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Technology spillovers from external investors in East Germany: no overall effects in favor of domestic firms

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Summary

The study deals with the question whether external (foreign and West German) investors in East Germany induce technological spillover effects in favor of domestic firms. It ties in with a number of other econometric spillover studies, especially for transition economies, which show rather mixed and inconclusive results so far. Different from existing spillover analyses, this study allows for a much deeper regional breakdown up to *Raumordnungsregionen* and uses a branch classification that explicitly considers intermediate and investment good linkages. The regression results show no positive correlation between the presence of external investors and domestic firms' productivity, no matter which regional breakdown is looked at (East Germany as a whole, federal states, or *Raumordnungsregionen*). Technology spillovers which may exist in particular cases are obviously not strong enough to increase the domestic firms' overall productivity.

Zusammenfassung

Die Studie setzt sich mit der Frage auseinander, ob externe (ausländische und westdeutsche) Investoren in Ostdeutschland Technologie-Spillovers zugunsten einheimischer Unternehmen induzieren. Die Untersuchung knüpft an eine Reihe ökonometrischer Spilloverstudien an, vor allem an solche für Transformationsländer, die bisher sehr uneinheitliche Ergebnisse liefern. Anders als die vorliegenden Studien verwendet diese Untersuchung eine regionale Aufgliederung bis hin zu Raumordnungsregionen. Ferner wird eine Branchenklassifizierung vorgenommen, die Vorleistungs- und Investitionsgüterverknüpfungen explizit berücksichtigt. Die Regressionsergebnisse zeigen jedoch keinen positiven Zusammenhang zwischen der Anwesenheit externer Investoren und der Produktivität einheimischer Unternehmen, unabhängig davon, welche regionale Betrachtungsebene gewählt wird (Ostdeutschland insgesamt, Bundesländer oder Raumordnungsregionen). Technologie-Spillovers, die in Einzelfällen möglicherweise existieren, sind offensichtlich nicht stark genug, um die Produktivität einheimischer Unternehmen insgesamt zu stärken.

Keywords: East Germany, foreign direct investment, technology spillovers, innovation, productivity

Content

1. Introduction

Roughly 14 years after the German Reunification, East Germany has experienced substantial progress in industrial restructuring and technological modernization, but compared to West Germany, there is still substantial effort needed in order to adapt economically. The lagging behind of East Germany becomes visible, especially with respect to productivity. In 2002, East Germany's productivity (gross value added per employee) accounted for 72% of West Germany (DIW Berlin/IAB/IfW/IWH/ZEW 2003). It is the backward level, but also the slowed down pace of catching-up since the mid 1990s that is being regarded as problematic. The reasons are manifold. Empirical research conducted by the IWH shows that lower capital intensities, deficiencies in infrastructure, and an unfavorable composition of branches within manufacturing industry contribute to the productivity gap (Ragnitz/Müller/Wölfl et al. 2001).

For the ongoing process of catching-up and the build-up of international competitiveness, it is essential to proceed with technological progress and restructuring which on the enterprise level materializes in the form of innovations. Innovation means the introduction of new products and production processes as well as organizational changes. This does not necessarily require own research and development (R&D), since new products or processes can also be based on the transfer of external technology. Besides a commercial technology transfer (e.g. license agreements), innovations can also derive from technology spillovers in the sense of trickle-down or synergy effects between enterprises. With respect to economically backward countries or regions, such spillover effects are expected to take place especially from foreign subsidiaries to local firms. Whether and in how far foreign companies contribute to domestic firm's innovation and thus productivity via spillovers will be subject of this paper.

Technology spillovers have gained much attention in economic research over the last decades, especially with respect to developing countries. With the increase of foreign direct investment (FDI) in former socialist countries after 1990, the question about innovation stimulating spillovers in favor of local firms has motivated researchers to engage in "spillover research" for this group of countries, too. For East Germany where FDI also plays an important role since 1990 hardly any empirical research about spillover effects has been carried out so far.[1] Yet, due to the fact that East Germany is still an eco-

[1] So far, only Peri/Urban (2002) have undertaken an econometric study about productivity spillovers for East Germany. They found evidence for spillovers from foreign subsidiaries, but the results bear some limitations related to the data source. In their study it was only possible to apply a regional breakdown on the level of federal states and even more important they could not find foreign subsidiaries for Saxony (*Sachsen*) in their dataset, which does certainly not correspond to reality.

nomically backward region, the topic of FDI led technology spillovers is of high importance, not only for scientists but for economic policy makers, too. This study is intended to fill the existing research gap for East Germany and contribute to the discussion of technology spillovers in catching-up economies in general.

The following chapter outlines the theoretical background, explains the different spillover mechanisms and refers to necessary framework conditions as well. Chapter 3 introduces some general features on foreign (and West German) investors in East Germany. Following this, the design of analysis (chapter 4) and regression results will be presented (chapter 5). Chapter 6 draws final conclusions.

2. Theoretical background

In economic theory, spillovers play a crucial role in new growth theory which points out spillover effects as a determining factor of economic growth (e.g. Romer 1986, Romer 1990, Lucas 1988, Grossman/Helpman 1997). The perception of technology as a public good or rather the consideration of „partial nonexcludability of knowledge“ (Grossman/Helpman 1997: 18) allows to explain economic growth endogenously. Thus, new growth theory lies the very base to trace back economic growth to inter-firm spillovers. Yet, the specific focus of this paper, namely technology spillovers from foreign to domestic firms has rather been a central theme of development economists who are concerned with the question how economically backward economies can catch up. Technology transfer and spillover effects from FDI are a major issue for development economists in various theoretical contributions (e.g. Hirschman 1965, Moran 1998, Reuber et al 1973). This project basically follows the development economist’s way of thinking, assuming that foreign subsidiaries contribute to local firm’s economic development in East Germany, too. While this forms the overall theoretical background, the study also needs to address the theoretical question how technology finally spills over from one company to another.

