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# Initial conditions and regional performance in the aftermath of disruptive shocks: the case of East Germany after socialism

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## Abstract

We investigate how specific regional conditions found in East Germany at the end of the socialist regime impact development during the turbulent shock transition to a market economy. Both the self-employment rate (an indicator of a pre-socialist entrepreneurial tradition) and the share of the workforce with a university degree (as measure of the general qualification of the workforce) have a strong positive effect on regional development. Our results show that entrepreneurship and knowledge are key regional resources for mastering disruptive historical shocks.

**JEL classification:** L26, R11, N93, N94

## 1. Sources of growth in a transition context

The answer to the question: “What are the determinants of economic growth?” may well depend on historical, social, political, and economic contexts. The most important factors in one context could be much less relevant or even unimportant under different framework conditions (Capello and Nijkamp, 2019; Welter and Baker, 2021). How different contexts impact the relevance of potential drivers of development is, however, largely unexplored. This particularly holds for determinants of growth when entire political and economic systems undergo radical changes.

Taking the unique case of East Germany, this paper investigates the drivers of regional development during the sudden and turbulent shock transformation from an isolated socialist economy to a globally integrated market economy (Sinn and Sinn, 1992; Brezinski and Fritsch, 1995). The socialist East German state, the former German Democratic Republic (GDR), emerged after the Second World War (WWII) in 1949. Forty years later, the GDR was reunited with the West German Federal Republic (FRG) that had a well-developed market economy. The already existing formal institutional framework of West Germany was transferred to East Germany practically overnight (Brezinski and Fritsch, 1995; Hall and Ludwig, 1995) and provoked massive structural changes that triggered an almost complete replacement of incumbent firms. Between 1989 and 1991 the share of manufacturing employment in East Germany dropped from 48.7% to 16.0% (Hall and Ludwig, 1995). As a result, the unemployment rate increased from virtually zero to more than 15% in 1992, which makes the East German transition one of the most dramatic episodes of economic disruption and change during the relatively peaceful years of the late 20th century (Burda and Hunt, 2001).

An interesting feature of the transition context is that measuring the initial conditions present just before a significant historical shock occurred reduces some of the most worrisome endogeneity in the analysis of regional growth. That is, we can rule out that the initial conditions are the outcome of path-dependency and recent market-mediated interactions as the historical shock implied a radical exogenously induced transition. Our key hypothesis, which is largely confirmed in the empirical analysis, is that the initial regional conditions played a key role in coping with such a sudden and fundamental transformation. Specifically, we expect that the regional economic performance after reunification will be positively affected by the self-employment rate and the general qualification of the regional workforce at the end of the socialist period.

Although a number of studies show the importance of entrepreneurship and knowledge for regional growth, we are not aware of an analysis of these factors in the context of a radical transition and disruptive historical shock. A distinctive feature of our approach is that we consider the small number of remaining self-employed people in the GDR at the outset of the transition process to represent a regional culture of entrepreneurship that survived 40 years of anti-entrepreneurial policy intent on eliminating private business ownership. The empirical evidence clearly indicates that the self-employment rate at the end of the socialist regime corresponds to the levels of entrepreneurship in pre-socialist times (e.g., [Fritsch and Wyrwich, 2014](#)). This suggests that informal institutions, such as traditions and “cultures” that are deeply rooted in a region’s history, can significantly shape the “response” of actors to external challenges. In particular, entrepreneurship and a well-qualified workforce contribute to making regions more resilient to severe shocks.

We also account for other potential drivers of regional growth during the transition period, such as agglomeration (measured by population density), industry structure, and the level of investment. A potential shortcoming of our approach is that we are unable to measure the regional capital stock at the end of the socialist period. This omission is, however, rather insignificant given East Germany’s poorly developed infrastructure and outdated machinery, most of which needed to be replaced ([Sinn and Sinn, 1992](#); [Fritsch and Mallok, 2002](#)).

Our results add to studies that confirm a positive role of entrepreneurship and knowledge in economic development.<sup>1</sup> In particular, we show that a well-developed entrepreneurial culture can have positive effects over long periods of time and is able to survive historical episodes of massive anti-entrepreneurial policies. Hence, we also contribute to discussions about the impact of history ([Spolaore and Wacziarg, 2013](#); [Nunn, 2020](#)) and informal institutions ([Beugelsdijk, 2007](#); [Kibler et al., 2014](#)) on economic development. Our analysis also demonstrates the relevance of regional contexts for any empirical analysis of economic development ([Capello and Nijkamp, 2019](#); [Welter and Baker, 2021](#)).

