.928	2.89	0.004
R-squared = 0,329 / Number of observations = 1283 / heteroscedasticity robust standard errors are reported				

Table A.10:
Employment growth – Pooled OLS Regression 2000-2003, 2005, 2007 with interaction terms

	Coefficient	Robust Std. Error	t-values	Significance
Treatment	7.365	7.069	1.04	0.298
Treatment * Firm size class ≥ 20 to < 50 employees	-4.503	6.935	-0.65	0.516
Treatment * Firm size class ≥ 50 to < 100 employees	-6.115	7.499	-0.82	0.415
Treatment * Firm size class ≥ 100 to < 250 employees	-1.294	7.087	-0.18	0.855
Treatment * Firm size class ≥ 250 to < 4000 employees	-6.227	7.400	-0.84	0.400
Treatment * West German ownership (yes)	0.188	2.365	0.08	0.936
Treatment * foreign ownership (yes)	-6.103	3.418	-1.79	0.074
Firm size class ≥ 20 to < 50 employees	-5.388	2.080	-2.59	0.010
Firm size class ≥ 50 to < 100 employees	-2.193	4.136	-0.53	0.596
Firm size class ≥ 100 to < 250 employees	-6.951	2.410	-2.88	0.004
Firm size class ≥ 250 to < 4000 employees	-5.308	2.786	-1.91	0.057
nonmetallic mineral product manufacturing, woodworking industry	0.801	3.249	0.25	0.805
iron, steel & metal manufacturing industry	0.702	2.174	0.32	0.747
manufacture of machinery and equipment	3.154	2.392	1.32	0.188
manufacture of automobiles and automobile parts, miscellanous vehicle construction	2.128	2.701	0.79	0.431
electrical engineering, manufacture of medical, precision and optical instruments, watches	0.981	2.455	0.4	0.689
paper & printing, publishing houses, textile & clothing, food, furniture, jewellery, recycling	1.487	2.409	0.62	0.537
West German ownership (yes)	-3.274	2.019	-1.62	0.105
foreign ownership (yes)	0.557	2.226	0.25	0.803
branch office (yes)	-1.091	1.551	-0.7	0.482
capital company/corporation (yes)	0.847	1.948	0.44	0.664
Foundation of establishment before 1990	-17.698	5.305	-3.34	0.001
Foundation of establishment 1990-1997	-15.539	4.918	-3.16	0.002
industry-wide wage agreement (yes)	-0.405	1.475	-0.27	0.784
company wage agreement (yes)	-1.320	1.182	-1.12	0.264
work council (yes)	-1.104	1.404	-0.79	0.432
Member of chamber of industry and commerce (yes)	1.844	2.533	0.73	0.467

insourcing (yes)	-20.282	5.033	-4.03	0.000
outsourcing (yes)	-10.448	2.613	-4	0.000
technical equipment: quite new	-5.835	2.496	-2.34	0.020
technical equipment: medium	-6.645	2.617	-2.54	0.011
technical equipment: quite old/completely old	-8.934	5.920	-1.51	0.132
wage costs (log)	3.396	3.045	1.12	0.265
wages/salaries above average (yes)	-1.018	1.287	-0.79	0.429
share of exports to East Germany in sales	0.019	0.036	0.52	0.603
share of exports to foreign countries in sales	-0.019	0.028	-0.7	0.486
share of intermediate inputs in sales	0.036	0.030	1.21	0.226
share of unskilled staff in total staff	22.498	11.121	2.02	0.043
share of apprentices and trainees	0.111	0.122	0.91	0.363
share of female employees	-0.030	0.066	-0.44	0.657
expectation: increase in number of employees	4.631	1.533	3.02	0.003
expectation: decrease in number of employees	-2.614	1.441	-1.81	0.070
expectation: unknown develoment of number of employees	-3.316	3.234	-1.03	0.305
State: Berlin	-5.022	2.734	-1.84	0.066
State: Brandenburg	2.395	2.711	0.88	0.377
State: Mecklenburg-Vorpommern	-0.529	1.663	-0.32	0.750
State Sachsen	0.928	1.562	0.59	0.552
State Sachsen-Anhalt	0.092	2.016	0.05	0.964
year dummy 2001	-1.956	1.869	-1.05	0.295
year dummy 2002	-2.037	1.427	-1.43	0.154
year dummy 2003	-1.306	2.708	-0.48	0.630
year dummy 2005	-5.007	1.744	-2.87	0.004
year dummy 2007	-0.363	2.540	-0.14	0.886
_cons	37.412	30.302	1.23	0.217
R-squared = 0,144 / Number of observations = 1307 / heteroscedasticity robust standard errors are reported				

A.9 MATCHING

Table A.11:
Pooled Probit Regression 2000-2003, 2005, 2007

	Coefficient	Std. Error	t-values	Significance
firm size: 20 <= employees < 50	0.241	0.136	1.78	0.075
firm size: 50 <= employees < 100	0.572	0.154	3.72	0.000
firm size: 100 <= employees < 250	0.632	0.170	3.72	0.000
firm size: 250 <= employees < 4000	0.795	0.198	4.02	0.000
nonmetallic mineral product manufacturing, woodworking industry	-0.508	0.181	-2.82	0.005
iron, steel & metal manufacturing industry	0.001	0.141	0.01	0.993
manufacture of machinery and equipment	-0.192	0.154	-1.25	0.211
manufacture of automobiles and automobile parts, miscel-lanous vehicle construction	-0.014	0.177	-0.08	0.935
electrical engineering, manufacture of medical, precision and optical instruments, watches	-0.716	0.148	-4.84	0.000
paper & printing, publishing houses, textile & clothing, food, furniture, jewellery, recycling	-0.529	0.144	-3.67	0.000
West German ownership (yes)	-0.159	0.097	-1.63	0.103
foreign ownership (yes)	-0.236	0.158	-1.49	0.136
branch office (yes)	-0.506	0.135	-3.74	0.000
capital company/corporation (yes)	0.013	0.129	0.1	0.919
Foundation of establishment before 1990	-0.245	0.176	-1.39	0.164
Foundation of establishment 1990-1997	-0.231	0.165	-1.4	0.162
industry-wide wage agreement (yes)	-0.265	0.130	-2.03	0.042
company wage agreement (yes)	-0.197	0.128	-1.54	0.123
work council (yes)	0.036	0.111	0.33	0.743
Member of chamber of industry and commerce (yes)	0.391	0.146	2.68	0.007
insourcing (yes)	-0.140	0.250	-0.56	0.577
outsourcing (yes)	0.016	0.221	0.07	0.941
technical equipment: quite new	-0.205	0.099	-2.07	0.039

