Going multinational: What are the effects on home market performance?

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Abstract:
A number of recent studies nd evidence for the existence of a persistent performance gap between multinational enterprises (MNE) and their domestic competitors. Therefore, the question arises whether successful rms become MNEs or whether going abroad improves home market performance. This paper investigates to what extent MNEs have superior performance characteristics, both prior to and after they have switched from national to multinational activities. In the rst case results are quite clear: Future multinationals outperform domestic rms. Since self-selection occurs, an endogenous treatment approach is necessary for comparing ex-post performance of rms. Using probit estimates of the decision to become a MNE, Heckman's (1978) treatment model is applied to account for potential endogeneity issues. The results suggest that after switching, both productivity and wage growth are higher for newly founded MNEs than for national rms. Employment growth is superior before switching but does not exhibit signi cantly higher ex-post growth rates. Moreover, capital intensities at multinationals evolve towards the use of capital.

Keywords:
Multinational enterprises; productivity; endogenous treatment

JEL-Classi cation:
F10, F21, F23, D24

Non Technical Summary

This paper investigates to what extent a regime change from national to multinational activities (switching) affects home market performance of parent rms relative to purely national rms in Germany. The analysis is conducted both prior to and after rms have gone multinational. In order to assess a broad range of rm attributes, I have constructed ve different performance measures: 1) rm size; 2) total factor productivity (TFP); 3) labour productivity; 4) average wage per rm; 5) capital intensities. Since multinationals do not arise randomly – only good rms accept the risk to invest abroad – Heckman's (1978) treatment model is used to account for potential endogeneity issues in the ex-post analysis.

Theoretical predictions are clear cut if ex-ante (before switching) performance differences between switchers and nationals are considered. When starting up or acquiring foreign af liates, rms need to overcome legal, cultural, and social barriers. Only good rms are able to cope with this kind of x ed costs and, thus, self-select into foreign markets. Whether the regime change from national to multinational activities also improves home market performance after switching is less obvious. If there is no other alternative to serve foreign markets besides the set-up or acquisition of an af liate (horizontal perspective), becoming a MNE would have no negative or even positive effects on domestic operations. If, in contrast, the purpose of a multinational's foundation is to vertically divide its production process, performance measures could rise or decline. The question whether investing abroad improves home market performance or not is therefore essentially an empirical issue.

My ndings provide clear evidence throughout the following points: During the years prior to the regime change, switchers exhibit higher performance attributes in levels, i.e. they are larger in size, pay higher wages, produce with higher capital intensities, and they are more productive. These results are con rmed by a two-sample Kolmogorov-Smirnov (KS) test on the equality of performance distributions. For all rm characteristics, distribution functions for nationals lie to the left of those for switchers. In terms of growth rates, signi cant ex-ante differences between newly founded MNEs and national rms can only be found with respect to the size of the operation. After the regime change, both productivity and wage growth are higher for switchers than for nationals. Capital intensities at multinationals evolve towards the use of capital, and switching does not affect rm size. Moreover, the implementation of Heckman's (1978) endogenous treatment

estimator suggests that self-selection matters. Though results are somewhat mixed here, I nd evidence that TFP growth in the rst year after going multinational, labour productivity in the rst and second period after becoming a MNE, and capital intensities for the whole sample period are signi cantly in uenced by selectivity issues.

Nicht technische Zusammenfassung

Die vorliegende Arbeit untersucht, inwiefern sich der Übergang von nationalen zu multinationalen Aktivitäten auf die Charakteristika des Mutterunternehmens in Deutschland im Vergleich zu rein national agierenden Firmen auswirkt. Die Untersuchung analysiert sowohl den Zeitraum vor dem Übergang als auch die Jahre nach dem Regimewechsel. Um dabei eine möglichst umfassende Auswahl von rmenbezogenen Eigenschaften abzudecken, werden fünf verschiedene betriebliche Charakteristika evaluiert: 1. die Firmengröße; 2. die totale Faktorproduktivität (TFP); 3. die Arbeitsproduktivität; 4. durchschnittliche Löhne; 5. die Höhe des Kapitaleinsatzes. Da potentiell nur erfolgreiche Firmen das Risiko einer Auslandsinvestition eingehen, könnten sich in der ex-post Analyse möglicherweise Endogenitätsverzerrungen der ökonometrischen Schätzungen ergeben. Um solche Probleme nachzuweisen und zu beheben, kommt Heckmans (1978) Treatment Modell zur Anwendung.

Betrachtet man ex-ante (vor dem Übergang zu einem MNU) Unterschiede zwischen national und international agierenden Unternehmen, so ergeben sich klar umrissene theoretische Aussagen. Die Gründung oder der Erwerb ausländischer Tochterunternehmen macht eine Überwindung rechtlicher, kultureller und sozialer Hindernisse notwendig. Da nur erfolgreiche Firmen dazu in der Lage sind, mit derartigen Fixkosten umzugehen, kommt es zur Selbstselektion solcher Firmen in ausländische Märkte. Ob ein Regimewechsel von nationalen zu multinationalen Aktivitäten auch nach dem Übergang zu besseren Betriebsergebnissen auf dem Heimatmarkt führt, ist weniger offensichtlich. Besteht die einzige Alternative einen Auslandsmarkt zu beliefern darin, vor Ort ein Tochterunternehmen zu gründen oder zu erwerben, so sollte sich dies nicht negativ oder im günstigsten Fall sogar positiv auf das heimische Unternehmen auswirken. Falls andererseits ein multinationales Unternehmen zum Zwecke der vertikalen Zergliederung des Produktionsprozesses gegründet wird, kann dies die Charakteristika des Mutterunternehmens sowohl positiv als auch negativ beein ussen. Die Frage, ob Auslandsinvestitionen die Leis-

tungsfähigkeit des Heimatmarktunternehmens verbessern, ist daher vor allem eine empirische Problemstellung.

Die vorliegende Arbeit kommt zu folgenden Resultaten: Während der Jahre vor dem Regimewechsel beschäftigen zukünftige multinationale Unternehmen im Vergleich zur ihrer einheimischen Konkurrenz mehr Personen, zahlen höhere Löhne, produzieren mit größerem Kapitaleinsatz und weisen ein höheres Produktivitätsniveau auf. Diese Ergebnisse werden auch von mehreren ”two-sample” Kolmogorov-Smirnov-Tests bestätigt. Dabei zeigt sich, dass bezogen auf oben genannte Charakteristika die Verteilungsfunktionen für nationale Unternehmen links von solchen für zukünftig international tätige Firmen liegen. Betrachtet man Wachstumsdifferenzen, so stellt sich heraus, dass signi kante Unterschiede nur im Hinblick auf die Entwicklung der Firmengrößen (vor dem Regimewechsel) bestehen. Nach dem Übergang zu internationalen Aktivitäten wachsen sowohl die Produktivität als auch die durchschnittliche Löhne schneller als bei rein national agierenden Unternehmen. Das Verhältnis von Kapital zu Arbeit entwickelt sich in Richtung eines höheren monetären Einsatzes, ein weiterhin schnelleres Wachstum hinsichtlich der Beschäftigung bei den neu gegründeten multinationalen Unternehmen kann nach dem Regimewechsel nicht mehr festgestellt werden. Darüber hinaus weist die Verwendung des Heckman (1978) Schätzers Selektionsproblemen einige Bedeutung zu. So zeigt sich, dass das Wachstum der TFP im ersten Jahr nach der Gründungsentscheidung, die Arbeitsproduktivität im ersten und zweiten Jahr nach dem Regimewechsel und schließlich der Kapitaleinsatz während des gesamten Stichprobenzeitraums signi kant von Selektionsproblemen beein usst wird.

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1 Introduction

Foreign direct investments (FDI) of domestic rms have attracted the interest of both the general public and politicians. The abrupt increase of multinational activities towards the end of the 20th century has raised concerns that domestic rms' foreign operations negatively affect home economies. Most managers and business leaders do not share this opinion. They consider international expansions of domestic rms as an important channel to enhance competitiveness. Economists can contribute to the heated political debate by evaluating performance characteristics of multinational enterprises (MNEs) relative to purely domestic rms. Since multinationals do not arise randomly – only good rms accept the risk to invest abroad – selectivity issues need to be taken into account.

In this paper, I investigate to what extent MNEs have superior performance attributes, both prior to and after they have switched from national to multinational activities. For this purpose the following questions are posed: How much better are multinationals? Do only successful rms invest abroad? And do MNEs grow faster than national companies? To answer the rst question I discuss differences between domestic rms, newly founded multinationals, and existing MNEs. The second and the third topics are covered by a comparison of new multinationals and national rms before, at the time of, and after switching. To assess a broad range of rm attributes, I have constructed ve different performance measures: 1) rm size; 2) total factor productivity (TFP); 3) labour productivity; 4) average wage per rm; 5) capital intensities. Selectivity problems necessitate applying an endogenous treatment approach for the evaluation of ex-post performance characteristics. Therefore, using probit estimates of the decision to become a MNE, Heckman's (1978) treatment model is used to account for potential endogeneity issues.

Theoretical predictions are clear cut if ex-ante (before switching) performance

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differences are considered. When starting up or acquiring foreign affiliates, firms need to overcome legal, cultural, and social barriers. Only good firms are able to cope with this kind of fixed costs and, thus, self-select into foreign markets. Whether the regime change from national to multinational activities also improves home market performance after switching is less obvious. Theoretical models in this respect are ambiguous. If there is no other alternative to serve foreign markets besides the set-up or acquisition of an affiliate (horizontal perspective), becoming a MNE would have no negative or even positive effects on domestic operations. If, in contrast, the purpose of a multinational's foundation is to vertically divide its production process, performance measures could rise or decline. Firm size, for example, is expected to suffer from cost-saving motives. An overall gain in competitiveness through cost reductions, on the other hand, may increase the number of employees at the parent location. The possible co-existence of market seeking and cost-reducing forces also makes predictions about the effect of switching on domestic productivity ambiguous. Learning effects due to new technological and managerial inputs may play a positive role. Contrariwise, the efforts of restructuring a newly founded multi-plant enterprise could be accompanied by productivity losses at the domestic operation. Similar pros and cons can be discussed for all performance measures, and I proceed with a more extensive discussion of these issues in chapter 7.1. The crucial point, however, is that whether investing abroad improves home market performance or not is, in the end, an empirical question.

My findings provide clear evidence throughout the following points: During the years prior to the regime change, switchers exhibit higher performance attributes in levels, i.e. they are larger in size, pay higher wages, produce with higher capital intensities, and they are more productive. These results are confirmed by a two-sample Kolmogorov-Smirnov (KS) test on the equality of performance distributions. For all firm characteristics, distribution functions for nationals lie to the left of those for switchers. In terms of growth rates, significant ex-ante differences between newly founded MNEs and national firms can only be found with respect to the size of the operation. After the regime change, both productivity and wage growth are higher for switchers than for nationals. Capital intensities at multinationals evolve towards the use of capital, and switching does not affect firm size. Moreover, the implementation of Heckman's (1978) endogenous treatment estimator suggests that self-selection matters. Though results are somewhat mixed here, I find evidence that TFP growth in the first year after going multinational, labour productivity in the first and second period after becoming a MNE, and capital inten-

sities for the whole sample period are signi cantly in uenced by selectivity issues.