This leads to international business literature, notably Dunning (1993) who’s well-established “eclectic paradigm” explains under which circumstances multinational companies establish a foreign subsidiary[2] and why foreign subsidiaries are technologically

[2] Foreign subsidiaries are defined as companies of which more than 50% of the voting shares are owned by a foreign corporation, called the parent company. In practice, most foreign subsidiaries are 100% foreign owned (Downes/Goodman 1993: 1037).

superior compared to domestic firms.[3] Technological superiority is, however, only a necessary precondition, not yet an explanation for spillovers as such. Thus, the different mechanisms of spillovers need to be elaborated in more detail. Before turning to this, a clear definition of technology spillovers should be given. In this paper, technology spillovers are defined as the transfer of technology and/or knowledge from foreign subsidiaries to domestic firms outside market transactions.

Very often, technology spillovers are put equal with positive external effects which can occur through the mechanism of demonstration effects from foreign to domestic firms (learning-by-watching) or through labor mobility of qualified workers who transfer knowledge by changing from a foreign to a domestic firm (Blomström/Kokko 2000). Apart from these rather anonymous and normally unintended effects, foreign subsidiaries may also voluntarily transfer technology to a local firm. Such spillovers are not external effects but usually based on an immediate cooperation between the two sides. They can occur in different contexts: it may e.g. be efficient for a foreign subsidiary to provide technological support to a local firm in order to enable it to become a future supplier – so called supplier support. On the other hand, a foreign investor may transfer extra technology to a domestic customer for marketing strategic reasons – so called customer support (Dunning 1993: 446ff, Blomström/Kokko 1998). Beyond this, it is conceivable that foreign subsidiaries and domestic firms work together within cooperation projects outside pure buyer-supplier-relations, such as joint research and development (R&D), innovation, or training projects. Here again, the foreign investor may find it efficient to voluntarily transfer technology to the domestic cooperation partner – we talk about "networking" as another mechanism of spillovers (Dunning 1993: 470).

Naturally, spillovers may occur within branches (horizontally) or across branches (vertically), but obviously both effects are likely to overlap (Meyer 2004; Görg/Greenaway 2001). Very often, supplier and customer contacts are inter-industry relations along the value added chain while demonstration and labor mobility are to a large extent branch specific spillover mechanisms. Apart from this, spatial proximity is an important factor for spillovers to become real. Although spillovers are imaginable across large distances, the presence of foreign subsidiaries "next door" means reduced transaction costs for the technology taking local firm, such as lower costs for observation, communication etc.

[3] According to Dunning's paradigm, multinational firms are driven by the intention to also exploit their firm specific technologies internally, that means within the multinational concern, instead of signing a license agreement with a local company abroad. The reason behind is that transactions in international technology markets (e.g. license agreements, blueprints) often fail because of asymmetric information between the two sides. Accordingly, it is assumed that foreign subsidiaries are equipped with advanced technology – at least compared to local firms in the foreign market.

As early as 1890, Marshall was the first to describe agglomeration advantages, among them the boosted flow of information deriving from "the concentration of specialized industries in particular locations" (Marshall 1962: 222). Agglomeration advantages in the sense of Marshall were later put forward by Krugman (1991).[4] In this sense, clusters of foreign and domestic firms should be predestinated for spillovers in the sense of this paper.

On the part of domestic firms, the absorptive capacity, that means the ability to adopt and implement external technology, is of high importance for technology transfers to become real. According to Cohen/Levinthal (1990) – the most reputed theorists in this field – the absorptive capacity is a function of own research & development and human capital. In the context of this paper, it means that the higher the absorptive capacity of domestic firms, the better the chances for positive spillover effects.

To sum up, the theoretical considerations outlined here suggest that the presence of foreign subsidiaries one way or another leads to technological innovations and over time to an economically better performance of domestic firms. The better performance, notably in terms of productivity, derives – on the one hand – from product innovations which allow access to new and possibly international markets with higher value added productivity. Process innovations and organizational changes on the other hand lead to higher technical and managerial efficiency.

3. Foreign and West German investors in East Germany: some stylized facts

It is generally known that East Germany attracted foreign and – even more – West German investors on a grand scale after 1990. Well known examples are AMD in Dresden, Dow Chemical in Schkopau, Volkswagen in Zwickau and Dresden, BMW in Leipzig etc. In the sense of this paper, foreign and West German subsidiaries fall into the same category, namely the category of firms that serve as a potential source of spillovers due to their technological superiority and other advantages related to their transnationality,

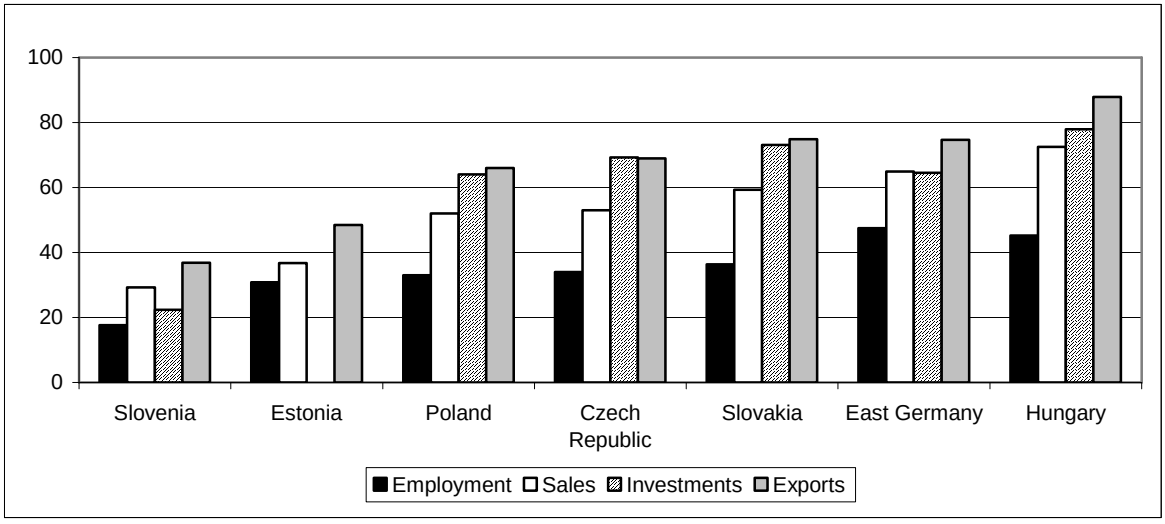
[4] Recently, much attention has been devoted to the potentially positive effects of clusters, industrial districts, regional (innovation) networks in economic sciences and policy programs too (see e.g. Günter 2004a: 152f; Pyka/Kueppers 2003; Koschatzky/Kulicke/Zenker 2001).