The remainder of the paper is organized as follows. [Section 2](#) discusses our analytical approach and the possible effects of initial conditions on growth in a post-socialist context. [Section 3](#) provides information about the empirical background. In this section, we also provide an overview of differences in the performance of East German regions subsequent to the regime switch in terms of employment and per capita gross domestic product (GDP). [Section 4](#) introduces data, [Section 5](#) presents the results of the empirical analysis, and [Section 6](#) offers a discussion of these results. The final section summarizes and draws implications for research and policy.

## 2. Analytical concept, theory, and hypotheses

### 2.1 Assessing regional growth in a post-socialist transition context

In the context of a fundamental economic transformation from central planning principles to a system driven by a free market, assessing regional growth by using capital and labor as main inputs for a production function ([Audretsch et al., 2006](#); [Mueller, 2006](#); [Capello and Nijkamp, 2019](#)) may not be appropriate. A key issue is that the functional relationships between production input and output are anything but stable when there are fundamental changes to applied

1 See [Fritsch \(2013\)](#) and [Fritsch and Wyrwich \(2017\)](#) for the effect of entrepreneurship in regional development. [Acs et al. \(2009\)](#), [Asheim and Gertler \(2006\)](#), and [Johansson and Karlsson \(2019\)](#) highlight the importance of the regional knowledge base. [Faggian et al. \(2019\)](#) review the role of human capital.

technologies, organizational procedures, the division of labor, and the number and composition of firms.<sup>2</sup> In an environment fraught with high levels of uncertainty and rapidly changing price structures, economic decisions may follow other criteria than in well-established market economies such as West Germany or the USA.

Furthermore, in many centrally planned economies the capital stock was underdeveloped and marked by a high level of depreciation, both of which contributed to the collapse of these systems. This implies that the capital stock in these countries at the outset of the transformation process was more an impediment than a driver of growth (e.g., Kornai, 1992; Vonyo and Klein, 2019). Sinn and Sinn (1992), for example, estimate that the physical production facilities in East Germany at the end of the socialist period were completely worthless and had to be completely replaced to compete in a market economy (“junkyard hypothesis”). This implies that the existing stock of machinery can be more or less ignored when assessing subsequent economic growth.<sup>3</sup> Moreover, the deficient infrastructure, such as roads, railways, public utilities, and nearly non-existent telecommunication networks, created a serious development bottleneck.

The turbulence of the shock transformation and the lack of an economically useful capital stock provoke the question of whether any initial conditions can systematically determine subsequent economic performance. This prompts our empirical approach of relating factors that existed at the advent of the shock transformation to explain the long-term development of regions in a post-socialist environment. The characteristics we examine are truly initial since they existed at the end of the socialist period just before the sudden and exogenous introduction of a fully fledged market economy. Hence, we can rule out that the initial conditions are an outcome of previous market forces and past growth dynamics typical for a well-developed market economy.

## 2.2 Determinants of regional growth in the context of a disruptive shock

The key problem that actors face in a situation with high levels of uncertainty in a fundamentally new economic and institutional environment is to find a productive response. Such a productive response requires entrepreneurship in the sense of Joseph Schumpeter (1934), i.e., introducing something new and acting as an agent of change. While Schumpeter highlighted the role of entrepreneurship as an important driver of growth in general, it is particularly important for economic performance in a transition context (see also McMillan and Woodruff, 2002).

While quite a number of studies find a positive effect of entrepreneurship on regional growth in developed market economies (Fritsch, 2013), this relationship has been left widely unexplored in unstable environments such as a post-socialist transition context (see Berkowitz and DeJong, 2005, as one of the few exceptions). The socialist regimes of Central and Eastern Europe discouraged self-employment, and most private enterprises were either absorbed by the state or carefully controlled (for details, see Pickel, 1992). Again, the example of socialist East Germany vividly exemplifies this paradigm. In 1989, the share of self-employed people in the GDR between the ages of 18 and 64 years was only 1.8% compared to more than about 9% in West Germany (Fritsch and Wyrwich, 2019). The self-employment rates at the end of the socialist regime varied considerably across regions, and this variation corresponds significantly to the regional levels of self-employment before WWII. Given the long-term persistence of the regional structure of self-employment, Fritsch and Wyrwich (2019) conclude that the remaining level of self-employment that survived the socialist regime indicates a regional culture of entrepreneurship and that this culture is a slowly changing informal institution that is resistant to external shocks. This conclusion is based on the idea that individuals who remain self-employed in spite of the obstacles and anti-entrepreneurial propaganda of the socialist regime must have a strong preference for self-employment.<sup>4</sup>

2 For a discussion of fundamental differences between a neoclassical production function and a production function in a centrally planned economy, see Albach (1993).