The remainder of this paper is organized as follows: Starting point is a brief summary of the existing literature. An overview of the data and a short discussion of the different performance measures is provided in section 3. Section 4 compares existing MNEs and switchers. Then I offer a detailed discussion of ex-ante differences in levels and growth rates, also including a set of Kolmogorov-Smirnov tests. The determinants of the switching decision are derived within a probit framework in chapter 6, and ex-post performance differences are discussed in section 7. Section 8 concludes the paper.

2 Related Literature

In a theoretical model Helpman, Melitz and Yeaple (2004) describe the relationship between rm productivity and the engagement in different stages of international trade. Highly productive rms become multinationals (MNEs), less productive companies serve foreign markets by exports, and the least productive rms stay on their domestic markets. Based on these predictions, Girma, Kneller and Pisu (2005) present an empirical investigation for the UK using the concept of statistical dominance. They clearly con rm that productivity distributions are ordered according to the Helpman et al. (2005) paper. Girma et al. (2005) also try to test for "marginal rms", i.e. they evaluate productivity differences between rst-time exporters and nationals, on the one hand, and newly founded, foreign owned MNEs (non-UK MNEs) and domestic producers, on the other. In their investigations some weak evidence of self selection for newly founded (foreign) MNEs and even weaker support of superior productivity for marginal exporters is found. In a similar study, Arnold and Hussinger (2005b) test the Helpman et al. (2005) setting for a sample of German manufacturers. Comparing the productivity distributions of purely national companies, domestic exporters, and rms with outward investment, their results exhibit clear support for the predictions of the theoretical model. In another recent study, Tomiura (2004) turns to a sample of 118 thousand Japanese manufacturers in order to conduct a productivity comparison between outsourcing, exporting, and FDI. He concludes that FDI rms are more productive than foreign outsourcing rms, which are equally productive as exporters and clearly more productive than domestic rms.

Earlier research mainly focuses on partial tests of the relationship suggested by Helpman et al. (2005). Starting with the comparison of exporters and nationals,

Clerides, Lach and Tybout (1998) ask whether learning by exporting is of importance. Their empirical investigations show that more efficient firms become exporters, but that there is no backward link between previous exporting activities and the firms' cost structures. A study with German data is Arnold and Hussinger (2005a). It is based on firm level data for the manufacturing sector in Germany and tries to reveal the causal relationship between export status and productivity. As in most other studies on this topic, Arnold and Hussinger show that higher productivity leads to self selection into foreign markets, but being an exporter does not come together with productivity gains on the domestic market. Girma and Greenaway (2002) use matching methods, usually applied in the evaluation literature of active labour market programmes, as a means to detect the direction of causality – from high performance to exports or vice versa. As an exception to other authors, they find for a sample of UK manufactures that exporting increases firms' productivity causatively. Bernard and Jensen (1999) use a similar framework as I do when analysing ex-ante and ex-post performance evolutions of newcomers on export markets. They find distinctive evidence that successful firms – as measured in levels and growth rates – become exporters. However, their study provides less clear results with respect to the benefits of breaking into foreign markets: employment growth and the survival probability seem to be higher for exporters but productivity and wage growth dominate the growth rates at national firms. Beyond other studies, both Bernard and Jensen (1999) and my analysis do not solely focus on productivity measures but use a wide range of performance characteristics. The paper at hand, as opposed to Bernard and Jensen (1999), considers MNEs instead of exporters and takes the endogeneity of the investment decision into account.

Apart from the relation between exporting and merely serving domestic markets, some studies compare multinationals and domestic producers as well as multinationals and exporting firms. An example for the first case is Castellani and Navaretti (2004). Employing propensity score techniques for Italian manufacturers, the authors analyse the effect of FDI on firm characteristics like employment or productivity growth. The results suggest that foreign expansions improve the growth of productivity and output but exhibit no significant impact on employment. Egger and Pfaffermayr (2003), on the other hand, try to evaluate the investment behaviour of MNEs if they were purely exporting firms. In other words, they are searching for the counterfactual domestic investment to foreign activities. Using three different methods to account for the endogeneity of the FDI decision, Egger and Pfaffermayr (2003) show for a sample of Austrian manufacturers that foreign activities do not

diminish domestic investment in intangible assets, while they increase investment in tangible assets.

3 Data and Construction of Performance Measures

In the study at hand I use data from the USTAN (*Unternehmensbilanzstatistik*) data base at Deutsche Bundesbank (BuBa) between 1992 and 2001. Every rm in Germany that draws a bill of exchange in a given year is required by law to report its balance sheet to BuBa, which collects this information in its USTAN data base when the bill of exchange is rediscounted. The draft of bills of exchange remains a common form of payment in Germany. However, increases in BuBa's value threshold for reporting resulted in several drops of the sample and a decrease of the sample size over time from an overall number of 75,393 observations in the year 1992 to 26,737 observations in 2001. Table 7 in appendix A exempli es the impact of the described sample reduction on the distribution of the variables employment and capital stock .[1] The table implies the existence of an attrition bias with respect to large companies, i.e. in later years mainly smaller rms drop from the USTAN data base. Among the variables extracted from USTAN are employment, rm age, investment, tangible and intangible assets, pro ts, intermediate inputs, et cetera. All nancial gures included in the analysis are de ated to unity at year end 1998 using the German CPI (from the IMF's International Financial Statistics).[2]

Information on outward FDI from Germany is obtained from the MIDI database (Microdatabase Directinvestment) of the Deutsche Bundesbank at the level of German parents and their foreign af liates. A rm is de ned as a newly founded MNE (*switcher*) if the parent identi er appears in the MIDI dataset for the rst time.[3] That is a multinational emerges if it "[...] acquires a substantial controlling interest

[1] The table depicts summary statistics for the overall USTAN data set without any further adaptations.

[2] The end of 1998 is the mid point of the matched 1996-2001 FDI data (see below). In addition, the introduction of the euro in early 1999 makes December 1998 a natural reference date.

[3] A parent appears before 1999 if it controls at least 20 percent of its foreign af liates' equity and the af liates' balance sheet total is at least 1 million DM. After 1998 the af liates had to satisfy either of the following two criteria: (i) the parent controls at least 10 percent of equity and the balance sheet total is at least 5 million EUR; or (ii) the parent controls at least 50 percent of equity and the balance sheet is at least 0.5 million EUR. Lipponer (2003) stresses that the modi cation of the noti cation limit in 1999 changes the number of reported af liat es signi cantly . However, as table 1 shows, the number of newly emerging parent rms is not affected by this change. It seems somewhat surprising that the number of switchers drops both in the MIDI and in the matched data set in 2001, although there is no further modi catio n of the noti cation limit.

in a foreign rm or sets up a subsidiary in a foreign country" (compare Markusen 2002, p. 5).

Firms from the MIDI database were string-matched by name to companies in the BuBa USTAN data set.[4] Overall, a total of 2,955 different rms were merged. In Becker, Ekholm, Jäckle and Muendler (2005b) (appendices A and B), the string matching procedure is described in more detail.

Both the USTAN as well as the MIDI data sets are available in the form of an unbalanced panel. Firms in the USTAN data base can be followed throughout the years 1992 to 2001 if they draw a bill of exchange every year. Individual parents in the MIDI data set are identi able during the period 1996 to 2001. This allows the identi cation of switchers between 1997 and 2001 and the comparison of ex-ante (before switching) parent characteristics between 1992 and 2000.[5]

Table 1 summarises the development of the different data sets in the course of time. The rst line reports the total number of USTAN rms for each year. In the second row the overall number of matched MIDI rms is depicted. These companies have already been MNEs in 1996 or switched status anytime between 1996 and 2001. A comparison with line ve, which includes the total number of FDI rms in the MIDI data set, allows an evaluation of the matching algorithm. The merge process yields a matching quote between 18 percent in 2001 and 25 percent in 1997.[6] Lines three and six report rms that became multinationals in the according year. Overall, 1,005 switchers appear in the matched sample. Thus, the matching quote for switchers lies between 12 percent in 2001 and 27 percent in 1997. This corresponds approximately to the quotes in the overall data set. Row four reports the remaining national companies of the USTAN data set.

All analyses are conducted at the rm level.[7] In order to get eliminate parent

[4]The string matching routine automatically chose rms with an equality of at least 50 percent of all letters included in their rm names. All potential matches were manually overseen before they were accepted as being the same company.

[5]Unfortunately, the data at hand does not allow to control for rms that appear in the MIDI data set before 1996, disappear in 1996, and then reappear in the period 1997-2001.

To avoid confusions about different sample periods, a short note of clari cation is presented at this point. The rst step of the productivity (TFP) estimates refers to the time span 1992-2001, the second step and therefore the construction of TFP refers to the period 1993-2001, and the overall time of evaluating performance measures lies between 1994 and 2001.

[6]Since for unmatched multinationals no parent information is available, performance attributes of matched FDI rms cannot be compared to characteristics of the overall number of multinationals in the MIDI data set.

[7]In this paper rms are de ned as legally independent operations that draws a bill of exchange in a certain year.

Table 1: NUMBER OF FIRMS IN DIFFERENT DATA SETS, ALL SECTORS

	1996	1997	1998	1999	2000	2001	Total
USTAN total	69,423	62,341	48,194	41,102	36,207	26,737	284,004
Matched FDI rms	1,730	1,788	1,720	1,700	1,694	1,445	10,077
Matched switchers	-	272	210	232	201	90	1005
Nationals	67,693	60,553	46,474	39,402	34,513	25,292	204,504
FDI rms total	8,006	7,274	7,498	7,304	7,788	8,106	37,970
Switchers total	-	1,012	1,138	1,098	1,036	751	13,041

Source: USTAN and MIDI, Deutsche Bundesbank 1996-2001, own calculations.

rms founded for the mere purpose of acquiring or building up foreign affiliates, all parent companies that belong to the Nace 4digit sectors 6523 (other financial intermediation) and 7415 (management activities of holding companies) as well as companies with firm age below 5 years or firm size below 8 employees are removed from the estimation sample. Additionally, to prevent outliers from affecting results, variable values larger than the 99% and smaller than the 1% quantile were examined and if necessary dropped from the estimation sample. The large size of the USTAN sample allows for the use of Nace 4digit sector codes. However, for some estimations I have classified the firms into seven different industry branches. Details of the aggregation can be found in table 8, appendix B.

Five different firm attributes are employed in order to describe differences in the performance of switchers and nationals: 1) firm size; 2) total factor productivity (TFP); 3) labour productivity; 4) average wage per firm; 5) capital labour ratios.