such as advanced international competitiveness, global sourcing and distribution channels etc.[5]

Foreign and West German subsidiaries have a relatively high weight in the East German economy. In 2001, the degree of "foreign penetration" reached levels that are comparable to those of the neighboring Central East European countries (CEEC), depending on the indicator looked at (see chart 1). In East Germany, external (foreign and West German) subsidiaries account for nearly 50% of employment, more than 60% of sales and investments, and nearly 80% of exports in 2001. In advanced OECD economies, foreign subsidiaries have a much lower share in overall employment and investments.[6]

Chart 1: "Foreign penetration" in manufacturing industry 2001

- share of external subsidiaries[a] in overall employment, sales, investments, and exports (%) -



[a] For East Germany, "external subsidiaries" means foreign and West German subsidiaries, for CEEC it means foreign subsidiaries.

Data source: East Germany: IAB establishment panel - calculation of the IWH; CEEC: WIIW "Database on Foreign Investment Enterprises" (relying on national sources)

[5] Of course, in the case of West German firms, one cannot automatically assume transnationality, but there are simply too many examples of multinational concerns among the West German investors for leaving them aside (e.g. Bayer, BASF, Bosch, BMW, Porsche, Siemens, Volkswagen)

[6] In 1998, the share of foreign subsidiaries, i.e. majority foreign owned firms, in total employment (or gross fixed capital formation) of manufacturing industry accounted to 28% (35%) in France, 16% (14%) in Finland, 20% (-) in Germany as a whole, 27% (40%) in Great Britain, 22% (30%) in the Netherlands, and 22% (20%) in Sweden (OECD, 2001).

Despite the strong "foreign penetration" in terms of employment, sales and investment shares, the pure number of foreign and West German establishments in East Germany is low. In 2001, about 17% of all establishments in the East German manufacturing industry were majority foreign or West German owned firms. This indicates that external investors are much bigger firms, and indeed, in 2001 foreign establishments employed on average 123 persons (West German establishments: 52) while East German establishments have on average 12 employees (Günther 2004b: 16f).

As regards qualitative aspects of external subsidiaries, it can be shown that they are indeed characterized by the assumed higher technological capability compared to domestic firms (see table 1). Furthermore, external subsidiaries in East Germany exhibit on average a clearly higher labor productivity than domestic firms even if one controls for differences in branches and firm size (Günther 2004b: 19ff).[7]

Table 1: Product innovations and R&D of foreign, West German, and East German establishments (establishments in %)

	Product innovations (1999-2000)			At least one of the 3 types of product innovation (1999-2000)	All 3 types of product innovation (1999-2000)	Research & Development (2001)
	Product improved or further developed	Enhancement of the range of products	Market innovation			
Foreign establishments	66.4	39.8	30.2	79.2	9.6	46.7
West German establishments	47.8	29.1	12.3	54.4	4.5	22.9
East German establishments	38.8	25.1	10.8	44.7	5.6	10.7
All establishments	40.5	25.7	11.4	46.4	5.5	13.3

Source: IAB establishment panel, calculation of the IWH.

Both the strong weight of external subsidiaries in East Germany and their superior technological capability justify the question about technology spillovers in favor of domestic companies. Moreover, compared to CEEC, East Germany is likely to provide more fa-

[7] Comparable results with respect to technological capability are found for foreign subsidiaries in CEEC (e.g. Habuda/Szalavetz 2000, Hunya 2002).

vorable framework conditions for spillovers to become real. The fact that the majority of external investors in East German are West German subsidiaries excludes language barriers. Since the mid 1990s, the German innovation policy has increasingly focused on support programs for innovation networks and cluster building in East Germany. And despite all weaknesses, small and medium sized companies in East Germany have easier access to private and public financing including risk capital than their counterparts in CEEC.

4. Design of the empirical spillover study

4.1. Basic considerations

Econometric spillover studies usually use models in which labor productivity or total factor productivity of domestic firms is regressed on a number of independent variables assumed to affect productivity, and so does this paper. In general, labor productivity is a good overall and easily observable measure for technological capability. Different from the majority of existing spillover analyses, the presence of foreign firms will be considered for clusters instead of single branches, and the spatial dimension of spillovers will be taken into account as well. To measure spillovers from foreign to domestic firms, a variable is included in order to proxy for the presence of foreign firms, usually the share of employment (or sales) in foreign subsidiaries over total employment (or sales). If the regression analysis results in a positive and statistically significant estimate of the coefficient on the foreign presence variable, it is regarded as evident that a positive productivity impact took place from foreign to local firms.[8] The use of labor (or total factor) productivity as dependent variable is based on the assumption that external investors induce innovations in domestic firms which finally result in higher productivity (see chapter 2). Of course, the approach for investigating spillover effects as described above is a rather indirect one, since a whole chain of processes has to work before evidence for

[8] Spillover studies of this type were pioneered by Caves (1974) and Globerman (1979) using cross sectional industry level data for Australia (for 1966) and Canada (for 1972) respectively. For a comprehensive overview of more recent econometric spillover analyses in general see e.g. Blomström/Kokko (1998) and Görg/Greenaway (2001).

spillovers can be proved, i.e. presence of external firms → spillover mechanisms (different types) → innovations in domestic firms → productivity increase.[9]

4.2. Data source: The IAB establishment panel

The regression analysis has been conducted by the use of micro level panel data, the IAB establishment panel (*IAB-Betriebspanel*). The IAB establishment panel is carried out annually by the Institute for Employment Research of the Federal Labour Services in Germany (*Institut für Arbeitsmarkt- und Berufsforschung der Bundesanstalt für Arbeit, IAB*). The survey is representative for the East German economy. Basic population is the employment statistics register of the Federal Employment Services (*Bundsanstalt für Arbeit*). The register includes all establishments with at least one employee who is obliged to social insurance contribution. Survey unit is the establishment, that means the local business unit (not the enterprise as a whole). This is a particular strength of the survey especially when making investigations in the East German economy, because many West German based enterprises have established subsidiaries in East Germany. In 2001, the sample for manufacturing industry comprised 1 800 establishments for East Germany. Weighting factors both for cross-section as well as longitudinal are provided by the IAB.[10] This paper uses data waves for 1999-2003 for manufacturing industry (excluding mining and construction industry). It is possible to identify establishments with majority foreign and West German ownership as well as majority East German owned firms. The panel gives information about general features of the establishments, such as branch (2-digit WZ-93 level), employees, sales, value added, and – last but not least – information about the location on county level.