3 This is largely in line with the conclusions of the secret so-called “Schuerer” report (Schuerer *et al.*, 1989) prepared for the GDR government in the fall of 1989. The report identifies the disastrous condition of the production facilities as one of the causes of poor economic performance. The authors state that production equipment in a number of sectors is badly worn out, resulting in an excessive need for maintenance and repair. Hence, it is fair to say that most of the capital stock was depreciated while investment into new production facilities was more or less absent.

4 Since the communist regime discouraged establishing private businesses, we assume that most of the firms founded early in the transition process were remnants of the pre-socialist period. Hence, the founders were experienced

A defining feature of an entrepreneurial culture is a collective mind-set and high social acceptance of entrepreneurship (Beugelsdijk, 2007; Kibler *et al.*, 2014; Sorenson, 2017). Previous research shows that the level of entrepreneurship that can be attributed to the presence of a local entrepreneurial culture is a critical driver of economic growth (Glaeser *et al.*, 2015; Fritsch and Wyrwich, 2017). One argument for the growth-facilitating impact of an entrepreneurial culture is that it may spur opportunity entrepreneurship rather than necessity entrepreneurship. In the transition context, there was a pronounced “window of opportunity” to start a firm after the collapse of socialism. For example, the high demand for consumer goods that were in short supply under the old regime created a conducive environment for start-ups that filled market niches (Smallbone and Welter, 2001; Fritsch, 2004).

In our transition context, there were more people with an entrepreneurial mind-set in places with significant remnants of self-employment, and it is likely that they proactively used the “window of opportunity” that opened up with the fall of the Iron Curtain. Furthermore, entrepreneurial initiative may make the regional economy more flexible and offer a productive response to external challenges such as severe changes in the socio-economic environment (McMillan and Woodruff, 2002; Fritsch and Wyrwich, 2019), ultimately spurring regional growth. Hence, we expect:

Hypothesis I: The regional share of self-employed people at the end of the communist period is positively related to regional development after the transition.

A second general factor that should have a positive effect on economic performance is the regional knowledge base that we evaluate by examining the qualifications of the regional workforce, innovative activity, and specialization in certain technological fields or industries (Boschma, 2018). Trying to assess what type of regional knowledge might alleviate issues caused by the transition is hampered by the stunted technological development of Eastern European countries that often followed different technological paths than those that became dominant in Western European countries (see, e.g., Bentley, 1992; Radosevic, 1999; Stokes, 2000). East Germany is no exception, and the transition to a market economy required the application of modern technologies in order to become competitive in the global market. As a result, much of the technology-specific knowledge became obsolete and was depreciated by the transition (Hitchens *et al.*, 1993; Fritsch and Mallok, 2002). Hence, we focus on more general (non-specific) knowledge that consists of basic qualifications and the ability to absorb and apply new knowledge.

We use the share of East German workers with a university degree at the transition’s onset to measure the regional knowledge stock. This is based on the assumption that people with a university degree are likely to have a relatively high absorptive capacity to learn and recombine their human capital for productive reuse in a market economy. As human capital theory suggests (Becker, 1962), the level of formal education indicates a higher general level of human capital and prosperity-enhancing productivity, not only at the individual level, but also at the regional level (Faggian *et al.*, 2019; Johansson and Karlsson, 2019).

Hypothesis II: The share of the workforce with a high level of general (i.e., non-specific) knowledge at the end of the communist period is positively related to economic growth after transitioning to a market economy.