technical equipment: medium	-0.500	0.122	-4.09	0.000
technical equipment: quite old/completely old	-0.443	0.346	-1.28	0.201
wage costs (log)	0.217	0.145	1.5	0.134
wages/salaries above average (yes)	-0.215	0.150	-1.43	0.154
share of exports to East Germany in sales	-0.008	0.002	-4.95	0.000
share of exports to foreign countries in sales	-0.002	0.002	-1.14	0.255
share of intermediate inputs in sales	0.000	0.002	0.06	0.948
share of unskilled staff in total staff	-0.389	0.217	-1.79	0.073
share of apprentices and trainees	0.016	0.007	2.31	0.021
share of female employees	0.006	0.002	2.33	0.020
expectation: increase in number of employees	0.229	0.096	2.39	0.017
expectation: decrease in number of employees	-0.237	0.126	-1.89	0.059
expectation: unknown develoment of number of employees	-0.253	0.182	-1.39	0.165
State: Berlin	-0.022	0.191	-0.12	0.907
State: Brandenburg	0.438	0.146	3.01	0.003
State: Mecklenburg-Vorpommern	0.079	0.151	0.52	0.600
State Sachsen	0.059	0.105	0.56	0.573
State Sachsen-Anhalt	0.024	0.124	0.19	0.846
year dummy 2001	-0.101	0.135	-0.75	0.455
year dummy 2002	-0.145	0.135	-1.07	0.283
year dummy 2003	-0.252	0.140	-1.8	0.072
year dummy 2005	-0.274	0.144	-1.9	0.057
year dummy 2007	-0.494	0.152	-3.25	0.001
_cons	-1.178	1.205	-0.98	0.328
Pseudo R-squared = 0,164 / Number of observations = 1307				

Table A.12:
Mean comparisons of treated and non-treated firms after the matching

	Coefficient	Std. Error	t-values	Significance
Propensity Score	0.500	0.496	0.27	0.785
firm size: employees < 20	0.100	0.106	-0.33	0.743
firm size: 20 <= employees < 50	0.231	0.242	-0.41	0.685
firm size: 50 <= employees < 100	0.242	0.215	1.00	0.318
firm size: 100 <= employees < 250	0.265	0.267	-0.08	0.938
firm size: 250 <= employees < 4000	0.163	0.170	-0.30	0.762
Chemical Industry	0.185	0.195	-0.39	0.694
Nonmetallic mineral product manufacturing, woodworking industry	0.050	0.054	-0.31	0.758
Iron, steel & metal manufacturing industry	0.273	0.256	0.60	0.546
Manufacture of machinery and equipment	0.156	0.171	-0.63	0.528
Manufacture of automobiles and automobile parts, miscel-lanous vehicle construction	0.094	0.080	0.74	0.456
Electrical engineering, manufacture of medical, precision and optical instruments, watches	0.115	0.112	0.13	0.895
Paper & printing, publishing houses, textile & clothing, food, furniture, jewellery, recycling	0.127	0.131	-0.18	0.854
East German ownership (yes)	0.479	0.474	0.17	0.866
West German ownership (yes)	0.388	0.403	-0.48	0.632
Foreign ownership (yes)	0.088	0.098	-0.56	0.579
Branch office (yes)	0.096	0.093	0.18	0.860
Capital company/Corporation (yes)	0.888	0.887	0.01	0.989
Foundation of establishment before 1990	0.421	0.425	-0.13	0.900
Foundation of establishment 1990-1997	0.502	0.502	-0.01	0.992
Foundation of establishment after 1997	0.077	0.066	0.68	0.497
Industry-wide wage agreement (yes)	0.206	0.180	1.01	0.311
Company wage agreement (yes)	0.131	0.141	-0.43	0.668
no wage agreement (yes)	0.663	0.679	-0.54	0.590
Work council (yes)	0.467	0.466	0.03	0.972
Member of chamber of industry and commerce (yes)	0.933	0.928	0.35	0.728
Insourcing (yes)	1.973	1.974	-0.09	0.931
Outsourcing (yes)	0.031	0.026	0.48	0.631
Technical equipment: very new	0.240	0.250	-0.39	0.698
Technical equipment: quite new	0.565	0.574	-0.31	0.759
Technical equipment: medium	0.185	0.164	0.86	0.389
Technical equipment: quite old/completely old	0.010	0.011	-0.08	0.936

Wage costs (log)	7.483	7.490	-0.29	0.771
Wages/salaries above average (yes)	0.090	0.087	0.17	0.868
Share of sales to East Germany	33.367	33.922	-0.29	0.775
Share of exports to foreign countries in sales	19.185	19.700	-0.32	0.746
Share of intermediate inputs in sales	54.237	54.981	-0.60	0.548
Share of unskilled staff in total staff	0.111	0.107	0.34	0.735
Share of trainees and apprentices	5.818	5.735	0.23	0.816
Share of female employees	27.100	26.803	0.22	0.822
Expectation: stable number of employees	0.585	0.581	0.13	0.893
Expectation: increase in number of employees	0.269	0.276	-0.24	0.808
Expectation: decrease in number of employees	0.106	0.103	0.19	0.853
Expectation: unknown development of number of employees	0.040	0.041	-0.08	0.938
State Berlin	0.046	0.044	0.11	0.916
State Brandenburg	0.110	0.106	0.20	0.838
State Mecklenburg-Vorpommern	0.085	0.084	0.09	0.928
State Sachsen	0.292	0.306	-0.47	0.637
State Sachsen-Anhalt	0.173	0.168	0.18	0.856
State Thuringia	0.294	0.291	0.08	0.935
Year dummy 2000	0.144	0.153	-0.42	0.673
Year dummy 2001	0.185	0.176	0.39	0.696
Year dummy 2002	0.194	0.180	0.55	0.579
Year dummy 2003	0.173	0.176	-0.14	0.886
Year dummy 2005	0.169	0.174	-0.20	0.843
Year dummy 2007	0.135	0.141	-0.25	0.801

A.10 DIFFERENCE IN DIFFERENCE (DID)

Table A.13:
Results of the DID estimation, dependent variable: investment per employee

Variable	Coefficient	t value	Probability value	Significance level
Treatment	0.579	0.140	4.14	0.000
Year dummy 1998	-0.454	0.134	-3.4	0.001
Year dummy 1999	-0.616	0.179	-3.44	0.001
Year dummy 2000	-0.663	0.208	-3.18	0.002
Year dummy 2001	-0.700	0.230	-3.05	0.002
Year dummy 2002	-0.760	0.253	-3.01	0.003
Year dummy 2003	-0.970	0.279	-3.48	0.001

Table A.14:
Results of the DID estimation, dependent variable: investment share

Variable	Coefficient	t value	Probability value	Significance level
Treatment	0.511	0.143	3.58	0.000
Year dummy 1998	-0.514	0.136	-3.77	0.000
Year dummy 1999	-0.585	0.184	-3.18	0.002
Year dummy 2000	-0.674	0.214	-3.15	0.002
Year dummy 2001	-0.734	0.236	-3.1	0.002
Year dummy 2002	-0.753	0.260	-2.9	0.004
Year dummy 2003	-0.955	0.286	-3.33	0.001