4.3. Consideration of horizontal and vertical effects: cluster approach

As mentioned earlier it is the intention of this paper to consider horizontal and vertical effects simultaneously since it is reasonable to assume that both exist in parallel. In order to consider this in the empirical analysis, the study does not simply apply the explanatory variables – first of all the presence variable – for single branches, but for clus-

[9] This is of course a simplified description of the whole process. In reality, it is not so one-dimensional since a variety of framework conditions are at work too. Yet, for the purpose of this paper, a basic model like this is indispensable.

[10] For further information see Kölling (2000).

ters of branches belonging together with respect to their input linkages. In this paper, input linkages are considered in terms of intermediate products as well as investment goods. In this sense, clusters have been build on the basis of input-output-tables on the one hand and investment good matrices on the other hand. Table 2 shows the linkages for each industrial branch.[11]

The table should be read as follows: Branch 1 (food, beverages and tobacco) receives inputs in terms of intermediate products from itself (branch 1) as well as from the branches 3 (wood, paper and printing), 4 (chemical industry), 5 (rubber, plastic) and 7 (metal industry). Furthermore, branch 1 receives investment goods from branch 8 (machinery). Thus, the branches 1, 3 to 5, and 7 to 8 build a cluster.

Table 2: Clusters of branches according to input linkages

Branches delivering goods \ Branches receiving goods	1	2	3	4	5	6	7	8	9	10	11	12
1	○											
2		○										○
3	○		○	○						○		○
4	○	○	○	○	○	○	○	○		○	○	○
5	○				○			○		○	○	○
6						○	○			○		
7	○			○	○		○	○	○	○	○	○
8	●	●	●	● / ○	● / ○	● / ○	● / ○	● / ○	●	● / ○	● / ○	● / ○
9			●	●				● / ○	● / ○	● / ○	●	
10								●	●	○	●	
11						●					● / ○	
12												○

○ – Input linkages in the sense of intermediate products (input coefficient > 5%), ● – Input linkages in the sense of investment goods

1 – food, beverages, tobacco (WZ 15+16); 2 – textiles, textile products, leather (WZ 17-19); 3 – wood + paper, publishing, printing (WZ 20-22); 4 – chemical industry (WZ 23+24); 5 – rubber, plastic products (WZ 25); 6 – non-metalic mineral products + recycling (WZ 26+37); 7 – basic metals + fabricated metal products (WZ 27+28); 8 – machinery (WZ 29+31); 9 – electronics (WZ 30+32); 10 – optical equipment (WZ 33); 11 – automobile + other vehicle construction (WZ 34+35); 12 – furniture, manufacturing n.e.c. (WZ 36)

Source: own depiction.

[11] The IAB establishment panel originally distinguishes between 16 branches in manufacturing industry. They basically correspond to the 2-digit branches of WZ-93 or NACE respectively. For the purpose of this paper, the 16 branches have been summarized to 12 branches by putting together those branches that are closely connected anyway, i.e. paper, printing, publishing + wood industry; automobile construction + other vehicle construction; basic metals + fabricated metal products; non-metallic mineral products + recycling.

With respect to intermediate products, the linkages could be determined exactly through the use of input-output-tables provided by the Federal Statistical Office of Germany, (*Statistisches Bundesamt*) (Statistisches Bundesamt 2004). An input coefficient above 5% has been used as threshold, i.e. the intermediate products a branch receives from another branch account for 5% or more of their production. Considering investment good linkages, an exact determination has not been possible since investment goods are not subject to the input-output-analysis of the Federal Statistical Office in Germany, at least not officially. Estimates from the Federal Statistical Office exist, but they are not available with a breakdown for single branches of manufacturing industry (Statistisches Bundesamt 2000: 235). However, the investment good matrix from the Statistical Office shows that machinery is by far the most important supplier for manufacturing industry as a whole followed by electronic industry (including optical equipment etc.). Basically, the matrix for investment goods of the Federal Statistical Office has been used as an orientation, while the final assignment of investment good linkages in table 2 is a result of plausibility considerations.

The cluster determination as described here is an individual preparatory work for the purpose of this paper and will be implemented as such in the econometric analysis. The clusters as composed here do not claim to be a final and general definition for East Germany.

4.4. Consideration of spatial proximity: *Bundesländer* and *ROR*

In order to meet the theoretical considerations outlined in chapter 2, it is necessary to account for spatial proximity too. Accordingly, the explanatory variables will not only apply to clusters but to regions as well. Of course, no general rule exists about the spatial range of spillover effects. It will always depend on individual circumstances. The analysis has been conducted for federal states (*Bundesländer*) as a more rough classification and combined counties (*Raumordnungsregionen*) which represents a more sophisticated and deeper breakdown. Berlin has been excluded from the regression analyses, because as a city state it represents a special and rather untypical situation, not comparable to the other federal (territorial) states. While the five federal states represent administrative borders, the definition of *Raumordnungsregionen* (ROR) follows a combined administrative and functional approach. The determination of ROR also takes into account commuter movements (Bundesforschungsanstalt für Landeskunde und Raumordnung 1996). For East Germany, 22 *Raumordnungsregionen* have been distinguished (see map 1), each consisting of approximately two to six counties. The investigation on the level of ROR is a significant novelty for spillover studies and has been possible here,

because the IAB establishment panel provides information on the establishment's location on county level. In addition to the analyses on the level of federal states and ROR and for the purpose of completeness, a regression for East Germany as a whole will be conducted as well.[12]

Map 1: *Bundesländer* and *Raumordnungsregionen* in East Germany

Source: IWH (own depiction)

[12] The investigation for East Germany as a whole includes East Berlin.