As usual, firm size is measured by the number of employees. Total factor productivity is unobservable and therefore needs to be estimated. The strategy in my study is to restrict technology parameters to a Cobb-Douglas production function and view the residual from the relationship between output and input factors as TFP. As is well known since the paper of Marschak and Andrews (1944), the correlation between unobserved, firm-specific productivity shocks and the firm's input choice causes a simultaneity bias.[8] In the literature different ways to deal with this problem have been documented. Following Olley and Pakes (1996) and Levinsohn and Petrin (2003), I use both investment in tangible and intangible assets and, in another

[8]In addition, if companies with smaller capital stock are more likely to close down their operations in consequence of a negative productivity shock, a selectivity problem occurs. In the USTAN data set firms drop out of the sample if they either exit the market or do not draw a bill of exchange in a certain year. Since it is not possible to distinguish these reasons, the selectivity issue cannot be addressed with the data at hand.

speci cation, intermediate input goods as proxies to address the simultaneity problem. Consequently, three different TFP variables are constructed: a) TFP Olley and Pakes (O.P.), using a semiparametric estimation approach, including regional dummies, a time trend, and applying Olley's and Pake's investment proxy; b) TFP O.P. rm age, as a) but using rm age as an additional control variable;[9] c) TFP Levinsohn and Petrin (L.P.), using the Stata ado le *levpet* (see Levinsohn, Petrin and Poi (2003)), which applies intermediate input goods as investment proxy. Appendix C includes a more detailed comparison of the different estimation methods.

In order to evaluate performance measures with respect to the rms' workforce, labour productivity, as constructed by the ratio of value added over employment, and the average wage per rm, measured as wage bill divided by employment, are used in the analysis. Finally, to assess capital intensities among different rms, capital labour ratios are used as a performance attribute.

4 How much better are Multinationals?

Common sense leads to the conclusion that multinational enterprises exhibit superior performance characteristics compared to their domestic competitors without foreign af liates. In this section, I discuss differences between non-MNEs and newly founded multinationals, in the year of switching, as well as differences between existing multinationals and national rms. [10]

Performance gaps between both groups are calculated as percentage values in the following regression:

$$logP_{i,t} = \beta_0 + \beta_1 MNE_{i,t}(+\Gamma' C_{i,t}) + \delta_1 state_i + \delta_2 sector_i + \delta_3 year_t + u_{i,t}, \quad (1)$$

where $P_{i,t}$ depicts the corresponding performance measure, $MNE_{i,t}$ is a dummy variable that indicates multinational activities, $state_i$, $sector_i$, and $year_t$ refer to region, industry and time dummies respectively, and $C_{i,t}$ stands for the additional

[9] In order to increase the number of observations, I did not employ rm age as explanatory variable in a).

[10] The data at hand do not include information about export activities of rms. A domestic enterprise can therefore merely serve national markets or additionally be active on export markets. In this respect, another caveat is the missing possibility to identify domestic rms which are owned by foreign multinationals. In a recent study, Criscuolo and Martin (2003) nd evidence for what they call the "MNE effect": MNEs, of foreign and domestic origin, are more productive than domestic rms. Either of these points might affect the results of this paper in the same way: Switching premia calculated on different occasions could be downward biased since the comparison group goes beyond the de nition of purely national rms in the above manner.

control variables age and size.[11]

Table 2 provides estimation results of the above equation. Each cell includes the coef cient of the $MNE_{i,t}$ dummy for another (dependent) performance variable. Columns (3) and (4) report the premia of already being a MNE between 1996 and 2001, whereas columns (1) and (2) describe the premia of becoming a MNE for the period 1997 to 2001. In the later case, all existing MNEs as well as switchers before and after the time of switching were removed from the estimation sample. Columns (2) and (4) depict results after adding additional controls ($C_{i,t}$).

The performance gap for all rm attributes is positive and signi cantly different from zero.[12] Largest differences are found with respect to rm size. The number of employees at existing multinationals is 130% to 140% higher than at national rms. At the time of switching, newly founded MNEs are about twice as large as nationals.

All productivity measures exhibit a persistent ef cienc y gap. Differences in total factor productivity range from 22% to 66%. As in the case of rm size, being a MNE goes along with a higher performance differential than becoming a multinational.[13] This could be seen as rst evidence for the existence of a positive performance dynamic after switching, i.e becoming a MNE could have a positive impact on the post-investment productivity of parent rms.

Performance measures related to the rms' work force, labour productivity and average wages show positive differences for all speci cations. Wages (value added per worker) at existing MNEs are (is) 15% to 18% (25% to 26%) higher than at national rms. In the yea of the regime change, MNE mark-ups for average wages (labour productivity) are between 11% and 13% (22% and 25%). These differences might indicate a skill bias towards high skilled workers in the labour force of MNEs.

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[11] The dimension of the domestic operation is approximated by the number of employees. It is not included if the dependent variable, $P_{i,t}$, is rm size.

[12] To improve comparability between sectors I also constructed performance characteristics in deviation of the corresponding sector means. The use of these relative measures as dependent variables in equation 1 did not alter performance premia in any important way. Another consistency check was to construct equal sample sizes for each performance regression related to a certain column of table 2. Again, results did not change in an important manner. Estimation results for both modi cations are available on request.

[13] Speci cations with additional control variables exhibit a difference of about ve percentage points between speci cations (2) and (4), whereas columns (1) and (3), excluding the variables rm age and size, show larger differences of around 10 percentage points.

Table 2: PERFORMANCE GAP, SWITCHERS VS. NATIONALS AND MNES VS. NATIONALS, ALL SECTORS

	Switchers[a]	Switchers, control[b]	MNE	MNE, control
	(1)	(2)	(3)	(4)
Employment	1.026[c]	1.046	1.413	1.310
	(.052)	(.055)	(.016)	(.016)
TFP O.P.	.331	.222	.408	.261
	(.020)	(.021)	(.006)	(.006)
TFP O.P. rm age	.341	.221	.411	.260
	(.022)	(.021)	(.006)	(.006)
TFP L.P.	.509	.222	.657	.271
	(.025)	(.021)	(.008)	(.006)
Labour productivity	.215	.246	.247	.264
	(.020)	(.022)	(.006)	(.006)
Average wage	.127	.106	.176	.147
	(.013)	(.014)	(.004)	(.004)
Capital/Labour	.210	.182	.330	.142
	(.057)	(.061)	(.017)	(.018)
N[d] overall employment	99,487	93,561	186,572	167,740
N treat. employment	690	551	7,782	7,043
N overall TFP OP	94,544	89,396	177,130	159,953
N treat. TFP OP	643	513	7,041	6,372
N overall TFP OP rm age	89,396	89,396	159,953	159,953
N treat. TFP OP rm age	513	513	6,372	6,372
N TFP LP	94,544	89,396	177,130	159,953
N treat. TFP LP	643	513	7,041	6,372
N overall labour prod.	98,615	92,926	184,936	166,583
N treat. labour prod.	670	538	7,668	6,945
N overall avrg. wage	98,820	93,074	185,304	166,855
N treat. avrg. wage	673	541	7,668	6,958
N overall capital/labour	97,659	91,841	183,158	164,724
N treat. capital/labour	682	545	7,711	6,983

Source: USTAN and MIDI, Deutsche Bundesbank 1996-2001, own calculations.

[a] Switchers are observed in the rst year of being a MNE. All existing MNEs as well as switchers before and after the time of switching were removed from the estimation sample.

[b] Coef cients in columns (2) and (4) are estimated using rm age and rm size as additional control variables. In row (1) only rm age is used as an additional control variable.

[c] Each cell includes the coef cient of the $MNE_{i,t}$ dummy for another performance variable in the regression $logP_{i,t} = \beta_0 + \beta_1 MNE_{i,t}(+\Gamma' C_{i,t}) + \delta_1 state_i + \delta_2 sector_i + \delta_3 year_t + u_{i,t}$, where $P_{i,t}$ is the performance variable, $state_i$ is a vector of German state dummies, $sector_i$ is a vector of 7 aggregated industry dummies, and $year_t$ are yearly time dummies. Standard errors are in parenthesis. If a parameter fails to be signi cant at the 10% level, it is set in italics.

[d] The number of observations refer to the overall number of observations in each performance regression (N overall P) and both to the number of switchers (N treat. P) in columns (1) and (2) and to the number of existing MNEs (N treat. P) in columns (3) and (4). Existing MNEs are observed in the time period from 1996 to 2001. Switchers are observed between 1997 and 2001.

Finally, I also investigate performance distinctions with respect to capital labour ratios. Differences in the capital intensities are between 18% and 21% for switchers and 14% and 33% for multinationals already active on foreign markets for a couple of years. This ts with the argument that being a MNE is accompanied by a shift in the rms' labour demand from production to non-production workers, meaning that average wages and capital intensities are both higher at MNEs than at national rms.

Table 2 should not be misunderstood in view of a causal link between multinational activities and growing performance attributes at the home market. Rather, the results reveal positive correlation patterns that con rm inherent performance differences for a series of rm characteristics. It is shown that multinational enterprises exhibit superior performance features. Differences are even larger if rms were already active on foreign markets for a couple of years. The following chapters investigate the performance premia of switchers in more detail.

5 Performance before Switching

Many studies have shown that multinationals outperform rms that serve only domestic markets.[14] Barba Navaretti and Venables (2004) argue that "MNEs are larger and sometimes more productive than national rms." In a recent paper Helpman et al. (2004) state that productivity differences on the home market lead to self-selection into foreign activities.

When companies start up or acquire af liates in foreign countries, they have to overcome a number of barriers to entry. Caves (1996) claims in his book that "the business rm [...] has a clear-cut national base and identity, with its internal planing and decision making carried out in the context of that nation's legal and cultural framework." That is, when investing abroad, rms need to deal with x ed costs due to legal, cultural, and social differences. Hence, it seems obvious that only rms with successful operations on domestic markets can handel the additional efforts that accompany the setting up of foreign af liates.

In this chapter two questions concerning ex-ante performance differences are assessed empirically: 1) Is there a performance gap (in levels) between switchers and nationals rms before switching? 2) What about performance growth in the run up to become a MNE? To back up these investigations, in section 5.2 a Kolmogorov-Schmirnov test is conducted.

[14] A number of references and examples can be found in Caves (1996) and Markusen (2002).

5.1 Ex-ante differences in levels

In chapter 4 evidence was found that multinationals at the time of switching have superior performance characteristics compared to their national counterparts. Consequently, the next step is to ask whether these differences also exist in the years prior to the regime change. To do so, the following equation is estimated:

$$logP_{i,T-t} = \beta_0 + \beta_1 Switch_{i,T}(+\Gamma' C_{i,T-t}) + \delta_1 state_i + \delta_2 sector_i + \delta_3 year_{T-t} + u_{i,T-t}, \quad (2)$$

where T is the date of switching (1997-2001) and t is the according time lag (t=1,2,3).[15] Performance attributes are assessed over a period of three years before switching. The corresponding time dimensions of the dependent variables in the estimation samples are therefore 1996-2000, 1995-1999, and 1994-1998.