Table A.15:
Results of the DID estimation, dependent variable: employment growth

Variable	Coefficient	t value	Probability value	Significance level
Treatment	0.934	6.276	0.15	0.882
Year dummy 1998	4.527	5.917	0.77	0.444
Year dummy 1999	-4.858	7.986	-0.61	0.543
Year dummy 2000	-3.610	9.342	-0.39	0.699
Year dummy 2001	-13.318	10.336	-1.29	0.198
Year dummy 2002	-18.126	11.410	-1.59	0.113
Year dummy 2003	-19.690	12.624	-1.56	0.119

A.11 TREATMENT-EFFECTS / SELECTION MODEL

Table A. 16:
Investment per employee – Pooled Treatment Regression 2000-2003, 2005, 2007

	Coefficient	Robust Std. Error	t-values	Significance
Treatment	0.919	0.316	2.91	0.004
firm size: 20 <= employees < 50	-0.658	0.098	-6.75	0.000
firm size: 50 <= employees < 100	-0.702	0.127	-5.53	0.000
firm size: 100 <= employees < 250	-0.745	0.140	-5.34	0.000
firm size: 250 <= employees < 4000	-0.656	0.169	-3.89	0.000
Nonmetallic mineral product manufacturing, woodworking industry	0.131	0.138	0.95	0.341
iron, steel & metal manufacturing industry	-0.196	0.099	-1.99	0.047
manufacture of machinery and equipment	-0.329	0.114	-2.89	0.004
manufacture of automobiles and automobile parts, miscel-lanous vehicle construction	-0.262	0.130	-2.02	0.044
Electrical engineering, manufacture of medical, precision and optical instruments, watches	-0.479	0.128	-3.74	0.000
paper & printing, publishing houses, textile & clothing, food, furniture, jewellery, recycling	-0.120	0.116	-1.03	0.304
West German ownership (yes)	0.085	0.074	1.14	0.253
foreign ownership (yes)	0.286	0.124	2.3	0.021
branch office (yes)	0.133	0.110	1.2	0.230
capital company/corporation (yes)	-0.324	0.091	-3.56	0.000
Foundation of establishment before 1990	-0.125	0.129	-0.97	0.331
Foundation of establishment 1990-1997	-0.099	0.122	-0.81	0.416
work council (yes)	0.290	0.080	3.63	0.000
Member of chamber of industry and commerce (yes)	0.272	0.102	2.68	0.007
insourcing (yes)	-0.251	0.184	-1.36	0.174
outsourcing (yes)	-0.264	0.155	-1.7	0.089
Technical equipment: quite new	-0.521	0.076	-6.85	0.000
Technical equipment: medium	-0.864	0.098	-8.77	0.000
Technical equipment: quite old/completely old	-1.163	0.252	-4.61	0.000
wage costs (log)	0.276	0.096	2.87	0.004

wages/salaries above average (yes)	-0.113	0.100	-1.13	0.257
share of exports to East Germany in sales	-0.002	0.001	-1.21	0.228
share of exports to foreign countries in sales	0.001	0.002	0.78	0.436
share of intermediate inputs in sales	0.000	0.002	-0.29	0.773
share of unskilled staff in total staff	-0.119	0.157	-0.76	0.445
expectation: increase in number of employees	0.167	0.077	2.18	0.029
expectation: decrease in number of employees	-0.042	0.092	-0.46	0.649
expectation: unknown develoment of number of employees	-0.188	0.135	-1.4	0.162
State: Berlin	0.199	0.133	1.5	0.135
State: Brandenburg	-0.099	0.110	-0.9	0.369
State: Mecklenburg-Vorpommern	0.041	0.112	0.37	0.712
State Sachsen	-0.004	0.076	-0.05	0.961
State Sachsen-Anhalt	-0.080	0.090	-0.89	0.375
year dummy 2001	-0.057	0.098	-0.58	0.559
year dummy 2002	0.038	0.098	0.39	0.698
year dummy 2003	-0.078	0.104	-0.75	0.456
year dummy 2005	-0.111	0.106	-1.05	0.295
year dummy 2007	0.018	0.117	0.15	0.881
_cons	7.970	0.810	9.84	0.000

Table A.17:
Pooled Probit Regression 2000-2003, 2005, 2007
(first stage equation in model for investment per employee)

	Coefficient	Std. Error	t-values	Significance
Share of trainees and apprentices	0.016	2.36	0.018	0.003
Share of female employees	0.006	2.5	0.012	0.001
Industry-wide wage agreement (yes)	-0.347	-2.68	0.007	-0.600
Company wage agreement (yes)	-0.191	-1.5	0.134	-0.440
Nonmetallic mineral product manufacturing, woodworking industry	-0.485	-2.75	0.006	-0.830
Iron, steel & metal manufacturing industry	0.007	0.05	0.962	-0.269
Manufacture of machinery and equipment	-0.173	-1.13	0.260	-0.474
Manufacture of automobiles and automobile parts, miscellanous vehicle construction	-0.002	-0.01	0.992	-0.344
Electrical engineering, manufacture of medical, precision and optical instruments, watches	-0.715	-4.89	0.000	-1.001
Paper & printing, publishing houses, textile & clothing, food, furniture, jewellery, recycling	-0.489	-3.45	0.001	-0.766
firm size: 20 <= employees < 50	0.366	2.82	0.005	0.111
firm size: 50 <= employees < 100	0.699	4.69	0.000	0.407
firm size: 100 <= employees < 250	0.757	4.56	0.000	0.432
firm size: 250 <= employees < 4000	0.931	4.79	0.000	0.550
West German ownership (yes)	-0.218	-2.22	0.027	-0.411
Foreign ownership (yes)	-0.282	-1.77	0.076	-0.593
Branch office (yes)	-0.461	-3.34	0.001	-0.732
Capital company/Corporation (yes)	0.000	0	0.998	-0.252
Foundation of establishment before 1990	-0.251	-1.45	0.148	-0.591
Foundation of establishment 1990-1997	-0.232	-1.42	0.154	-0.551
Work council (yes)	0.086	0.78	0.437	-0.131
Member of chamber of industry and commerce (yes)	0.428	3.05	0.002	0.153
Insourcing (yes)	-0.177	-0.72	0.470	-0.659
Outsourcing (yes)	0.032	0.14	0.885	-0.401
Technical equipment: quite new	-0.192	-1.96	0.050	-0.385
Technical equipment: medium	-0.508	-4.13	0.000	-0.749
Technical equipment: quite old/completely old	-0.594	-1.84	0.066	-1.226
Wage costs (log)	0.298	2.12	0.034	0.023
Wages/salaries above average (yes)	-0.203	-1.35	0.176	-0.497
Share of sales to East Germany	-0.008	-5.05	0.000	-0.011
Share of exports to foreign countries in sales	-0.002	-0.94	0.347	-0.006
Share of intermediate inputs in sales	0.000	-0.14	0.886	-0.004