The impact of agglomeration economies and diseconomies on regional development in a transition context is unclear. One reason is that market-mediated linkages that foster such externalities are absent in a centrally planned economy. In addition, the infrastructure of cities was in disrepair relative to more peripheral regions. The transition process also involved significant urban adjustments and the relocation of factories. Many large production facilities that

and motivated entrepreneurs because they had resisted the pressures of the socialist state. Given that everyone had a constitutional right to be in dependent employment in socialist countries, we also assume that this entrepreneurship was not driven by the fear of being unemployed.

were located in inner cities were no longer sustainable there because of a market-induced restructuring of land prices (e.g., Berentsen, 1992; Andrusz *et al.*, 1996). Apart from that, there was a general tendency of geographic deconcentration, particularly suburbanization of employment (Suedekum, 2006), in East and West Germany so that population density and employment growth tend to be negatively related in the period of analysis. One factor that may have fueled economic growth in East German urban places is the greater demand for the construction sector that could have created spillover effects to other industries. In sum, there are arguments speaking for a negative link but also arguments for a positive link.

We do not expect the effect of initial regional conditions to remain stable over time. Policy interventions and changes in growth-relevant regional conditions may lessen the effect of initial conditions and the evolution of structural conditions after the regime switch may have increasing importance for regional growth. Apart from that, it could be the case that the effects of initial conditions become visible only after a time lag when the turbulence of the first years of the transition process begins to fade. This “transition noise” includes the complex processes and effects related to the closure or privatization of state-owned enterprises. These complex interactions often led to large employment losses and shaped the development of entire regions. At the same time, it is possible that entrepreneurial culture and knowledge play a particularly important role for re-organizing the creative and effective use of economic resources in periods of high turmoil and change.<sup>5</sup> Hence, we have no firm expectation whether the effect is stable over time.

### 3. Study context: regional development in East Germany after WWII

At the end of the WWII, Germany was divided into four zones, each governed by one of the allied powers. The Western Allies (France, the UK, and the USA) occupied the Western part of the country and soon began the process of rebuilding the FRG (West Germany) into a state based on a market economy. The Soviet Union occupied the Eastern part of the country and installed a centrally planned economy dominated by state-owned enterprises. In 1949, the GDR was founded and absorbed into the Soviet bloc.

The socialist regime in East Germany favored collectivist values and declared entrepreneurship as a bourgeois anachronism (e.g., Pickel, 1992; Thomas, 1996). Hence, it implemented a rigorous anti-entrepreneurship policy strategy that included massive socialization of private enterprises and strict regulation of any remaining private sector activity (for details, see Brezinski, 1987). It is estimated that the socialist regime installed by the Soviets in East Germany caused the exodus of between 9% and 13% of all East German firms<sup>6</sup> and about 25% of the population (mostly well-qualified individuals) migrated from East to West Germany until the border was closed in 1961 (e.g., Becker *et al.*, 2020). The centrally planned GDR economy was inefficient and resulted in a decaying infrastructure with production facilities that were below prevalent technological standards. The consequence was low labor productivity, which, at the end of the 1980s, was just under 30% of the West German level (van Ark, 1995).

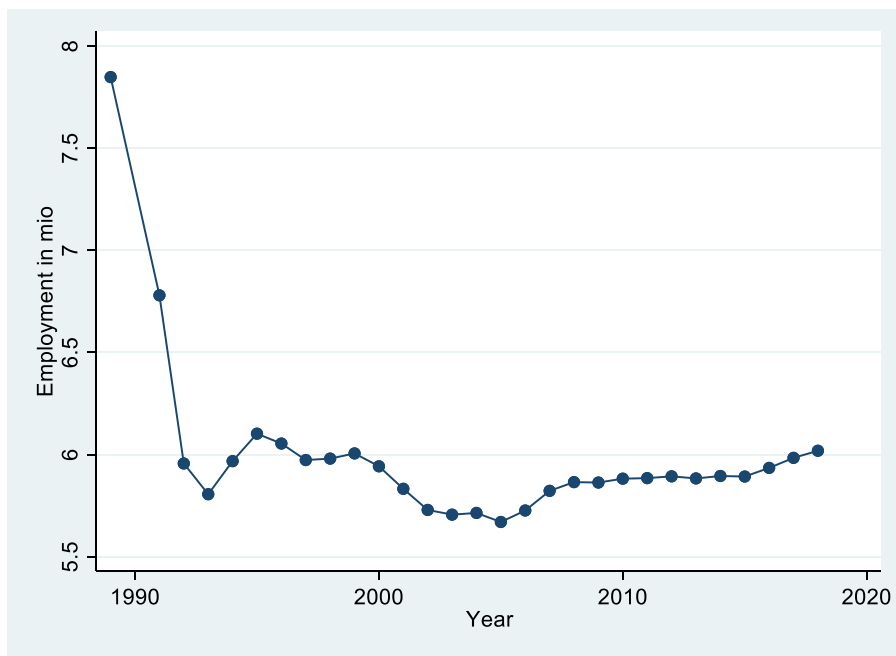
The GDR collapsed in the final months of 1989, and the opening of its western border on November 9, 1989, was the first step of the country's shock transformation to a market economic system. All of a sudden, East German firms had to cope with competitors from the West that usually provided higher-quality products and were seen as a preferable choice by East Germans. The currency union with West Germany on July 1, 1990, induced sharp wage and price increases resulting in the loss of customers from Eastern European countries. Finally, the reunification of the two German states on October 3, 1990, led to a more or less complete transfer of the West German institutional system to East Germany that became effective virtually overnight (Sinn and Sinn, 1992; Brezinski and Fritsch, 1995).