Appendix 1 shows the weight of external investors (percentage share in employment) for each cluster and ROR.

5. The empirical model and regression results

According to the theoretical background outlined in this paper, the existence of a technology gap between external and domestic firms constitutes a fundamental precondition for spillovers. In order to account for this, the regression analyses as introduced in the following include only those East German establishments that really exhibit a technology gap compared to external investors within the relevant cluster. In accordance with earlier studies (Günther 2004b: 27f), the majority of East German firms exhibit a productivity level below that of external investors' average in the cluster. Firms with a technology gap are particularly predestinated for benefiting from external investors. It can and should, of course, not being excluded that spillovers may occur just between all firms, independent of their productivity level, branch, ownership structure etc., but it is the intention of this paper to investigate a particular form of spillovers, namely those directed from external to domestic firms. This is what economic theory implies (see chapter 2) and what is typically being discussed and expected from policy makers in catching-up economies.

5.1. Investigation at the level of *Bundesländer* and *ROR*

As mentioned above, labor productivity of domestic firms (value added per employee) has been used as dependent variable (VAP). The presence (PRE) of external establishments – the central explanatory variable – is operationalized as the share of employment in external firms in total employment of the relevant East German establishment's cluster and region (federal state, ROR). Besides the presence of external firms, the enterprise density (DEN) in the East German establishment's region (federal state, ROR) needs to be taken in consideration because an extremely low number of establishments would limit the chance for spillovers to become real. Furthermore, the absorptive capacity (ADOP) is an important condition for spillovers to fall on fruitful ground. In this paper, absorptive capacity has been operationalized via human capital, i.e. the share of qualified employees in the East German establishment's total employment. In order to capture possible crowding out effects, a control variable has been included using the Herfindahl index of the East German establishment's branch as a proxy for competition intensity (HF). Furthermore, control variables for the East German establishment's size

(SIZE) and export intensity (EXPO) are included since both have an impact on the establishment's productivity. Naturally, dummies for branches are introduced as well.

Model for federal states and ROR respectively:

$$VAP_{i,t} = a_0 + a_1\, PRE_{i,t-1(2)} + a_2\, DEN_{i,t} + a_3\, ADOP_{i,t-1(2)} + a_4\, HF_{i,t-1(2)} + a_5\, EXPO_{i,t-1(2)} + a_6\, SIZE_{i,t-1(2)} + \underbrace{a_7\, \text{branch dummy1} + \ldots + a_{17}\, \text{branch dummy11}}_{\text{controll variables}}$$

$VAP_{i,t}$	Value added per employee in the particular East German establishment
$PRE_{i,t-1(2)}$	Share of employment in external establishments in total employment of the cluster and region of the particular East German establishment (region = federal state, ROR)*
$DEN_{i,t}$	Number of all establishments per km^2 for the cluster and region of the particular East German establishment (region = federal state, ROR)*
$ADOP_{i,t-1(2)}$	Share of qualified employees in total employment for the particular East German establishment
$HF_{i,t-1(2)}$	Herfindahl index for the branch of the particular East German establishment*
$EXPO_{i,t-1(2)}$	Share of turnover in West German and foreign markets for the particular East German establishment
$SIZE_{i,t-1(2)}$	Number of employees in the particular East German establishment (logarithm)

*Variables calculated by the use of cross section weighting factors

The transmission of technology spillovers needs some time to translate into productivity effects. Therefore we use a lag model. The IAB establishment panel allows estimates with a time lag of one (two) years between dependent and independent variables. For reasons of data availability, only the density variable falls into the same year as VAP. The regression has been carried out using longitudinal weighting factors.

Finally, the estimation results both for ROR and federal states do not show the expected positive correlation between the presence of external firms and East German establishments' productivity. Looking at ROR, the presence variable shows a positive sign only in two out of seven estimates. In one case, PRE even turns out to have a negative sign (see table 3). Similar results appear for federal states (see table 4). Here, the presence

variable shows a positive sign in only three cases. In general, the regression results show a rather inconclusive picture, also with respect to the other variables. DEN shows a negative correlation while no significant coefficients could be observed for ADOP and HF. In cases where EXPO and SIZE show a significant coefficient at all, the sign is positive as expected, but overall the picture is rather inconsistent. The coefficient of determination (R^2), lying between 0.1 and 0.2, is rather weak too.

The results become even more instable if the estimates are conducted for the development instead of the absolute level of domestic firms' value added productivity.

Table 3: Estimation results for ROR (signs of the significant coefficients)

Lag structure	**PRE**	DEN	ADOP	HF	EXPO	SIZE	Number of dummies with significant sign	adj. R^2
99 - 98		–				+	2 (+)	0.22
00 - 98		–				+	2 (–) 1(+)	0.22
00 - 99					+		5 (+)	0.19
01 - 99	–	–					2 (–)	0.09
01 - 00	+					+	1 (+)	0.11
02 - 00	+						3 (–) 1 (+)	0.18
02 - 01					+		3 (+)	0.22

Table 4: Estimation results for federal states (signs of the significant coefficients)

Lag structure	**PRE**	DEN	ADOP	HF	EXPO	SIZE	Number of dummies with significant sign	adj. R^2
99 - 98		–				+	2 (+)	0.24
00 - 98		–				+	2 (–) 1(+)	0.23
00 - 99	+	–			+		1 (–) 4 (+)	0.22
01 - 99		–				+	2 (–) 1 (+)	0.10
01 - 00	+					+	1 (+)	0.11
02 - 00	+						3 (–) 2 (+)	0.16
02 - 01					+		3 (+)	0.22

5.2. Investigation for East Germany as a whole

Remains the question whether the presence of external establishments (PRE) turns out to exhibit a positive impact when estimated for East Germany as a whole. Here the analysis has been carried out as a pooled regression basically using the same variables as before plus fixed effects time dummies. Different from the firm specific approach in chapter 5.1, the data of interest is now aggregated on branch level.