Each cell of table 3 includes coef cients of the $Switch_{i,T}$ dummy. Performance gaps for all rm attributes are signi cantly positive and – when taking con dence intervals on the estimators into account – roughly consistent over time.[16] Again, rm size exhibits the largest differences. These are between 100% (98% without additional controls) in $T-1$ and 96% (91%) in $T-3$. Performance premia for switchers with respect to total factor productivity range from 26% (53%) in the year before switching to 22% (48%) three years before the regime change. Moreover, rms that become multinationals pay on average 11%-12% (11%-13%) higher wages, have a 23%-25% (22%) larger valued added per worker, and capital intensities exceed those of national rms by 16%-19% (22%-25%). A comparison with table 2 shows that performance differences, found in the year of switching, already existed in about the same magnitude one to three years before the according rms became multinationals.

5.2 Kolmogorov-Smirnov test on the equality of distributions

To back up the investigations in section 5.1 a number of Kolmogorov-Smirnov (KS) two-sample tests on the equality of performance distributions are conducted.[17] The KS test provides the possibility to determine differences in the distributions of rm attributes for switchers and non-multinationals. That is, it compares not only the

[15] All other variables are de n ed according to the covariates in equation 1.

[16] Performance measures in deviation of the according sector means and equal sample sizes did not alter results.

[17] These tests are implemented using the software package Stata. The KS test has no underlying distributional assumptions. It is therefore a non-parametric test. Additionally, t-tests on mean-differences were accomplished. They con rm the ndings in the KS setting.

Table 3: PERFORMANCE GAP, FUTURE MNES VS. NATIONALS t YEARS BEFORE SWITCHING, ALL SECTORS

	lag1[a]	lag1 ctrl.[b]	lag2	lag2 ctrl.	lag3	lag3 ctrl.
	(1)	(2)	(3)	(4)	(5)	(6)
Employment	.976[c]	1.030	.928	.995	.912	.956
	(.060)	(.061)	(.062)	(.062)	(.066)	(.064)
TFP O.P.	.353	.253	.333	.222	.308	.207
	(.024)	(.025)	(.024)	(.024)	(.025)	(.025)
TFP O.P. rm age	.356	.252	.325	.221	.303	.207
	(.024)	(.025)	(.025)	(.024)	(.025)	(.025)
TFP L.P.	.534	.261	.508	.232	.480	.215
	(.029)	(.025)	(.029)	(.024)	(.030)	(.025)
Labour productivity	.221	.245	.217	.228	.223	.237
	(.023)	(.024)	(.024)	(.024)	(.024)	(.024)
Average wage	.138	.121	.121	.102	.113	.106
	(.015)	(.017)	(.015)	(.016)	(.016)	(.016)
Capital/labour	.241	.157	.223	.153	.252	.187
	(.066)	(.071)	(.068)	(.068)	(.070)	(.069)
N[d] overall employment	92,504	88,070	83,572	80,103	75,273	72,361
N treat. employment	492	441	458	421	408	386
N overall O.P.	88,040	74,039	79,509	76,497	71,541	69,030
N treat. O.P.	458	360	422	389	380	360
N overall O.P. age	84,180	74,039	76,499	76,497	69,032	69,030
N treat. O.P. age	409	360	389	389	360	360
N overall L.P.	88,040	74,039	79,509	76,497	71,541	69,030
N treat. L.P.	458	360	422	389	380	360
N overall labour productivity	91,809	76,917	83,024	79,635	74,824	71,979
N treat. labour productivity	483	379	448	414	401	380
N overall average wage	91,973	77,002	83,117	79,694	74,876	72,006
N treat. average wage	485	381	451	416	403	383
N overall capital/labour	90,762	75,864	81,933	78,511	73,704	70,837
N treat. capital/labour	485	380	451	414	403	381

Source: USTAN and MIDI, Deutsche Bundesbank 1994-2001, own calculations.

[a] Performance characteristics of switchers are observed in the three years before switching (lag1 - lag3).

[b] Coef cients in columns (2), (4) and (6) are estimated using rm age and rm size as additional control variables. In row (1) only rm age is used as an additional control variable.

[c] Each cell includes the coef cient of the $Switch_{i,T}$ dummy for another performance variable in the regression $logP_{i,T-t} = \beta_0 + \beta_1 Switch_{i,T}(+\Gamma' C_{i,T-t}) + \delta_1 state_i + \delta_2 sector_i + \delta_3 year_{T-t} + u_{i,T-t}$, where T is the date of switching (1997-2001), t is the according time lag (t=1,2,3), $P_{i,T-t}$ is the performance variable, $state_i$ is a vector of German state dummies, $sector_i$ is a vector of 7 aggregated industry dummies, and $year_{T-t}$ are yearly time dummies. Standard errors are in parenthesis. If a parameter fails to be signi cant at the 10% level, it is set in italics.

[d] The number of observations refer to the overall number of rms in each performance regression (N overall P) and to the number of switchers (N treat. P). Performance measures of switchers are observed between 1994 and 2000. The formation of new MNEs (switching) is observed between 1997 and 2001. All existing MNEs as well as switchers before and after the time of switching were removed from the estimation sample.

rst moments of the distribution functions but tests if the distribution (density) of P_t with respect to newly founded MNEs is to the right of the one for national rms.

Earlier papers written by Girma et al. (2005) and Arnold and Hussinger (2005b) use the above setting to check whether productivity levels of multinationals exceed those of exporters, which in turn are questioned to be grater than the productivity levels of purely national rms. Their studies accomplish a set of Kolmogorov-Smirnov tests on a contemporaneous basis, i.e. they ask whether *existing* MNEs are signi cantly different to nationals and exporters. Girma et al. (2005) also apply KS tests on a subset of rst-time exporters in the period before they change export status and on a sample of foreign owned domestic rms in the year before they were acquired by foreign multinationals. Unlike the above studies, the paper at hand tests for differences in parent characteristics between future multinationals and nationals up to three years before switching.

Table 10 in the appendix provides results of the Kolmogorov-Smirnov test for three time lags. The rst block (rows (1) - (6)) refers to performance differences in $t-1$, the second one to $t-2$, and the third block to differences in $t-3$. The KS test makes use of the maximum vertical difference (D) between the distribution functions of switchers ($F(P_t^s)$) and nationals ($F(P_t^n)$). Rows (1), (7) and (13) include the largest positive deviations, $D^+ = \max(F(P_t^n) - F(P_t^s))$, in the cumulative fractions of both groups. The corresponding p-values are reported in the lines below.[18] Thus, the hypothesis that the distribution function of P_t for nationals lies to the left of the distribution function for switchers is tested by asking whether P_t for nationals contains smaller values than for newly founded multinationals. Accordingly, maximum deviations in lines (3), (9) and (15) are de ned as the statistic $D^- = \max(F(P_t^s) - F(P_t^n)) = min(F(P_t^n) - F(P_t^s))$. These rows, together with (4), (10), and (16), test the hypothesis that P_t for nationals exhibits larger values than for switchers. Finally, row (5) of each block includes the combined test statistic $D = max(|D^+|, |D^+|)$.

Results depicted in table 10 clearly con rm the ndings in section 5.1.[19] In each of the three years before switching, national rms exhibit signi cantly smaller performance measures than future MNEs. For all rm characteristics, distribution functions for nationals lie to the left of those for switchers. The hypothesis that P_t for domestic producers exhibits larger values than for multinationals could be

[18] All p-values presented in table 10 are based on on the asymptotic distributions derived by Smirnov (1939).

[19] Implementing KS tests with performance measures in deviation of the according sector means did alter vertical differences D slightly but had no impact on the overall results.

rejected overwhelmingly. Furthermore, p-values of the combined test statistics are not higher than 0.003 and therefore reject the null hypothesis of the equality of distributions clearly.

Hence, my investigations so far show that not only existing MNEs outperform national rms but also newly founded MNEs during the time before switching have superior performance attributes compared to their national counterparts.

5.3 Ex-ante differences in growth rates

At this stage of the paper a second question emerges. If level differences in performance attributes show stable premia for switchers, it seems natural to analyse deviations of performance growth rates in the run up to becoming a multinational. For that purpose the following regressions are run:

$$\begin{aligned}[logP_{i,T} - logP_{i,T-t}]/t &= \beta_0 + \beta_1 Switch_{i,T}(+\Gamma' C_{i,T-t}) + \\ &+ \delta_1 state_i + \delta_2 sector_i + \delta_3 year_{T-t} + u_{i,T-t}, \quad (3)\end{aligned}$$

where T is the date of switching (1997-2001) and t is the corresponding time lag (t=1,2,3).[20] Growth rates are measured as yearly averages assessed over the three preceding years up to switching. So, the corresponding time dimensions of the dependent variables in the estimation samples are 1996-2001, 1995-2000, and 1994-1999.

The coef cient β_1 of the $Switch_{i,T}$ dummy measures the average differences in growth rates per year between switchers and multinationals. Table 4 depicts results for the related time lags and all performance attributes. In the three years leading up to switching (columns (5) and (6)), employment (2 percentage points) and total factor productivity (1-2 percentage points) exhibit signi cantly higher growth rates at companies that become MNEs than at national rms. [21] Average performance growth during the two preceding years before the regime change is signi cantly larger (3-4 percentage points) at future multinationals only with respect to employment. In the last year before investing abroad, again, only employment turns out to have superior growth rates. These are 3-5 percentage points higher at future MNEs than at domestic companies.

[20] All other variables are de n ed according to the covariates in equation 1.

[21] Performance measures in deviation of the according sector means and equal sample sizes did not alter results.

Table 4: DIFFERENCES IN PERFORMANCE GROWTH, FUTURE MNES VS. NATIONALS t YEARS BEFORE SWITCHING, ALL SECTORS

	lag1[a]	lag1 ctrl.[b]	lag2	lag2 ctrl.	lag3	lag3 ctrl.
	(1)	(2)	(3)	(4)	(5)	(6)
Employment	.051[c]	.031	.043	.032	.024	.020
	(.009)	(.009)	(.006)	(.006)	(.005)	(.005)
TFP O.P.	*.017*	*.0005*	*.011*	*.006*	.016	.009
	(.011)	(.011)	(.007)	(.007)	(.005)	(.005)
TFP O.P. age	*.009*	*.0002*	.012	*.006*	.014	*.008*
	(.011)	(.011)	(.007)	(.007)	(.005)	(.005)
TFP L.P.	.019	*.005*	.015	*.010*	.019	.012
	(.010)	(.010)	(.006)	(.006)	(.005)	(.005)
Labour productivity	*-.003*	*-.006*	*.004*	*.0008*	*.005*	*-.0005*
	(.010)	(.010)	(.006)	(.006)	(.006)	(.006)
Average wage	*-.006*	*-.013*	*.003*	*.001*	*.004*	*-.002*
	(.008)	(.008)	(.005)	(.005)	(.004)	(.004)
Capital/labour	*.002*	*.012*	*.014*	*.016*	*.010*	*.007*
	(.020)	(.021)	(.014)	(.015)	(.012)	(.013)
N[d] overall employment	90,947	86,648	81,610	78,266	73,189	70,399
N treat. employment	490	439	457	420	406	384
N overall TFP O.P.	86,155	82,461	77,093	74,260	68,947	66,619
N treat. TFP O.P.	453	404	417	384	372	352
N overall TFP O.P. age	82,461	82,461	74,260	74,260	66,619	66,619
N treat. TFP O.P. age	404	404	384	384	352	352
N overall TFP L.P.	86,155	82,461	77,093	74,260	68,947	66,619
N treat. TFP L.P.	453	404	417	384	372	352
N overall labour productivity	90,093	85,940	80,910	77,668	72,591	69,885
N treat. labour productivity	477	430	443	411	396	376
N overall average wage	90,322	86,118	81,063	77,782	72,675	69,949
N treat. average wage	478	431	444	412	396	378
N overall capital/labour	89,071	84,837	79,783	76,492	71,416	68,675
N treat. capital/labour	482	431	449	412	400	378

Source: USTAN and MIDI, Deutsche Bundesbank 1994-2001, own calculations.