Share of unskilled staff in total staff	-0.287	-1.36	0.173	-0.699
Expectation: increase in number of employees	0.260	2.75	0.006	0.075
Expectation: decrease in number of employees	-0.242	-1.94	0.052	-0.486
Expectation: unknown development of number of employees	-0.196	-1.11	0.268	-0.544
State „Berlin“	-0.034	-0.18	0.856	-0.404
State „Brandenburg“	0.428	3.06	0.002	0.153
State „Mecklenburg-Vorpommern“	0.073	0.49	0.626	-0.219
State „Saxony“	0.030	0.29	0.770	-0.171
State „Saxony-Anhalt“	0.013	0.11	0.915	-0.229
Year dummy 2001	-0.056	-0.42	0.672	-0.314
Year dummy 2002	-0.143	-1.09	0.276	-0.400
Year dummy 2003	-0.202	-1.47	0.142	-0.471
Year dummy 2005	-0.251	-1.76	0.079	-0.531
Year dummy 2007	-0.489	-3.27	0.001	-0.782
Constant	-1.909	-1.62	0.105	-4.219

Table A.18:
Investment share – Pooled Treatment Regression 2000-2003, 2005, 2007

	Coefficient	Robust Std. Error	t-values	Significance
Treatment	1.105	0.276	4.00	0.000
firm size: 20 <= employees < 50	-0.595	0.097	-6.13	0.000
firm size: 50 <= employees < 100	-0.717	0.124	-5.79	0.000
firm size: 100 <= employees < 250	-0.721	0.136	-5.3	0.000
firm size: 250 <= employees < 4000	-0.644	0.164	-3.93	0.000
nonmetallic mineral product manufacturing, woodworking industry	0.250	0.136	1.84	0.066
iron, steel & metal manufacturing industry	0.024	0.099	0.24	0.812
manufacture of machinery and equipment	-0.116	0.113	-1.02	0.306
manufacture of automobiles and automobile parts, miscellanous vehicle construction	-0.221	0.130	-1.7	0.089
Electrical engineering, manufacture of medical, precision and optical instruments, watches	-0.260	0.124	-2.1	0.036
paper & printing, publishing houses, textile & clothing, food, furniture, jewellery, recycling	-0.022	0.114	-0.19	0.850
West German ownership (yes)	-0.053	0.075	-0.71	0.478
foreign ownership (yes)	0.012	0.124	0.1	0.920
branch office (yes)	0.079	0.108	0.73	0.465
capital company/corporation (yes)	-0.335	0.091	-3.67	0.000
Foundation of establishment before 1990	-0.187	0.129	-1.44	0.149
Foundation of establishment 1990-1997	-0.259	0.123	-2.11	0.035
work council (yes)	0.185	0.080	2.32	0.020
Member of chamber of industry and commerce (yes)	0.071	0.101	0.71	0.480
insourcing (yes)	-0.343	0.187	-1.84	0.066
outsourcing (yes)	-0.205	0.157	-1.31	0.191
Technical equipment: quite new	-0.398	0.076	-5.25	0.000
Technical equipment: medium	-0.637	0.097	-6.59	0.000
Technical equipment: quite old/completely old	-0.830	0.252	-3.3	0.001
wage costs (log)	-0.393	0.097	-4.05	0.000
wages/salaries above average (yes)	-0.250	0.099	-2.53	0.011
share of exports to East Germany in sales	-0.002	0.001	-1.56	0.119
share of exports to foreign countries in sales	-0.002	0.002	-1.09	0.276

share of intermediate inputs in sales	-0.010	0.002	-6.3	0.000
share of unskilled staff in total staff	0.124	0.156	0.8	0.427
expectation: increase in number of employees	0.212	0.075	2.81	0.005
expectation: decrease in number of employees	0.015	0.092	0.16	0.872
expectation: unknown develoment of number of employees	-0.144	0.138	-1.04	0.298
State: Berlin	0.230	0.135	1.71	0.088
State: Brandenburg	-0.245	0.109	-2.24	0.025
State: Mecklenburg-Vorpommern	-0.112	0.112	-1	0.318
State Sachsen	-0.017	0.077	-0.23	0.819
State Sachsen-Anhalt	-0.159	0.091	-1.76	0.079
year dummy 2001	-0.111	0.098	-1.14	0.255
year dummy 2002	-0.049	0.098	-0.5	0.618
year dummy 2003	-0.111	0.105	-1.06	0.291
year dummy 2005	-0.142	0.107	-1.33	0.183
year dummy 2007	-0.124	0.116	-1.08	0.282
_cons	2.323	0.814	2.86	0.004

Table A.19:
Pooled Probit Regression 2000-2003, 2005, 2007
(first stage equation in model for investment share)

	Coefficient	Std. Error	t-values	Significance
Share of trainees and apprentices	0.015	2.27	0.023	0.002
Share of female employees	0.005	2.24	0.025	0.001
Industry-wide wage agreement (yes)	-0.365	-2.8	0.005	-0.620
Company wage agreement (yes)	-0.199	-1.57	0.117	-0.449
Nonmetallic mineral product manufacturing, woodworking industry	-0.510	-2.9	0.004	-0.855
Iron, steel & metal manufacturing industry	-0.017	-0.12	0.901	-0.288
Manufacture of machinery and equipment	-0.193	-1.27	0.204	-0.490
Manufacture of automobiles and automobile parts, miscellanous vehicle construction	-0.023	-0.13	0.894	-0.363
Electrical engineering, manufacture of medical, precision and optical instruments, watches	-0.715	-4.89	0.000	-1.001
Paper & printing, publishing houses, textile & clothing, food, furniture, jewellery, recycling	-0.490	-3.46	0.001	-0.768
firm size: 20 <= employees < 50	0.365	2.81	0.005	0.111
firm size: 50 <= employees < 100	0.706	4.76	0.000	0.416
firm size: 100 <= employees < 250	0.763	4.62	0.000	0.439
firm size: 250 <= employees < 4000	0.940	4.85	0.000	0.560
West German ownership (yes)	-0.204	-2.07	0.038	-0.397
Foreign ownership (yes)	-0.269	-1.7	0.089	-0.580
Branch office (yes)	-0.484	-3.53	0.000	-0.754
Capital company/Corporation (yes)	-0.020	-0.16	0.874	-0.270
Foundation of establishment before 1990	-0.243	-1.4	0.161	-0.583
Foundation of establishment 1990-1997	-0.228	-1.4	0.161	-0.547
Work council (yes)	0.083	0.75	0.453	-0.134
Member of chamber of industry and commerce (yes)	0.438	3.12	0.002	0.163
Insourcing (yes)	-0.195	-0.79	0.431	-0.680
Outsourcing (yes)	0.026	0.12	0.908	-0.408
Technical equipment: quite new	-0.200	-2.04	0.041	-0.392
Technical equipment: medium	-0.529	-4.37	0.000	-0.766
Technical equipment: quite old/completely old	-0.626	-1.9	0.057	-1.271
Wage costs (log)	0.285	2.02	0.043	0.009
Wages/salaries above average (yes)	-0.197	-1.31	0.190	-0.491
Share of sales to East Germany	-0.008	-5.01	0.000	-0.011
Share of exports to foreign countries in sales	-0.002	-0.92	0.358	-0.006
Share of intermediate inputs in sales	0.000	-0.21	0.835	-0.004