Model for East Germany (pooled, unweighted estimate):

$$\begin{aligned} \text{ØVAP}_{i,t} = {} & a_0 + a_1\,\text{PRE}_{i,t-1} + a_2\,\text{DEN}_{i,t} + a_3\,\text{ØADOP}_{i,t-1} \\ & a_4\,\text{HF}_{i,t-1} + a_5\,\text{branch dummy1} + \ldots + \\ & a_{15}\,\text{branche dummy11} + a_{16}\,\text{time dummy1} + \ldots + \\ & a_{18}\,\text{time dummy3} \end{aligned}$$

} controll variables

$\text{ØVAP}_{i,t}$	Average value added productivity of East German establishments by branches*
$\text{PRE}_{i,t-1}$	Share of employment in external establishments in total employment of the cluster*
$\text{DEN}_{i,t}$	Number of establishments in the cluster*
$\text{ØADOP}_{i,t-1}$	Average share of qualified employees in total employment by branches*
$\text{HF}_{i,t-1(2)}$	Herfindahl index by branches*

*Variables calculated by the use of cross section weighting factors

Here again, the estimation results do not show a positive correlation between the presence of external firms and East German establishments' productivity.

Table 5: Estimation results for East Germany as a whole (signs of the significant coefficients)

Lag structure	**PRE**	DEN	ADOP	HF	Number of dummies with significant sign		adj. R^2
					time	branches	
One-year -lag				+		2 (–) 2 (+)	0,65

6. Conclusions

At first glance, the regression results imply that external firms do not induce technology spillovers in favor of East German establishments at all. However, all that can be shown through the regression estimate is that the presence of external investors has no positive impact on domestic firms' overall productivity. Nevertheless, spillovers and synergy effects may exist between external and domestic firms in particular cases. And in face of the fact that there are numerous regional networks and cooperations in East Germany (Günther 2004a) it is reasonable to assume that domestic firms learn from external investors, but it is obviously not a representative process. This finding is in line with several other econometric spillover studies for transition economies as well as structurally weak regions in West European countries (for an overview see e.g. Görg/Greenaway 2001). Nevertheless, the special approach and novelty of this study has been the consideration of clusters and spatial proximity up to *Raumordnungsregionen*, which had to be neglected so far in other studies due to the lack of data. The assumption that an inclusion of linkage-based branch clusters and a much deeper regional breakdown would bring to light spillover effects can, however, not be confirmed for East Germany.

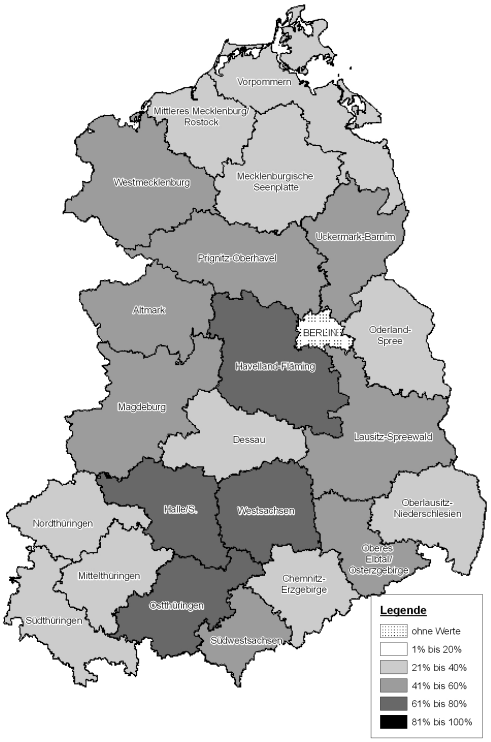
One can conclude that the realization of spillovers between domestic and foreign firms is a very complex process. As mentioned earlier, the assumption of spillover effects as a more or less one-dimensional process (see chapter 4.1.), seems to fall far short and calls for deeper insights into the mechanisms and framework conditions of spillovers. This requires further qualitative research into the subject.

Finally, the more fundamental question whether "foreign capital participation" as such is a crucial determinant of technological progress in catching-up economies at all has to be discussed. Previous studies on related issues suggest that it is not foreigness as such, but several firm specific characteristics such as the availability of R&D, size, or export intensity (transnationality) that induce developmental effects for the whole economy (Bellak 2004), and the latter may be characteristics of domestic firms too. Thus, a change of perspective would possibly lead to new insight and policy recommendations as well. The study shows - once again - that the pure focus on foreign subsidiaries as a significant source of advanced technology and knowledge is too limited.

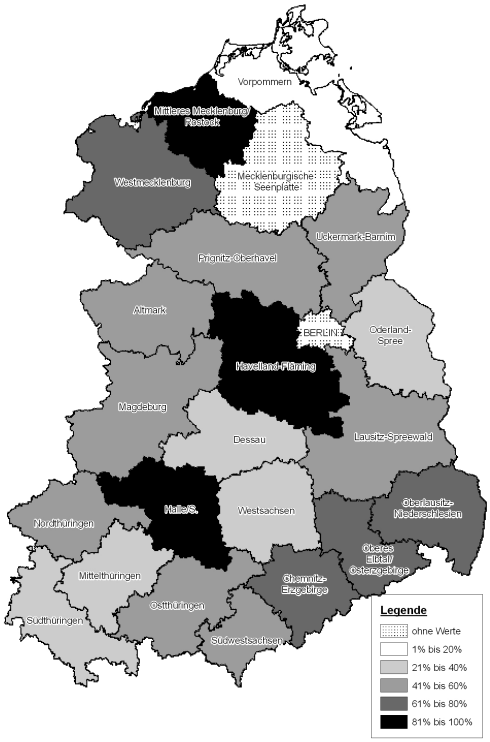
Appendix

Weight of external investors
(percentage share in employment) for each cluster and ROR 2003