[a] Growth rates are measured as yearly averages assessed over the three preceding years up to switching (lag1-lag3).

[b] Coefficients in columns (2), (4), and (6) are estimated using firm age and firm size as additional control variables. In row (1) only firm age is used as an additional control variable.

[c] Each cell includes the coefficient of the $Switch_{i,T}$ dummy of the following performance regressions $[logP_{i,T} - logP_{i,T-t}]/t = \beta_0 + \beta_1 Switch_{i,T}(+\Gamma' C_{i,T-t}) + \delta_1 state_i + \delta_2 sector_i + \delta_3 year_{T-t} + u_{i,T-t}$, where T is the date of switching (1997-2001), t is the corresponding time lag (t=1,2,3), $[logP_{i,T} - logP_{i,T-t}]/t$ is the yearly average growth rate, $state_i$ is a vector of German state dummies, $sector_i$ is a vector of 7 aggregated industry dummies, and $year_{T-t}$ are yearly time dummies. Standard errors are in parenthesis. If a parameter fails to be significant at the 10% level, it is set in italics.

[d] The number of observations refer to the overall number of firms in each performance regression (N overall P) and to the number of switchers (N treat. P). Performance measures of switchers are observed between 1994 and 2001. The formation of new MNEs (switching) is observed between 1997 and 2001. All existing MNEs as well as switchers before and after the time of switching were removed from the estimation sample.

Consequently, the above findings may be interpreted as evidence that firms preparing for a forthcoming expansion to foreign markets have additional personnel requirements. Unfortunately, with the data at hand a distinction between low and high skilled workers is not possible. Since theory predicts that firms demand different amounts of high and low skilled labour, this is perhaps a field that requires further research.

My findings up to this point show clear differences between future multinationals and national firms. In the years prior to the regime change, switchers exhibit higher performance attributes in levels, they are larger in size, pay higher wages, produce with higher capital intensities, and they are more productive. Furthermore, average employment at firms that become MNEs is found to grow faster. Hence, it seems that success on the home market leads to self-selection into foreign markets.

6 The decision to become a multinational

Taking the selectivity issues raised at the end of chapter 5 into account necessitates modelling the – possibly endogenous – decision to become a MNE. One of the most common approaches to incorporate endogenous treatment effects is the Heckman (1978) estimator. When using this method, it is necessary to employ a probit model that includes the determinants of the switching decision. A binary choice model suffers from the shortcoming that it does not allow the inclusion of (foreign) location specific variables.[22] It is, however, possible to apply indirect measures that control for host country effects. To construct such variables I use average foreign affiliate characteristics of existing MNEs. These attributes allow an augmentation of the probit specifications with information on host country specifics of existing multinationals active in the same home market sector as potential switchers. Further details of this kind of controls are discussed below.

In a recent study, Becker, Ekholm and Muendler (2005a) estimate reduced-form location choice functions in order to control for selectivity issues in a multinational's location-specific labour demand. In this section, I present an adapted version of their first-step, location-choice model to explain driving forces behind the decision to become a multinational.

In period $t-1$ a firm's management decides whether to invest in foreign loca-

[22] Econometric models that allow us to control for country specific attributes are, for example, the conditional or the nested logit model. For a more elaborate evaluation of this problem, see Becker, Ekholm, Jäckle and Muendler (2005c).

tions or not. Becoming a MNE in period t means producing a vector of nal goods $\mathbf{X}_{i,t} = (\mathbf{x}^H_{i,t}, \mathbf{x}^F_{i,t})$ at home ($\mathbf{x}^H_{i,t}$) and abroad ($\mathbf{x}^F_{i,t}$), whereas staying means serving foreign markets by exports or producing solely for the national market ($\mathbf{X}_{i,t} = \mathbf{x}^H_{i,t}$). For its switching decision the rm i maximises expected pro ts

$$E_{i,t-1}(\Pi_{i,t}) = E_{i,t-1}(\mathbf{p}'\mathbf{X}_{i,t} - c_{i,t}(\mathbf{X}_{i,t}, \mathbf{w}_t)), \tag{4}$$

where $\mathbf{p}$ are nal goods prices on competitive world markets, and $c_{i,t}(.)$ is a rm' s cost function depending on output $\mathbf{X}_{i,t}$ and a vector of (home and foreign speci c) input prices $\mathbf{w}_t$. Given the above optimization problem, a rm' s "switching-rule" can be written as

$$\text{Switch iff}: E_{i,t-1}[\Pi_{i,t}(\mathbf{x}^{F\,*}_{i,t}, \mathbf{x}^{H}_{1,i,t}{}^{*}) - \Pi_{i,t}(\mathbf{x}^F_{i,t} = 0, \mathbf{x}^{H}_{2,i,t}{}^{*})] > F_{i,t}, \tag{5}$$

where $F_{i,t}$ are sunk costs the rm faces when investing abroad, $\mathbf{x}^{F\,*}_{i,t}$ is the part of the output vector that is produced in foreign locations, $\mathbf{x}^{H}_{1,i,t}{}^{*}$ is the fraction of $\mathbf{X}^*_{i,t}$ produced at home in case of an investment aborad, and $\mathbf{x}^{H}_{2,i,t}{}^{*}$ is the optimal domestic output in case no foreign af liates are founded.[23] Using equation 4 in 5 and adding a stochastic error term $u_{i,t}$ with zero mean and variance σ^2_u yields:

$$S_{i,t} = \begin{cases} 1 \text{ if} & E_{i,t-1}[\mathbf{p}'\mathbf{X}^*_{i,t}] - E_{i,t-1}[c_{i,t}(\mathbf{x}^{F\,*}_{i,t}, \mathbf{x}^{H}_{1,i,t}{}^{*}, \mathbf{w}_{i,t}) - \\ & -c_{i,t}(\mathbf{x}^F_{i,t} = 0, \mathbf{x}^{H}_{2,i,t}{}^{*}, \mathbf{w}_{i,t})] - F_{i,t} + u_{i,t} > 0 \\ 0 & \text{otherwise}, \end{cases} \tag{6}$$

where $S_{i,t} = 1$ means a rm decides to become a MNE, $E_{i,t-1}[\mathbf{p}'\mathbf{X}^*_{i,t}]$ are expected revenues from producing the optimal amount of output, and the second term on the right hand side of equation 6, $E_{i,t-1}[c_{i,t}(\mathbf{x}^{F\,*}_{i,t}, \mathbf{x}^{H}_{1,i,t}{}^{*}, \mathbf{w}_{ti,t}) - c_{i,t}(\mathbf{x}^F_{i,t} = 0, \mathbf{x}^{H}_{2,i,t}{}^{*}, \mathbf{w}_{ti,t})]$, depicts the cost bene ts of producing abroad. Assuming $u_{i,t}$ to be normally distributed gives rise to a probit model, where the probability to switch is estimated as

$$P(S_{i,t} = 1) = P(S^*_{i,t} > 0) = P(u_{i,t} > -\mathbf{Z}'_{i,t-1}\gamma - \mathbf{Y}'_{s,t-1}\delta). \tag{7}$$

Here, $S^*_{i,t}$ is a latent variable (e.g. the propensity to invest abroad), $Z_{i,t-1}$ and $Y_{s,t-1}$ are vectors that proxy the rm' s expectations in period $t-1$ with regard to the decision rule of equation 6. $Z_{i,t-1}$ exhibits variation on the rm level, whereas $Y_{s,t-1}$ varies only over sectors. The dependent variable $S_{i,t}$ equals 1 if a rm becomes a MNE in period t. All existing MNEs as well as switchers before and after the time of switching were removed from the estimation sample.

[23] The vector $\mathbf{x}^{H}_{1,i,t}{}^{*}$ does in general not equal $\mathbf{x}^{H}_{2,i,t}{}^{*}$.

To proxy expected revenues, $E_{i,t-1}[\mathbf{p}'\mathbf{x}_{i,t}^{F\,*}]$, I use the log of average affiliate turnover domestic competitors realise in their foreign locations in the year before switching, i.e. the average revenue MNEs active in the same home market sector as potential switchers make abroad in period $t-1$. To approximate expected cost benefits, $E_{i,t-1}[c_{i,t}(\mathbf{x}_{i,t}^{F\,*}, \mathbf{x}_{1,i,t}^{H\,*}, \mathbf{w}_{ti,t}) - c_{i,t}(\mathbf{x}_{i,t}^{F} = 0, \mathbf{x}_{2,i,t}^{H\,*}, \mathbf{w}_{ti,t})]$, parent firm characteristics like size (ln employment), ln liabilities/total assets, ln capital/labour ratio, ln equity, and ln average wage are used. Additionally, as a sector-specific control variable, the log of average wages domestic competitors pay in foreign countries are included. Since sunk costs cannot be directly measured, they are approximated by including the number of existing MNEs from the same sector in period $t-1$. To account for the firm's innovative abilities, the log of its intangible to tangible plus intangible assets ratio is included. For the purpose of controling intra-sector market power, the proportion of each firm's value added to sector-wide value added is included. Finally, in most specifications firm age serves as an additional control.[24] Apart from the value-added ratio, all sector-specific variables refer to NACE 2-digit codes. Time dummies control for the foundation of MNEs in different years. All explanatory variables are lagged one period.

Since results of the probit estimates are of main interest with respect to the Heckman (1978) estimator applied in section 7, only the most important findings are briefly discussed at this point. Estimation results are depicted in table 5. Each specification refers to another lagged productivity measure and is used as selection equation for one of the different dependent variables of equation 9. It becomes clear from either specification that size and productivity in $t-1$ are important determinants of the choice to become a MNE, i.e. high values of these attributes increase the probability to switch. Hence, findings in chapter 5 – large and productive firms go multinational – are supported.

In line with the existing literature, I find that domestic firms with large intangible to total assets ratios are more likely to run business abroad than firms staying on national markets. Intangible assets are supposed to have public good characteristics within multi-plant companies. Markusen (2002) generally names these kind of assets "knowledge capital". The particular characteristics of the knowledge capital should help companies to overcome potential sunk costs. At this point, my findings – a high rate of intangible assets increases the probability to switch – might confirm Markusen's theory.