Share of unskilled staff in total staff	-0.282	-1.34	0.182	-0.695
Expectation: increase in number of employees	0.254	2.69	0.007	0.069
Expectation: decrease in number of employees	-0.231	-1.86	0.063	-0.476
Expectation: unknown development of number of employees	-0.204	-1.15	0.252	-0.553
State „Berlin“	-0.033	-0.18	0.860	-0.403
State „Brandenburg“	0.423	3.02	0.003	0.149
State „Mecklenburg-Vorpommern“	0.068	0.46	0.645	-0.222
State „Saxony“	0.029	0.29	0.774	-0.171
State „Saxony-Anhalt“	0.003	0.03	0.979	-0.239
Year dummy 2001	-0.062	-0.47	0.636	-0.321
Year dummy 2002	-0.146	-1.11	0.266	-0.402
Year dummy 2003	-0.208	-1.52	0.130	-0.477
Year dummy 2005	-0.261	-1.82	0.069	-0.542
Year dummy 2007	-0.491	-3.29	0.001	-0.784
Constant	-1.711	-1.45	0.147	-4.026

Table A.20:
Employment growth – Pooled Treatment Regression 2000-2003, 2005, 2007

	Coefficient	Robust Std. Error	t-values	Significance
Treatment	4.450	9.634	0.46	0.644
firm size: 20 <= employees < 50	-6.397	2.267	-2.82	0.005
firm size: 50 <= employees < 100	-4.130	3.137	-1.32	0.188
firm size: 100 <= employees < 250	-6.946	3.437	-2.02	0.043
firm size: 250 <= employees < 4000	-7.937	4.166	-1.91	0.057
nonmetallic mineral product manufacturing, woodworking industry	1.743	3.363	0.52	0.604
iron, steel & metal manufacturing industry	1.932	2.246	0.86	0.390
manufacture of machinery and equipment	4.337	2.656	1.63	0.103
manufacture of automobiles and automobile parts, miscellanous vehicle construction	3.083	2.941	1.05	0.295
Electrical engineering, manufacture of medical, precision and optical instruments, watches	1.281	3.232	0.4	0.692
paper & printing, publishing houses, textile & clothing, food, furniture, jewellery, recycling	1.909	2.836	0.67	0.501
West German ownership (yes)	-3.390	1.709	-1.98	0.047
foreign ownership (yes)	-1.799	2.876	-0.63	0.532
branch office (yes)	-0.333	2.738	-0.12	0.903
capital company/corporation (yes)	0.828	2.052	0.4	0.687
Foundation of establishment before 1990	-17.214	2.958	-5.82	0.000
Foundation of establishment 1990-1997	-15.054	2.815	-5.35	0.000
work council (yes)	-1.014	1.812	-0.56	0.576
Member of chamber of industry and commerce (yes)	1.365	2.363	0.58	0.563
insourcing (yes)	-19.800	4.190	-4.72	0.000
outsourcing (yes)	-10.951	3.520	-3.11	0.002
Technical equipment: quite new	-5.903	1.777	-3.32	0.001
Technical equipment: medium	-6.924	2.438	-2.84	0.005
Technical equipment: quite old/completely old	-8.325	5.793	-1.44	0.151
wage costs (log)	3.542	2.178	1.63	0.104
wages/salaries above average (yes)	-1.209	2.359	-0.51	0.608
share of exports to East Germany in sales	0.022	0.035	0.61	0.540
share of exports to foreign countries in sales	-0.019	0.036	-0.53	0.598

share of intermediate inputs in sales	0.037	0.034	1.07	0.284
share of unskilled staff in total staff	21.840	3.620	6.03	0.000
expectation: increase in number of employees	4.548	1.797	2.53	0.011
expectation: decrease in number of employees	-2.517	2.119	-1.19	0.235
expectation: unknown develoment of number of employees	-3.185	3.097	-1.03	0.304
State: Berlin	-4.943	3.021	-1.64	0.102
State: Brandenburg	2.327	2.607	0.89	0.372
State: Mecklenburg-Vorpommern	-0.593	2.540	-0.23	0.815
State Sachsen	1.032	1.730	0.6	0.551
State Sachsen-Anhalt	0.302	2.044	0.15	0.883
year dummy 2001	-1.790	2.216	-0.81	0.419
year dummy 2002	-2.041	2.244	-0.91	0.363
year dummy 2003	-1.191	2.407	-0.49	0.621
year dummy 2005	-4.958	2.448	-2.03	0.043
year dummy 2007	-0.134	2.792	-0.05	0.962
_cons	34.657	18.582	1.87	0.062

Table A.21:
Pooled Probit Regression 2000-2003, 2005, 2007
(first stage equation in model for employment growth)

	Coefficient	Std. Error	t-values	Significance
Share of trainees and apprentices	0.015	2.27	0.023	0.002
Share of female employees	0.005	2.24	0.025	0.001
Industry-wide wage agreement (yes)	-0.365	-2.8	0.005	-0.620
Company wage agreement (yes)	-0.199	-1.57	0.117	-0.449
Nonmetallic mineral product manufacturing, woodworking industry	-0.510	-2.9	0.004	-0.855
Iron, steel & metal manufacturing industry	-0.017	-0.12	0.901	-0.288
Manufacture of machinery and equipment	-0.193	-1.27	0.204	-0.490
Manufacture of automobiles and automobile parts, miscellanous vehicle construction	-0.023	-0.13	0.894	-0.363
Electrical engineering, manufacture of medical, precision and optical instruments, watches	-0.715	-4.89	0.000	-1.001
Paper & printing, publishing houses, textile & clothing, food, furniture, jewellery, recycling	-0.490	-3.46	0.001	-0.768
firm size: 20 <= employees < 50	0.365	2.81	0.005	0.111
firm size: 50 <= employees < 100	0.706	4.76	0.000	0.416
firm size: 100 <= employees < 250	0.763	4.62	0.000	0.439
firm size: 250 <= employees < 4000	0.940	4.85	0.000	0.560
West German ownership (yes)	-0.204	-2.07	0.038	-0.397
Foreign ownership (yes)	-0.269	-1.7	0.089	-0.580
Branch office (yes)	-0.484	-3.53	0.000	-0.754
Capital company/Corporation (yes)	-0.020	-0.16	0.874	-0.270
Foundation of establishment before 1990	-0.243	-1.4	0.161	-0.583
Foundation of establishment 1990-1997	-0.228	-1.4	0.161	-0.547
Work council (yes)	0.083	0.75	0.453	-0.134
Member of chamber of industry and commerce (yes)	0.438	3.12	0.002	0.163
Insourcing (yes)	-0.195	-0.79	0.431	-0.680
Outsourcing (yes)	0.026	0.12	0.908	-0.408
Technical equipment: quite new	-0.200	-2.04	0.041	-0.392
Technical equipment: medium	-0.529	-4.37	0.000	-0.766
Technical equipment: quite old/completely old	-0.626	-1.9	0.057	-1.271
Wage costs (log)	0.285	2.02	0.043	0.009
Wages/salaries above average (yes)	-0.197	-1.31	0.190	-0.491
Share of sales to East Germany	-0.008	-5.01	0.000	-0.011
Share of exports to foreign countries in sales	-0.002	-0.92	0.358	-0.006
Share of intermediate inputs in sales	0.000	-0.21	0.835	-0.004