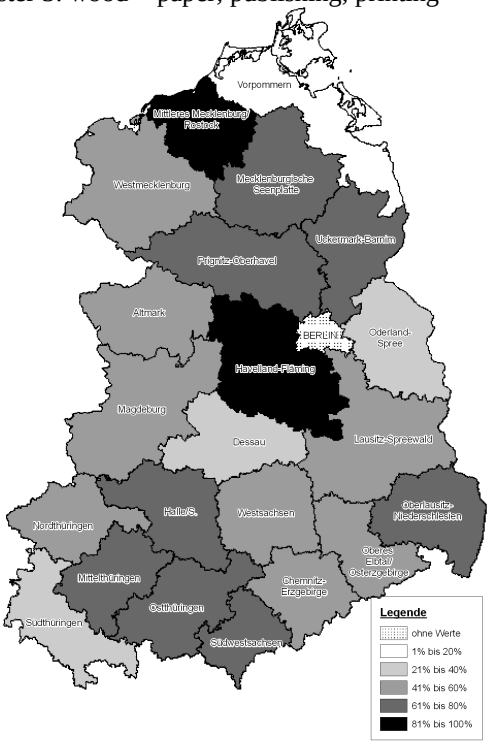
Cluster 1: food, beverages, tobacco



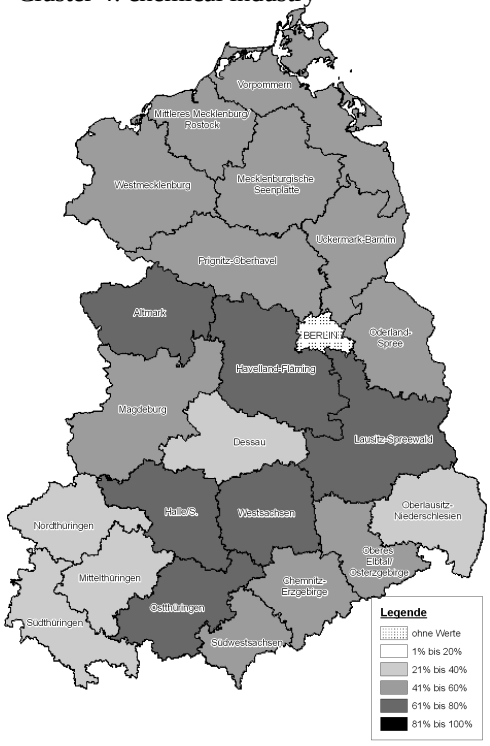
Cluster 2: textiles, textile products, leather