[24] In some specifications also firm age squared was included. However, I could not detect any significant influence and therefore did not report these results in table 5.

Table 5: PROBIT ESTIMATES OF THE PROBABILITY TO BECOME A MNE, ALL SECTORS, 1997-2000

	(1)	(2)	(3)	(4)
lag log (l.l.) TFP O.P.		.113[a] (.048)**		
(l.l.) TFP O.P. age	.178 (.055)***			
(l.l.) TFP L.P.				.140 (.057)**
(l.l.) labour productivity			.351 (.063)***	
(l.l.) employment	.125 (.035)***	.112 (.032)***	.177 (.028)***	.100 (.034)***
(l.l.) liabilities/tot. assets	-.251 (.083)***	-.304 (.073)***	-.282 (.081)***	-.243 (.083)***
(l.l.) equity	.037 (.022)*	.038 (.020)*	.026 (.021)	.040 (.022)*
(l.l.) capital/labour	-.013 (.023)	-.010 (.022)	-.055 (.023)**	-.018 (.023)
(l.l.) foreign wages	.281 (.141)**	.372 (.132)***	.300 (.132)**	.391 (.138)***
(l.l.) foreign turnover	-.050 (.025)**	-.033 (.022)	-.038 (.022)*	-.035 (.024)
lag MNE count sector	-.0001 (.00007)	-.0001 (.00006)*	-.00009 (.00006)	-.00008 (.00007)
lag rm age	-.002 (.0006)***		-.002 (.0006)***	-.002 (.0006)***
(l.l.) intang. ass /tang.+intang. ass.	.048 (.015)***	.061 (.014)***	.040 (.015)***	.050 (.015)***
(l.l.) rm val. add./sec. val. add.	.042 (.024)*	.031 (.022)		.040 (.024)*
(l.l.) average wage	-.018 (.092)	-.003 (.082)	-.157 (.095)*	.007 (.092)
east/west dummy	.105 (.092)	.072 (.083)	.042 (.089)	.039 (.089)
cons.	-4.895 (1.338)***	-6.000 (1.284)***	-7.331 (1.223)***	-6.717 (1.379)***
year dummies	yes	yes	yes	yes
N	41879	44401	42417	41879
pseudo R2	.075	.07	.072	.073

Source: USTAN and MIDI, Deutsche Bundesbank 1997-2000, own calculations.

[a] Standard errors are in parenthesis: * signi cant at ten, ** at ve, and *** at one percent.

Surprisingly, I nd a positive correlation between average wages domestic competitors pay at their foreign locations and the probability to go multinational. Two arguments may solve this puzzle: First, assuming that the main motive behind investing abroad is the access to other countries' markets, high wages in foreign locations should simply re ect the fact that most FDI goes to places which are similar to Germany in relative factor endowments. Secondly, since Blomström, Fors and Lipsey (1997) for Sweden and Marin (2004) for Germany and Austria report evidence that MNEs tend to locate the more skill-intensive activities abroad my results may indicate a skill-seeking motive behind German foreign direct investments.[25]

Finally, another interesting point is the negative in uence of credit capital (short and long run liabilities/total assets) on the probability to become a multinational. This could both be an indicator for the negative impact of credit constraints, on the one hand, and – through the different nancing structure of small, medium, and large rms in Germany – simply be another criterion for the size of an operation.

7 Performance after switching

Results in sections 4 – 6 provide clear evidence that successful rms – both before and at the date of switching – become multinationals. Hence, the next issue at hand is to investigate rm performance in a post-investment framework. The question at this juncture is what happens to the ef cienc y of rms in the three years after their choice to become a MNE?

7.1 Theoretical considerations of post-investment developments

Theoretical answers to this question are not clear cut. Concerning rm size, it depends on whether the parent retains operations at home that are complementary or substitutional to foreign activities. A substitutional relationship, which is likely when cost-saving reasons play a decisive role (vertical FDI), comes along with smaller operations on the home market. Contrariwise, even for purely cost-reducing FDI an employment gain at the domestic operation is possible if potential cost reductions allow the rm to increase overall market shares. Furthermore, especially when investing in industrialized countries, market access motives and the

[25] To investigate this problem in more detail one needs access to both, the skill structure of foreign subsidiaries and the skill distribution at the German parent r ms. Unfortunately such information is not available in the BuBa MIDI and USTAN data.

proximity-concentration trade-off need to be considered (horizontal FDI).[26] In this case, instead of exporting goods MNEs produce at the foreign location. Thus, the employment effect is twofold: On the one hand, the home operation could be larger if the rm exported goods to the host country. On the other hand, if there were no other opportunity to serve the foreign market besides the set-up of a foreign af liate, becoming an MNE would have no negative or even positive effects on domestic rm size. Since, in reality, the decision to become an MNE is possibly brought about by the co-existence of both cost-reducing and market-seeking motives, the overall effect on the parent rm is ambiguous.[27]

Another effect I am interested in is the impact of the switching choice on productivity. Again, different theoretical aspects should be considered in this respect. One argument for productivity increases at the domestic rm is the public good characteristic of rm-speci c assets. Pfaffermayr (1999) tests for a sample of Austrian manufacturers whether the volume of foreign output in uences labour productivity at home through multi-plant scale effects. He nds that production at subsidiaries, Austrian rms run abroad, increases the productivity at domestic plants. However, the reasons for productivity changes may work in both directions. Barba Navaretti and Venables (2004) argue that also changes in the composition of factor inputs and learning effects (technological and managerial knowledge) play a role. Since technological and managerial knowledge exhibit public good characteristics within rms, it seems obvious that learning through switching – whatever motives (vertical, horizontal, or both) are behind the decision – should positively affect domestic productivity. In case of changes in the composition of factor inputs, it is a priori not clear whether home market productivity gains or loses from the decision to found an MNE. Such changes are very likely to occur if the management vertically divides the production process, meaning that labour intensive production stages are shifted abroad. However, whether in that case ef cienc y at the remaining operation increases or decreases cannot be predicted. Marin (2004) argues that Austrian and German rms take advantage of cheap and abundant high skilled labour in Eastern and Central Europe. Hence, in this situation the productivity evolution at the domestic location might suffer. Moreover, the tremendous efforts of restructuring a newly

[26] In fact, a major part of German MNEs' foreign operations is concentrated in high- rather than low-income countries.

[27] Becker et al. (2005c) test for substitutability of labour in different world regions and Germany. The study conducts analysis for existing MNEs (long- or medium-term perspective) and nds for both industrialized regions (e.g. Western Europe) and for transition countries (Central and Eastern Europe) a substitutional relationship.

founded multi-plant enterprise may – at least in the short run – be accompanied by productivity losses at the domestic location. To put it in a nutshell, with respect to the productivity development after switching, theory provides a good rationale for both the boost and the fall story.

Finally, also the development of average wages is theoretically not unambiguously predictable. On the rm level, increasing productivity should raise wages. The displacement of labour intensive, blue collar jobs also implies the rise of average wages. Otherwise, Marin's (2004) "skill-searching" argument could have the reverse effect and lower average wages at the domestic location. Moreover, market access motives do not provide any clear cut predictions, either.

To draw a conclusion on the above considerations, the effect of going multinational on rms' size, productivity, average wages, and capital intensities is theoretically ambiguous and it is therefore mainly an empirical question to explore how performance differences evolve after the rise of a new multinational.

7.2 Empirical considerations of post-investment developments

After having discussed theoretical issues behind performance developments, an empirical examination of the problem needs to be made. The easiest way of evaluating the effect of a regime change on domestic rm attributes is to run simple OLS regressions of the rms' average outcome changes in $T + t$ on the switching status and a number of initial control variables in period T:

$$\begin{aligned}[logP_{i,T+t} - logP_{i,T}]/t &= \beta_0 + \beta_1 Switch_{i,T} + \Gamma' C_{i,T} + \\ &+ \delta_1 state_i + \delta_2 sector_i + \delta_3 year_T + u_{i,T}, \qquad (8)\end{aligned}$$

where T is the date of switching (1997-2000) and t is the time span we look ahead (t=1,2,3). Average performance growth is assessed over a period of three years after the decision to go multinational. The corresponding switching-dates for the different time spans are therefore 1997-2000, 1997-1999, and 1997-1998. Additional to rm size and rm age the vector $C_{i,T}$ proxies the average wage per rm over the average sector wage (not included if the dependent variable is average wage growth) and value added per rm over sector wide value added (not included for value added over employment).[28]

As argued in the previous chapters, it is likely that selectivity issues bias results. Hence, equation 8 is re-estimated taking the endogeneity of the switching choice

[28]These variables are meant to control for the initial skill level of the rms' work force and the competitive position within the domestic sector.

into account. To incorporate endogenous treatment effects a Heckman (1978) estimator is used to compute the following regression:

$$\begin{aligned}
[lnP_{i,T+t} - lnP_{i,T}]/t &= \beta_0 + \beta_1 Switch_{i,T} + \Gamma' control_{i,T} + \delta_1 state_i + \delta_2 sector_i + \\
&+ \delta_3 year_T + \rho\sigma_\epsilon[\frac{-\phi(\mathbf{Z'_{i,T-1}}\gamma + \mathbf{Y'}_{s,T-1}\delta)}{1 - \Phi(\mathbf{Z'}_{i,T-1}\gamma + \mathbf{Y'}_{s,T-1}\delta)}] + \epsilon_{i,T} \qquad (9) \\
S^*_{i,T} &= Z'_{i,T-1}\gamma + Y'_{s,T-1}\delta + \eta_{i,T} \\
S_{i,T} &= 1 \text{ if } S^*_{i,T} > 0, 0 \text{ otherwise,} \qquad (10)
\end{aligned}$$

where $[\frac{-\phi(Z_{i,T-1'\gamma}+Y'_{s,T-1}\delta)}{1-\Phi(Z'_{i,T-1}\gamma+Y'_{s,T-1}\delta)}]$ is called the inverse Mill's ratio (IMR), ϕ is a standard normal density, and Φ is the standard normal cumulative distribution function. $Z_{i,T-1}$ and $Y_{s,T-1}$ are variable vectors that proxy the rms' expectations in period $T-1$ with regard to the decision to become a MNE.[29] Estimates of the corresponding coef cients of these variables are taken from table 5.[30] $S_{i,T} = 1$ means a rm chooses to change status from national to multinational, and $S^*_{i,T}$ is a latent variable that describes the propensity to invest. The error terms $\epsilon_{i,T}$ and $\eta_{i,T}$ are supposed to be bivariate, normally distributed with correlation ρ ($[\epsilon_{i,T}, \eta_{i,T}] \sim$ bivariate normal $[0, 0, 1, \sigma_\epsilon, \rho]$).