Share of unskilled staff in total staff	-0.282	-1.34	0.182	-0.695
Expectation: increase in number of employees	0.254	2.69	0.007	0.069
Expectation: decrease in number of employees	-0.231	-1.86	0.063	-0.476
Expectation: unknown development of number of employees	-0.204	-1.15	0.252	-0.553
State „Berlin“	-0.033	-0.18	0.860	-0.403
State „Brandenburg“	0.423	3.02	0.003	0.149
State „Mecklenburg-Vorpommern“	0.068	0.46	0.645	-0.222
State „Saxony“	0.029	0.29	0.774	-0.171
State „Saxony-Anhalt“	0.003	0.03	0.979	-0.239
Year dummy 2001	-0.062	-0.47	0.636	-0.321
Year dummy 2002	-0.146	-1.11	0.266	-0.402
Year dummy 2003	-0.208	-1.52	0.130	-0.477
Year dummy 2005	-0.261	-1.82	0.069	-0.542
Year dummy 2007	-0.491	-3.29	0.001	-0.784
Constant	-1.711	-1.45	0.147	-4.026

A.12 IMPACT ANALYSIS OF R&D GRANTS

Table A.22:
Definition of treatment and control variables

Variable	Description
Treatment Variable	
drd =1	if firm received a subsidy either from the federal state Thuringia, national or EU wide programmes; 0 otherwise.
Standard firm specific control variables and skill structure	
size	Firm size in terms of total employment
age	Number of years since firm was created, relative to 2004
capint	Capital intensity
Capage	Age of the capital stock (can take values from 1 to 4 as being "up to date", "sufficient", "parts being obsolete" and "all being obsolete")
inveqmt	Investment intensity defined as total investment per employee in 2003
hchigh	Share of high skilled employees as share of total employment
Internationalization and regional input-output relations	
import	Import share in percent, defined as imports relative to total inputs, in %
inregn	Input from suppliers within the core region (30km) relative to total inputs, in %
inthrg	Input from suppliers outside the core region (30km) but within Thuringia relative to total inputs, in %
ineast	Input from suppliers from East Germany relative to total inputs, in %
inwest	Input from suppliers from West Germany relative to total inputs, in %
export	Export share in percent, de¯ned as total exports relative to sales, in %
outregn	Sales within the core region (30km) relative to total sales, in %
outthrg	Sales outside the core region (30km) but within Thuringia relative to total sales, in %
outeast	Sales within East Germany relative to total sales, in %
outwest	Sales within West Germany relative to total sales, in %
Binary dummy variables	

dlbty	= 1 if firm owner has full legal liability, 0 for limited liability
dwgroup	= 1 if firm belongs to a parent company in West Germany
dforeign	= 1 if firm belongs to a parent company abroad
deast	= 1 if firm belongs to a parent company in East Germany
dwequal	= 1 if firm pays a nominal wage equal to the union rate
dwplus	= 1 if firm pays a nominal wage above the union rate
dwminus	= 1 if firms pays a nominal wage below to the union rate
drddpmt	= 1 if firm is permanently engaged in R&D activity, proxy for R&D department
Sectoral Dummies	(according to German classification of Economic Activities [WZ], Edition 2008)
dind15	= 1 if firm belongs to WZ 15 and 16 (Manufacture of food products and beverages and tobacco products)
dind17	= 1 if firm belongs to WZ 17, 18 and 19 (Manufacture of textiles, of wearing apparel; dressing and dyeing of fur; Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear)
dind20	= 1 if firm belongs to WZ 20 (Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials)
dind21	= 1 if firm belongs to WZ 21 and 22 (Manufacture of pulp, paper and paper products; Publishing, printing and reproduction of recorded media)
dind24	= 1 if firm belongs to WZ 24 (Manufacture of chemicals and chemical products)
dind25	= 1 if firm belongs to WZ 25 (Manufacture of rubber and plastic products)
dind26	= 1 if firm belongs to WZ 26 (Manufacture of other non-metallic mineral products)
dind27	= 1 if firm belongs to WZ 27 and 28 (Manufacture of basic metals; of fabricated metal products, except machinery and equipment)
dind29	= 1 if firm belongs to WZ 29 (Manufacture of machinery and equipment n.e.c.)
dind30	= 1 if firm belongs to WZ 30 to 33 (Manufacture of office machinery and computers; of electrical machinery and apparatus n.e.c.; of radio, television and communication equipment and apparatus; and of medical, precision and optical instruments, watches and clocks)
dind34	= 1 if firm belongs to WZ 34 and 35 (Manufacture of motor vehicles, trailers and semi-trailers; of other transport equipment)
dind36	= 1 if firm belongs to WZ 36 and 37 (Manufacture of furniture; manufacturing n.e.c.; receycling)
dind72	= 1 if firm belongs to WZ 72 to 74 (Computer and related activities; Research and development; Other business activities)

Table A.23:
Descriptive statistics for continuous variables

Variable	N	Mean	Standard Deviation	Min	Max
Rdint	359	0.097	0.298	0.00	4.62
Rdxpdt	367	0.413	1.574	0.00	20.72
Rdemp	170	16.83	54.29	1	621
Pat	962	1.633	26.95	0	820
Size	962	71.49	145.52	5	1980
Age	862	10.94	6.43	1	71
Capint	869	67.80	198.04	0	3875
Capage	924	1.69	0.67	1	4
Inveqmt	758	12.39	52.73	0	1254
Hchigh	962	0.212	0.209	0.005	1
Import	863	11.21	18.75	0	100
Inregn	876	19.30	23.92	0	100
Inthrg	879	14.77	18.54	0	100
Ineast	871	46.22	30.40	0	100
Inwest	884	42.85	27.97	0	100
Export	915	15.83	23.70	0	100
Outregn	926	16.74	24.42	0	100
Outthrg	930	12.32	17.22	0	100
Outeast	923	41.10	33.71	0	100
Outwest	935	43.46	29.87	0	100