Cluster 3: wood + paper, publishing, printing

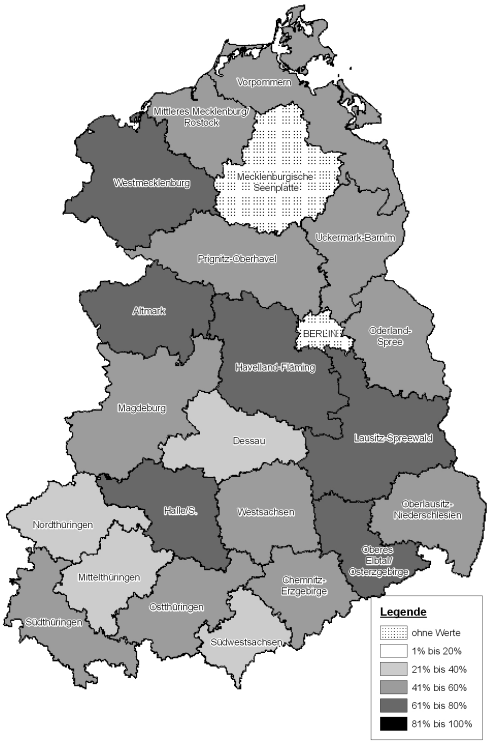


Cluster 4: chemical industry

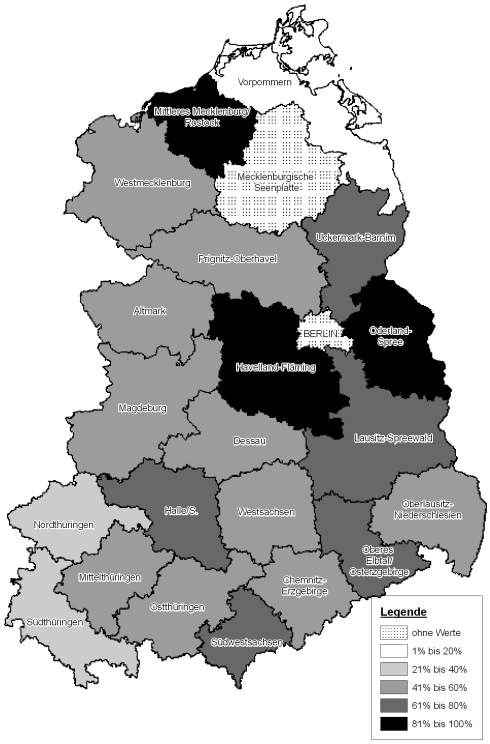


Source: IAB establishment panel 2003

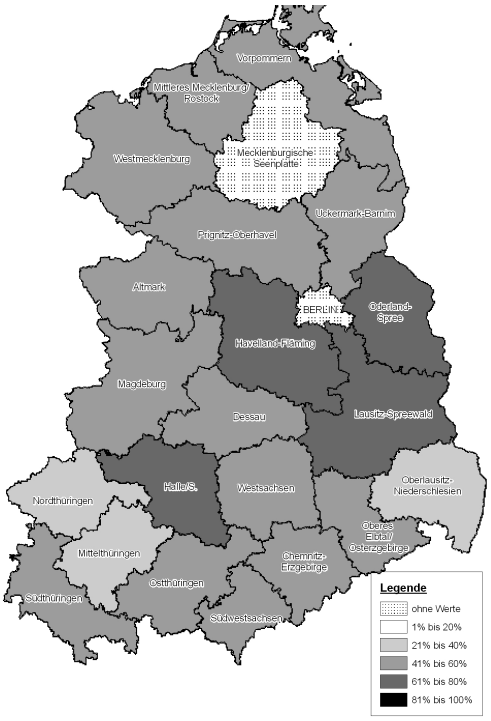
Cluster 5: rubber, plastic products



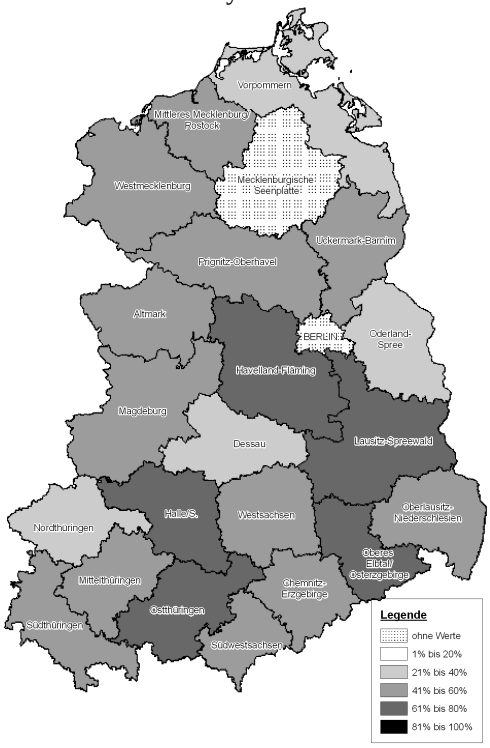
Cluster 6: non-metallic mineral products + recycling



Cluster 7: basic metals + fabricated metal products

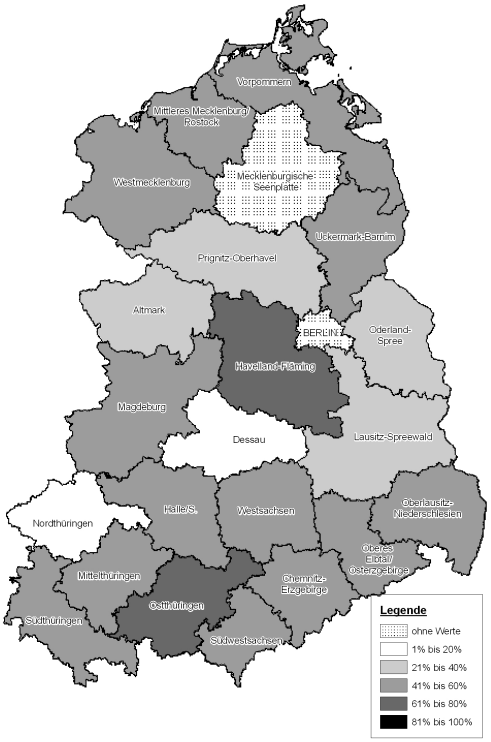


Cluster 8: machinery

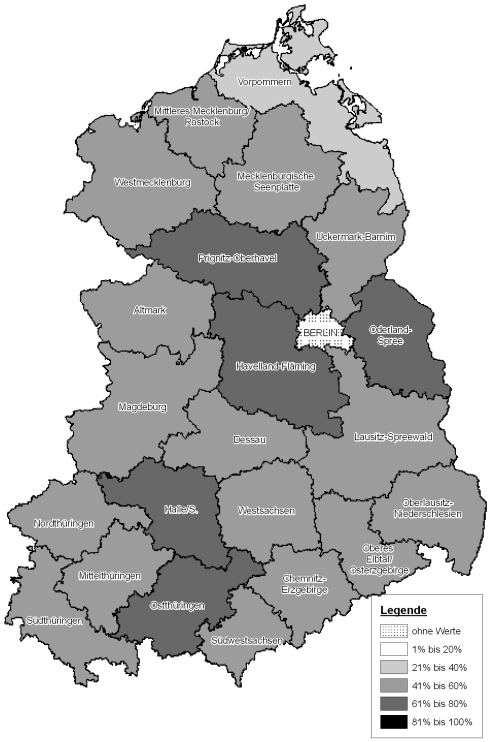


Source: IAB establishment panel 2003

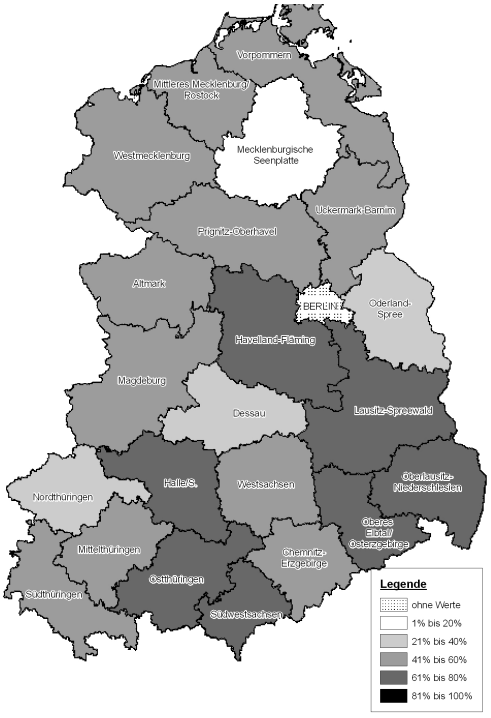
Cluster 9: electronics



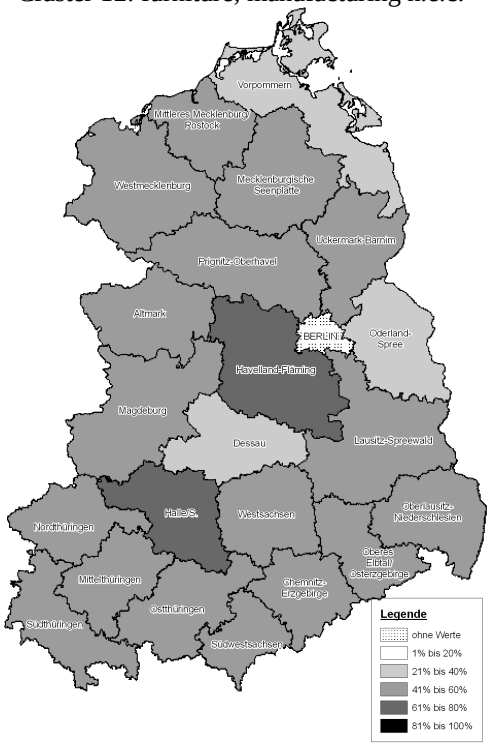
Cluster 10: optical equipment



Cluster 11: automobile + other vehicle construction



Cluster 12: furniture, manufacturing n.e.c.



Source: IAB establishment panel 2003

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