The coef cient β_1 of the $Switch_{i,T}$ dummy in 9 measures the *average treatment effect* (ATE), i.e. the expected impact of the switching decision on a randomly drawn rm. [31] A likelihood ratio (LR) test on the independence of equations 9 and 10 allows us to formally test for the occurrence of selectivity issues. If selectivity problems are of no relevance, the ATE is already described by the OLS estimates of the treatment dummy in equation 8. All p-values of the LR-tests are depicted beneath the respective numbers of observations. Columns (1) and (2) of table 6 report the MNE premia in the rst year after switching; columns (3) and (4) as well

[29] Including the vectors $Z_{i,T-1}$ and $Y_{s,T-1}$ increases the sample periods to 1996-2000, 1996-1999, and 1996-1998, respectively. Hence, vis-à-vis the OLS regressions Heckman's procedure comes along with a reduction in the number of observations, which is due to the unbalanced panel structure of the data at hand. To arrive at comparable results, sample sizes of the OLS estimates were arti cially reduced to match the observations of the Heckman (1978) estimator.

[30] Post-investment growth rates of TFP O.P. rm-age, employment, average wages, and capital intensities are estimated using speci cation (2) of table 5 as probit equation. The growth of TFP O.P. refers to speci cation (1), TFP L.P. to column (4), and labour productivity to speci c ation (3).

[31] As opposed to the *average treatment effect on the treated* (ATT), the ATE also makes statements on units that would never be suitable for treatment. This problem can be reduced if rms were excluded from the population that would never be eligible. Through the exclusion of existing MNEs, switchers before and after the date of the regime change, and observations smaller and younger than a certain threshold I've tried to adjust the estimation sample accordingly. Nevertheless, results are still not comparable to the ATT. For a more elaborate discussion of this problem, see Wooldridge (2002).

as (5) and (6) depict results for the subsequent two years. In columns (1), (3), and (5) OLS estimates are presented, columns (2), (4), and (6) include results using the Heckman (1978) estimator. As usual, I have dropped existing MNEs and switchers before and after the date of switching.

Reported p-values of the LR tests show that self-selection matters. Results for TFP growth in the rst year after going multinational, labour productivity in the rst and second period after becoming a MNE, and capital intensities for the whole sample period are signi cantly in uenced by selectivity issues. Moreover, corresponding parameter estimates without endogeneity controls exhibit no signi cance at the 1%-10% level.

Compared to national rms, average TFP growth in the rst year after the regime change is signi cantly higher at newly founded MNEs. A randomly drawn rm' s productivity bene ts from the decision to become a multinational with a premium between 5%-7%. However, the effect lasts only for one year, i.e in later sample periods no positive impact on productivity growth is found. This leads to the conclusion that the internalization of the foreign plants' knowledge capital comes along with an immediate increase in productivity at the domestic rm. Yet, these learning effects seem to be restricted to the rst year after switching.

Average wages and capital labour ratios exhibit signi cant growth premia for all years under consideration. Apart from the results for period three, parameter estimates for average wages are not driven by self selection. Capital intensities, on the other hand, are clearly in uenced by selectivity issues during the whole sample period. Average growth rates with respect to wages (capital intensities) are between 3-4 percentage points (1-2 percentage points) higher at newly founded MNEs than at national rms. These developments might also be the decisive points behind the relative expansion path of labour productivity (2-9 percentage points). With a faster growing ratio of capital to labour and increasing average wages, it seems straightforward to expect superior productivity growth rates at a just-founded multinational relative to a purely domestic one. Here, it also ts well in that ex-post employment growth, though superior before switching, exhibits no signi cantly higher rates at new multinationals. In other words, I found evidence that rms prepare for a forthcoming expansion to foreign markets by hiring additional employees. These workers then seem to meet the companies' requirements for the next three years, since employment growth during the period after switching is no higher than at national rms.

Summing up, the above analysis presents evidence that becoming an MNE increases post-investment performance with respect to productivity and average

Table 6: DIFFERENCES IN PERFORMANCE GROWTH, MNEs VS. NATIONALS t YEARS AFTER SWITCHING, ALL SECTORS

	$T+1$[a]		$T+2$		$T+3$	
	OLS[b]	Heckit	OLS	Heckit	OLS	Heckit
Employment	*.005*[c]	*-.035*	*.009*	*-.033*	*-.006*	*-.026*
	(.011)	(.022)	(.009)	(.024)	(.010)	(.023)
TFP O.P.	*.009*	.067	*-.009*	*.016*	*.013*	.051
	(.014)	(.025)	(.009)	(.020)	(.009)	(.018)
TFP O.P. age	*.008*	.058	*-.010*	*.011*	*.013*	.048
	(.014)	(.026)	(.009)	(.021)	(.009)	(.019)
TFP L.P.	*.011*	.047	*-.003*	*.008*	.017	.038
	(.012)	(.025)	(.008)	(.019)	(.008)	(.021)
Labour productivity	*.009*	.085	*.011*	.077	.020	.047
	(.012)	(.025)	(.009)	(.019)	(.009)	(.026)
Average wage	.026	.059	.012	.038	*.007*	.036
	(.010)	(.022)	(.007)	(.015)	(.006)	(.011)
Capital/labour	*-.010*	.110	*.015*	.150	*.026*	.118
	(.023)	(.046)	(.019)	(.036)	(.020)	(.039)
N[d] overall employment	32,375		20,631		11,576	
N treat. employment	269		180		102	
p-value LR test[e]	.110		.159		.345	
N overall TFP O.P.	32,269		20,530		11,498	
N treat. TFP O.P.	267		178		100	
p-value LR test	.058*		.284		.152	
N overall TFP O.P. age	32,267		20,527		11,497	
N treat. TFP O.P. age	267		178		100	
p-value LR test	.104*		.373		.194	
N overall TFP L.P.	32,269		20,530		11,498	
N treat. TFP L.P.	267		178		100	
p-value LR test	.201		.582		.474	
N overall labour productivity	32,447		20,687		11,610	
N treat. labour productivity	267		177		101	
p-value LR test	.016**		.017**		.347	
N overall average wage	32,330		20,592		11,556	
N treat. average wage	268		180		102	
p-value LR test	.231		.176		.069*	
N overall capital/labour	32,352		20,617		11,565	
N treat. capital/labour	269		180		102	
p-value LR test	.064*		.012***		.074*	

Source: USTAN and MIDI, Deutsche Bundesbank 1997-2001, own calculations.

[a] Growth rates are measured as yearly averages assessed over the three after switching ($T+1$-$T+3$).

[b] Coef cients in columns (1), (3), and (5) are estimated using ordinary least square (OLS), parameters in columns (2), (4), and (6) refer to the Heckman (1978) endogenous treatment (Heckit) estimator.

[c] Each cell includes the coef cient of the $Switch_{i,T}$ dummy in a regression that is either based on equation 8 (OLS) or equations 9 and 10 (Heckit). Standard errors are in parenthesis. If a parameter fails to be signi cant at the 10% level, it is set in italics.

[d] The number of observations refer to the overall number of rms in each performance regression (N overall P) and to the number of switchers (N treat. P).

[e] Rows starting with "p-value LR test" include results of the likelihood ratio test of the hypothesis that the error terms of the probit and the treatment equation are uncorrelated.

wages. Capital intensities evolve towards the use of capital, and switching does not affect rm size.

8 Conclusions

This paper investigates the extent to which performance attributes of multinational enterprises exceed those of purely national rms, both prior and after they have switched from national to multinational activities. For that purpose a range of rm characteristics is evaluated. At the time of switching, newly founded MNEs exhibit performance premia of 10% (average wages) to 100% (rm size) compared to their nationals counterparts. Further regressions show, that multinationals already outperform national rms in the run up to invest abroad. Throughout this time period, the performance gap ranges from 91%-100% with respect to rm size and exhibits values between 22%-53% for the different productivity measures. Moreover, future multinationals pay on average 11%-13% higher wages, and capital intensities exceed those of national rms by 16%-25%. A two-sample Kolmogorov-Smirnov (KS) test on the equality of performance distributions con rms the above results. The tests clearly show that distribution functions of all rm characteristics for nationals lie to the left of those for switchers. With regard to ex-ante growth rates it turns out that only rm size exhibits higher rates. Average differences between future MNEs and nationals are between 3-5 percentage points.

The use of an endogenous treatment model shows that after the decision to invest abroad, selectivity issues are of importance. I nd evidence that TFP in the rst year after going multinational, labour productivity in the rst and second period after becoming a MNE, and capital intensities for the whole sample period are signi cantly in uenced by the endogeneity of the switching decision. The dimension of ex-post growth rate differences between newly founded MNEs and domestic rms is 3-4 percentage points with respect to wages and 5-9 percentage points for the different productivity measures. The growth rate premia for capital labour ratios is between 1-2 percentage points per year.

These results are in line with the opinion that international expansions of domestic rms are an important channel to raise overall competitiveness. The decision to become a multinational enterprise strengthens domestic operations. However, one has to take into account that the presented results refer to short run developments. The evaluation of performance measures at existing multinationals over a longer time horizon is beyond the scope of this paper and may yield different results.

Appendix

A Sample attrition of the Buba USTAN data set

Table 7: SUMMARY STATISTICS, EMPLOYMENT AND CAPITAL STOCK

	employment			capital stock[a]			
	mean	std.dev.	obs.	mean	std.dev.	obs.	overall obs.
1993	329.45[b]	4113.14	47,641	3404.67	12853.37	69,924	74,456
1994	331.6	4182.34	49,089	3901.77	14544.77	70,145	75,021
1995	335.89	4623.54	51,331	4078.39	15190.11	66,913	71,544
1996	343.83	4771.02	50,840	4164.61	15409.32	64,851	69,423
1997	376.54	4949.87	45,054	4688.06	16900.98	58,103	62,341
1998	475.63	5991.08	35,072	5710.04	18741.58	44,541	48,194
1999	541.71	6565.96	30,432	7024.70	21080.23	37,798	41,102
2000	595.57	6908.83	27,343	7906.59	22361.82	33,257	36,207
2001	688.85	7633.93	20,718	8041.65	22204.77	24,601	26,737

Source: Ustan, Deutsche Bundesbank 1993-2001, own calculations.
[a] The capital stock is measured in thousands.
[b] The table depicts summary statistics for the overall USTAN data set without any further adaptations.