Table A.24:
Descriptive Statistics for binary variables

Variable	No. of firms with variable X = 1	Percent
dpat	171	17.77
drd	198	23.86
dlbty	119	12.37
dwgroup	141	14.66
dforeign	53	5.51
deast	650	67.57
dwequal	568	59.04
dwplus	270	28.07
dwminus	49	5.09
drddpmt	280	29.11
dind15	48	4.99
dind17	21	2.11
dind20	20	2.08
dind21	35	3.64
dind24	34	3.53
dind25	82	8.52
dind26	66	6.86
dind27	199	20.69
dind29	102	10.60
dind30	157	16.32
dind34	29	3.01
dind36	42	4.37
dind72	110	11.43

Table A.25:
Estimation results of the binary probit model for R&D programme participation

Variable	Coefficient	P-value	Coefficient	P-value
log(size)	-0.0920		-0.0629	
log(ageinv)	-0.3466	**	-0.2892	*
log(capint)	0.0063		0.0163	
log(capage)	-0.0497		-0.0730	
log(inveqmt)	-0.0619			
log(hchigh)	0.5145	***	0.5559	***
log(import)	0.0367	*	0.0432	**
log(inregn)	-0.0396	*	-0.0422	**
log(inthrg)	-0.0134		-0.0053	
log(ineast)	0.0562		0.0380	
log(inwest)	0.0013		-0.0018	
log(export)	0.0156		0.0212	
log(outregn)	0.0260		0.0259	
log(outthrg)	-0.0072		0.0020	
log(outeast)	0.0262		0.0260	
log(outwest)	0.1087	**	0.0875	**
Dlbty	0.0070		0.1196	
Dwgroup	0.1152		0.0835	
Dforeign	0.2223			
Deast	0.4855			
dwequal	0.0239		0.0443	
Dwplus	-0.0549		0.0628	
dwminus	-0.8846	*	-0.4169	
Drddpmt	1.2372	***	1.2401	***
N	502		633	
Pseudo R2	0.3621		0.3663	
Log Likelihood	-188.30		-222.12	

Note: ***, **, * = denote significance levels at the 1%, 5% and 10% level respectively.

Coefficient results of the sector dummies are skipped for brevity.

Table A.26:
R&D investment per employee – OLS regression results

	Coefficient	Robust Std. Error	t-values	Significance
treatment	0.806	0.199	4.05	0.000
firm size: 20 <= employees < 50	-0.923	0.336	-2.75	0.007
firm size: 50 <= employees < 100	-1.377	0.423	-3.26	0.001
firm size: 100 <= employees < 250	-1.478	0.442	-3.34	0.001
firm size: 250 <= employees < 4000	-1.525	0.576	-2.65	0.009
Manufacture of textiles, of wearing apparel; dressing and dyeing of fur; Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear	-0.640	1.103	-0.58	0.562
Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	1.597	0.788	2.03	0.044
Manufacture of pulp, paper and paper products; Publishing, printing and reproduction of recorded media	0.873	0.825	1.06	0.291
Manufacture of chemicals and chemical products	0.462	0.918	0.5	0.616
Manufacture of rubber and plastic products	0.729	0.672	1.08	0.280
Manufacture of other non-metallic mineral products	1.182	0.720	1.64	0.103
Manufacture of basic metals; of fabricated metal products, except machinery and equipment	0.642	0.656	0.98	0.329
Manufacture of machinery and equipment n.e.c.	0.819	0.713	1.15	0.252
Manufacture of office machinery and computers; of electrical machinery and apparatus n.e.c.; of radio, television and communication equipment and apparatus; and of medical, precision and optical instruments, watches and clocks	1.285	0.642	2	0.047
Manufacture of motor vehicles, trailers and semi-trailers; of other transport equipment	0.742	0.701	1.06	0.291
Manufacture of furniture; manufacturing n.e.c.; receycling	1.033	0.722	1.43	0.154
Computer and related activities; Research and development; Other business activities	2.266	0.725	3.12	0.002
Capital company/Corporation (yes)	-0.874	0.485	-1.8	0.073
East German affiliate	-0.002	0.378	0	0.997
West German ownership (yes)	-0.114	0.239	-0.48	0.633
Foreign ownership (yes)	0.337	0.465	0.72	0.470
Member of chamber of industry and commerce (yes)	-0.460	0.362	-1.27	0.205
Industry-wide wage agreement (yes)	0.952	0.412	2.31	0.022
Company wage agreement (yes)	0.159	0.346	0.46	0.645
R&D Department	0.785	0.217	3.62	0.000
age of firm	-0.101	0.177	-0.57	0.570

Wage costs (log)	-0.267	0.339	-0.79	0.432
Capital intensity (log)	-0.096	0.120	-0.8	0.427
investment share	0.001	0.001	1.36	0.177
Share of sales to East Germany	0.011	0.008	1.27	0.205
Share of sales to West Germany	0.012	0.005	2.27	0.024
Share of exports to foreign countries in sales	0.016	0.006	2.71	0.007
Share of intermediate inputs in sales	-0.316	0.419	-0.76	0.451
Share of imports from East Germany	-0.004	0.007	-0.61	0.543
Share of imports from West Germany	-0.006	0.005	-1.18	0.238
Share of imports to foreign countries in sales	-0.005	0.006	-0.89	0.375
Share of high-skilled staff in total staff	0.389	0.742	0.52	0.601
Share of unskilled staff in total staff	-0.805	0.661	-1.22	0.225
constant	-6.153	1.697	-3.63	0.000

Table A.27:
R&D expenditure share – OLS regression results

	Coefficient	Robust Std. Error	t-values	Significance
treatment	0.708	0.191	3.70	0.000
firm size: 20 <= employees < 50	-0.654	0.281	-2.32	0.021
firm size: 50 <= employees < 100	-1.218	0.408	-2.99	0.003
firm size: 100 <= employees < 250	-1.111	0.417	-2.66	0.008
firm size: 250 <= employees < 4000	-1.101	0.554	-1.99	0.048
Manufacture of textiles, of wearing apparel; dressing and dyeing of fur; Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear	-0.410	0.890	-0.46	0.646
Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	1.448	0.905	1.6	0.111
Manufacture of pulp, paper and paper products; Publishing, printing and reproduction of recorded media	0.656	0.828	0.79	0.429
Manufacture of chemicals and chemical products	0.148	0.945	0.16	0.876
Manufacture of rubber and plastic products	0.512	0.727	0.7	0.482
Manufacture of other non-metallic mineral products	0.742	0.765	0.97	0.333
Manufacture of basic metals; of fabricated metal products, except machinery and equipment	0.063	0.706	0.09	0.929
Manufacture of machinery and equipment n.e.c.	0.508	0.745	0.68	0.496
Manufacture of office machinery and computers; of electrical machinery and apparatus n.e.c.; of radio, television and communication equipment and apparatus; and of medical, precision and optical instruments, watches and clocks	0.957	0.704	1.36	0.176
Manufacture of motor vehicles, trailers and semi-trailers; of other transport equipment	0.572	0.774	0.74	0.461
Manufacture of furniture; manufacturing n.e.c.; receycling	0.611	0.771	0.79	0.429
Computer and related activities; Research and development; Other business activities	1.350	0.742	1.82	0.070
Capital company/Corporation (yes)	-0.280	0.491	-0.57	0.569
East German affiliate	-0.045	0.355	-0.13	0.899
West German ownership (yes)	-0.089	0.226	-0.39	0.695
Foreign ownership (yes)	0.257	0.423	0.61	0.544
Member of chamber of industry and commerce (yes)	-0.254	0.346	-0.73	0.464
Industry-wide wage agreement (yes)	0.756	0.399	1.9	0.060
Company wage agreement (yes)	0.116	0.318	0.36	0.716
R&D Department	0.670	0.174	3.86	0.000
age of firm	-0.162	0.173	-0.94	0.351