B Aggregated sector de nitions

Table 8: AGGREGATED SECTOR DEFINITIONS

1	Agriculture and mining
2	Food and textiles
3	Machinery and equipment
4	Wood, chemicals and others
5	Commerce
6	Finance and business
7	Other services

C Construction of total factor productivity

As for the estimation of total factor productivity, I classi ed the USTAN data set into seven different branches (see appendix B). For each rm within an aggregated industry the following Cobb-Douglas production function is considered:

$$y_{i,t} = \beta_0 + \beta_1 l_{i,t} + \beta_2 k_{i,t} + \gamma_1 a_{i,t} + \gamma_2 r_i + \gamma_3 t_t + \nu_{i,t} + \varepsilon_{i,t}. \tag{11}$$

Lower case letters indicate logarithmic values of the according variables. $Y_{i,t}$ is the valued added of rm i at time t, $L_{i,t}$ and $K_{i,t}$ are its labour and capital inputs, $A_{i,t}$ is the rm age, r_i is a regional dummy that distinguishes East- and West-German observations, t_t is a linear time trend, $\nu_{i,t}$ is the part of productivity that in uences the rm' s input decision (unobservable for the researcher), and $\varepsilon_{i,t}$ includes both a measurement error as well as unpredictable shocks to productivity.[32] Table 9 exempli es estimation results of the above equation for the sector *Wood, Chemicals and Others* during the period 1992 to 2001 using ordinary least squares (OLS), rm-speci c x ed effects (Within), Olley's and Pakes's (O.P.), and Levinsohn's and Petrin's (L.P.) methods to control for endogeneity. A common feature of all estimation approaches is the assumption of constant, sector-speci c production parameters over time, i.e. each rm active in the same industry produces with the same technology but with possibly different amounts of factor inputs. In columns (1), (2) and (4) the simple OLS approach, which does not allow to treat $\nu_{i,t}$ and $\varepsilon_{i,t}$ independently, is used. Columns (2) and (4) augment the rst speci cation with the rms' age and investment as additional control variables. The within estimator of column (3) considers $\nu_{i,t}$ to vary over individual rms but to be constant over time. The results in columns (5)-(8) are based on semi-parametric estimation methods similar to the one proposed by Olley and Pakes (1996). Finally, column (9) is estimated using the Stata ado- le *levpet* (compare Levinsohn et al. (2003)).[33]

When applying the O.P. approach, the following assumptions are made: a) the inverted investment function can be written as $\nu_{i,t} = f(i_{i,t}, k_{i,t})$ ($i_{i,t}$ is the log of investment); b) labour is the only variable factor, i.e. its demand is in uenced by contemporaneous values of $\nu_{i,t}$; c) $k_{i,t}$ and $a_{i,t}$ are x ed variables in uenced only by past values of the unobserved productivity shocks ($\nu_{i,t-1}$). Therefore, equation 11 changes to:

$$y_{i,t} = \beta_0 + \beta_1 l_{i,t} + \gamma_1 a_{i,t} + \gamma_2 r_i + \gamma_3 t_t + \phi_t(i_{i,t}, k_{i,t}) + \varepsilon_{i,t}, \tag{12}$$

where $\phi_t = \beta_2 k_{i,t} + f(i_{i,t}, k_{i,t})$ and is approximated by a 3rd order polynomial in log investment and log capital. Equation 12 yields consistent estimates of β_0, β_1, γ_1, γ_2, and γ_3, while the coef cient of logarithmic capital β_2 is not identi ed. On this account, a second step is necessary to get consistent values of β_2. The second estimation equation is:

$$y_{i,t+1} - \beta_0 - \beta_1 l_{i,t+1} - \gamma_1 a_{i,t+1} - \gamma_2 r_i - \gamma_3 t_{t+1} = \beta_2 k_{i,t+1} + h(\phi_t - \beta_2 k_{i,t}) + \eta_{i,t+1} + \varepsilon_{i,t+1}, \tag{13}$$

[32] Hence, $\beta_0 + \gamma_2 r_i + \gamma_3 t_t$ is a shock to productivity common to all rms in the same sector, region and year.

[33] Since the ado- le is very restrictive and does not allow to include other variables than capital and labour it mainly serves as an additional control speci cation.

where $\eta_{i,t+1} = \nu_{i,t+1} - E(\nu_{i,t+1}|\nu_{i,t})$ and $h(.)$ is approximated by a third order polynomial in $k_{i,t}$ and ϕ_t. Estimation results of the O.P. approach are presented in columns (5) to (8).[34]

None of the results in table 9, columns (1), (2), and (4), account for the fact that ignoring $\nu_{i,t}$ causes an omitted variable bias. If the correlation between unobserved, rm-speci c productivity shocks and the rm' s factor demand is positive, one expects positively biased OLS estimates. Turning to the O.P. and L.P. estimates should reduce much of the simultaneity problems. In fact, a comparison of columns (5) to (9) with columns (1), (2), (4) reveals a decrease of the labour coef cient between eight percent in case of O.P. and, with signi cantly more observations at hand, nineteen percent in case of Levinsohn's and Petrin's method. The within estimator, though it suffers from the problem to model $\nu_{i,t}$ as constant over time, also provides evidence for a positive bias in the OLS estimates. However, the relatively low capital coef cients are a little worrying, since they could be caused by a potential selectivity problem that cannot be addressed with the data at hand.

To focus on three productivity measures only, the results of columns (5), (7) and (9) are used to calculate total factor productivity. For these speci cations my TFP measures are constructed as

$$TFP_{i,t} = exp(y_{i,t} - \beta_1 l_{i,t} - \beta_2 k_{i,t}[-\Gamma' C_{i,t}]), \tag{15}$$

where $C_{i,t}$ are additional variables like rm age and other controls depending on the according speci cation. In order to gain observations, I constructed out of sample predictions for rms where the investment or intermediate input proxy was not available.

[34]Table 9 also includes a version where $\eta_{i,t}$ is assumed to follow a random walk process (see columns (5) and (7)). Equation 13 then reduces to:

$$y_{i,t+1} - \beta_0 - \beta_1 l_{i,t+1} - \gamma_1 a_{i,t+1} - \gamma_2 r_i - \gamma_3 t_{t+1} - \phi_t = \beta_2(k_{i,t+1} - k_{i,t}) + \eta_{i,t+1} + \varepsilon_{i,t+1}. \tag{14}$$

Table 9: ESTIMATION OF PRODUCTION FUNCTION PARAMETERS, SECTOR: WOOD, CHEMICALS AND OTHERS

	OLS	OLS age	Within	OLS inv.	OP r.w.	OP polyn.	OP age r.w.	OP age polyn.	LP
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ln employment	.874	.876	.579	.845	.803	.803	.805	.805	.622
	(.002)***	(.003)***	(.004)***	(.003)***	(.002)***	(.002)***	(.002)***	(.002)***	(.005)***
ln cap. stock	.131	.131	.067	.070	.083	.091	.084	.091	.071
	(.002)***	(.002)***	(.002)***	(.002)***	(.005)***	(.005)***	(.005)***	(.005)***	(.005)***
ln rm age		-.022	.149	-.016			-.009	-.009	
		(.002)***	(.004)***	(.002)***			(.002)***	(.002)***	
ln investment				.082					
				(.002)***					
region	.413	.420		.425	.431	.431	.431	.431	
	(.007)***	(.008)***		(.009)***	(.006)***	(.006)***	(.007)***	(.007)***	
time trend	.016	.011	-.002	.011	.014	.014	.010	.010	
	(.0006)***	(.0006)***	(.0004)***	(.0006)***	(.0006)***	(.0006)***	(.0006)***	(.0006)***	
cons.	3.370	3.453	5.140	3.541	4.141	4.141	4.140	4.140	
	(.010)***	(.011)***	(.020)***	(.011)***	(.035)***	(.035)***	(.040)***	(.040)***	
N 2nd step					45,995	45,995	37,629	37,629	
N 1st step	85,175	65,804	66,312	53,902	69,103	69,103	53,902	53,902	87,400

Source: Ustan, Deutsche Bundesbank 1992-2001, own calculations.

Note 1: The dependent variable in columns (1) - (4) is the log of value added. The dependent variable in columns (5) and (7) is $y_{i,t+1} - \hat{\beta}_1 l_{i,t+1}[-\hat{\gamma}_1 a_{i,t+1}] - \hat{\beta}_0 - \hat{\gamma}_2 r_i - \hat{\gamma}_3 t_{t+1} - \hat{\phi}_{i,t}$, where $\hat{\phi}_{i,t}$ is approximated by a 3rd order polynomial in log investments and log capital from the 1st step estimation. The dependent variable in columns (6) and (8) is $y_{i,t+1} - \hat{\beta}_l l_{i,t+1}[-\hat{\gamma}_1 a_{i,t+1}] - \hat{\beta}_0 - \hat{\gamma}_2 r_{i,t} - \hat{\gamma}_3 t_{t+1}$ and (9) is estimated using the Stata ado- le levpet (compare Levinsohn et al. (2003)).

Note 2: The number of observations refer to rst (N 1st step) and second step (N 2nd step) estimates accordingly. The 1st step includes the time period 1992 to 2001. Since it was necessary to use lagged values of some variables in the 2nd step the time period for speci cations (5) - (8) is 1993-2001.

Table 10: KOLMOGOROV SMIRNOV TEST OF THE EQUALITY OF DISTRIBUTIONS, ALL SECTORS

	employment	TFP O.P.	TFP O.P. age	TFP L.P.	labour prod.	average wage	capital/labour
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
lag1 $P\ D^{+}$ [a]	.448	.202	.245	.359	.181	.256	.11
p-value	0	0	0	0	0	0	0
lag1 $P\ D^{-}$	-.004	-.0003	-.0003	-.0006	-.003	-.0001	-.004
p-value	.986	1	1	1	.99	1	.987
lag1 combined	.448	.202	.245	.359	.181	.256	.11
p-value	0	0	0	0	0	0	.00002
N [b]	92,868	88,040	84,180	88,388	92.171	92,336	91,125
lag2 $P\ D^{+}$	.422	.213	.244	.366	.23	.238	.085
p-value	0	0	0	0	0	0	.001
lag2 $P\ D^{-}$	-.004	-.0002	-.0001	-.0006	-.0009	-.002	-.0007
p-value	.988	1	1	1	.999	.997	1
lag2 combined	.422	.213	.244	.366	.23	.238	.085
p-value	0	0	0	0	0	0	.003
N	83,866	79,509	76,499	79,791	83,314	83,408	82,225
lag3 $P\ D^{+}$	.417	.178	.197	.331	.231	.229	.092
p-value	0	0	0	0	0	0	.001
lag3 $P\ D^{-}$	-.003	-.0008	-.002	-.002	-.001	-.002	-.0008
p-value	.99	1	.997	.998	.998	.996	.999
lag3 combined	.417	.178	.197	.331	.231	.229	.092
p-value	0	0	0	0	0	0	.002
N	75,528	71,541	69,032	71,787	75,078	75,130	73,958

Source: USTAN and MIDI, Deutsche Bundesbank 1994-2001, own calculations.

[a] Rows (1) + (2), (7) + (8), and (13) + (14) test the hypothesis that the performance measures P_t for nationals contain smaller values than for switchers. Lines (1), (7), and (13) are the corresponding distances between the distribution functions. Rows (3) + (4), (9) + (10), and (15) + (16) test the hypothesis that P_t contains larger values for nationals than for switchers. Lines (3), (9), and (15) are the corresponding distances between the distribution functions.

[b] The number of observations refer to the overall number of rms in each test. The number of switchers equals the number of treated observations in the corresponding cells of table 3. Overall numbers of observations in table 3 are slightly lower since control variables are necessary when estimating the corresponding equations.

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