Wage costs (log)	0.371	0.304	1.22	0.224
Capital intensity (log)	-0.011	0.108	-0.1	0.920
investment share	0.001	0.000	1.37	0.173
Share of sales to East Germany	0.010	0.006	1.58	0.116
Share of sales to West Germany	0.008	0.004	1.79	0.075
Share of exports to foreign countries in sales	0.012	0.005	2.4	0.017
Share of intermediate inputs in sales	-0.328	0.290	-1.13	0.260
Share of imports from East Germany	-0.005	0.006	-0.81	0.419
Share of imports from West Germany	-0.007	0.005	-1.49	0.138
Share of imports to foreign countries in sales	-0.001	0.005	-0.23	0.819
Share of high-skilled staff in total staff	0.638	0.649	0.98	0.327
Share of unskilled staff in total staff	-0.665	0.615	-1.08	0.281
constant	7.630	1.557	4.9	0.000

Table A.28:

Mean comparison of subsidized firms, firms without subsidization and selected control group of firms without subsidization based on the kernel matching procedure

Variable	Treated	Unmatched nontreated firms	p-value	Matched nontreated firms	p-value
Propensity score	0.5367	0.1445	***	0.5339	
log(*size*)	3.6848	3.5808		3.7941	
log(*ageinv*)	-2.3103	-2.2732		-2.3539	
log(*capage*)	0.4335	0.4386		0.4432	
log(*capint*)	3.3786	3.5311		3.3559	
log(*export*)	0.6404	-1.7769	***	0.0919	
log(*hchigh*)	-1.4274	-2.1789	***	-1.5127	
log(*import*)	-0.5585	-2.6652	***	-0.5503	
log(*ineast*)	3.1110	2.9026		2.5460	*
log(*inregn*)	0.6056	0.3921		0.3554	
log(*inthrg*)	0.3228	0.5529		0.0312	
log(*inwest*)	3.0485	2.7840		3.2547	
log(*outeast*)	2.5365	2.2370		2.5194	
log(*outregn*)	-0.4482	-0.5066		-0.6753	
log(*outthrg*)	-0.3056	-0.3971		0.1332	
log(*outwest*)	3.4570	2.3381	***	3.5081	
deast	0.7219	0.6341	**	0.7139	
dforeign	0.0530	0.0561		0.0742	
dlbty	0.0729	0.1497	**	0.0715	
dwequal	0.5762	0.5821		0.5550	
dwgroup	0.1457	0.1642		0.1616	
dwminus	0.0331	0.0665		0.0159	
dwplus	0.3113	0.2827		0.3391	
drddpmt	0.7152	0.1559	***	0.7099	

Note: ***, **, * = denote significance levels at the 1%, 5% and 10% level respectively. Statistical significance was tested in a two-tailed t-test between the supported firms (column 2) and firms either from the potential control group (column 3) or from the selected control group (column 4). Results for the sector dummies are skipped for brevity.

A.13 INTERVIEW GUIDE

Interviews with representatives of the six East German states

- Berlin
- Brandenburg
- Mecklenburg-Pommerenia
- Saxony
- Saxony-Anhalt
- Thuringia

Interviews with:

- Representatives of the managing authorities (ERDF)
- Representatives of the GRW (Common Task)

Content

a) Introduction

Short overview regarding the study, performed on behalf of DG Regional Policy

- Investment subsidies
- R&D support to enterprises
- Special feature: Use of statistical methods that use comparisons of treated and non-treated firm to identify the impact of the policies
- Main Results:
  - Investment subsidies:
    - Higher investment by treated firms
    - Additional employment
    - But, impact on investment is relatively higher than the increase in employment
    - Capital deepening and enhancing productivity
    - No statistical differences between SME and other size classes concerning the impact on investment and employment
    -
  - R&D subsidies:
    - Support leads to high R&D expenditures
    - Public funds do not replace private engagement

b) Questions

General

a. How important are direct investment subsidies for the development of the competitiveness of your region from your point of view?
   i. Very high (5) to not at all (0)

b. How important are direct R&D subsidies for the development of the competitiveness of your region from your point of view?
   i. Very high (5) to not at all (0)

Specifically concerning the study:

c. The study shows that supported firms have investments that are 2.5 times higher than those of the non-supported firms, i.e. on average €11-12,000/employee rather than €4000. Moreover, on average a given € of grant produced something like €1.50 of investment.
   a. How do you assess these results?
   b. Do these estimates correspond with your experience/expectations or are you surprised that investment subsidies are that important for an individual firm?
   c. How would you explain/account for these results? (or is this what you meant by "a" above?)

d. While the study finds that investment subsidies lead to real employment gains, these tend to be small – the main effect is on productivity. This suggests that firms are using subsidies to modernized and deepen their capital stock, rather than to increase employment.
   a. How do you assess these results?
   b. Do these estimates correspond with your experience…

e. The study detects no difference between various size classes of firm. Neither for investment, nor employment. A preferential treatment of SMEs seems not to be justified from this point of view.
   a. How do you assess these results?
   b. Do these estimates correspond with your expectations?
   c. Could you name other reasons why SME should be preferred?

f. Regarding R&D-support it could be shown that supported firms have twice as high R&D spending compared to non-supported firms. But, more or less the total amount of this additional investment can be traced back to the public support.
   a. How do you assess these results?
   b. Do these estimates correspond with your experience?

Specifically concerning the methods of investigation:

g. The study is based on a statistical approach that works with the comparison of groups using sophisticated statistical methods. It is connected with high data requirements and it is necessary to observe supported and non-supported firms on a regular basis over a longer period.
   c. Are there attempts to implement counterfactual data analysis in your area of responsibility?
   d. Are you interested in having more information about counterfactual methods, so that you would be able to support one or the other study in this area in the future?

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