At the end of the socialist period in 1989, the share of self-employed individuals in East Germany between the ages of 18 and 64 years was only 1.8%, compared to about 9% in the western

<sup>5</sup> It could also be the case that the intensity and length of the turmoil depends on the initial regional conditions. Hence, transition noise may play a more important role in regions with unfavorable condition at the advent of transition.

<sup>6</sup> Falck *et al.* (2013) document the impact of the arrival of East German machine tool companies in West Germany after the war, illustrating how regional industry structures were impacted by this exodus.



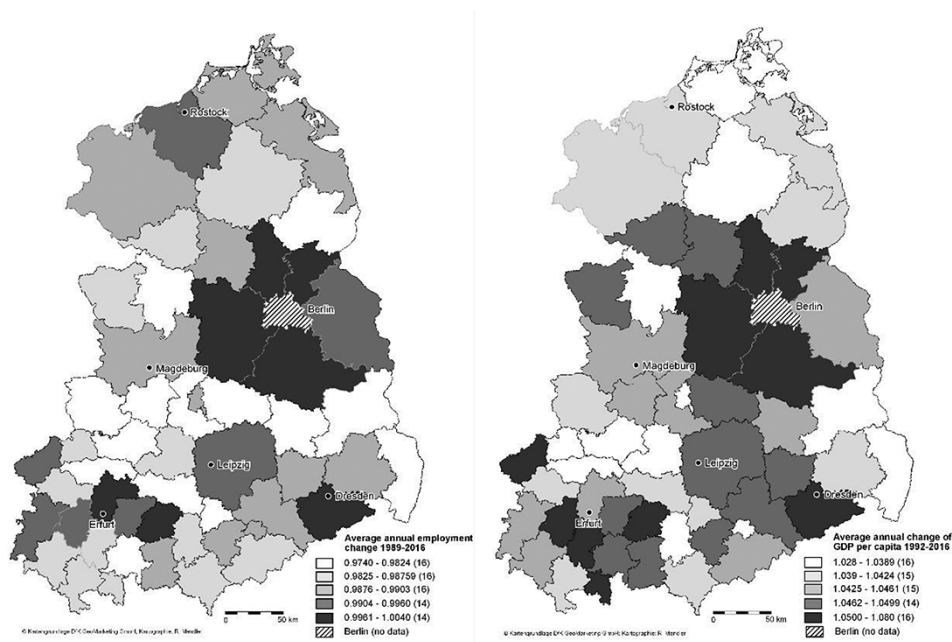


**Figure 1.** Employment development in East Germany (excluding Berlin) between 1989 and 2018

part of the country (Fritsch and Wyrwich, 2019). The private firms that existed in East Germany at that time focused on small trades not suited to inflexible centrally planned state firms. More than half of the self-employed worked in manufacturing trades (*produzierendes Handwerk*) that included repair and small-scale production in sectors such as textiles, engineering, and the light industry. A large segment of the self-employed (21.6%) worked in the service sector, particularly domestic retail and wholesale trade (for details see Wyrwich, 2012). Remarkably, there were pronounced regional differences in the level of remaining self-employment that correspond to historical levels of self-employment before WWII. The regional differences in the share of people that resisted the anti-entrepreneurship policy by remaining self-employed may be regarded an indication of the remnants of a regional tradition and culture of entrepreneurship that is pre-socialist in origin (for a detailed argumentation, see Fritsch and Wyrwich, 2019).

The shock transformation required the instant and fundamental restructuring of East German society. It plunged the East German economy into a deep and long-lasting crisis that is still felt today. The value of production in 1991 fell to 35% of the value achieved in 1989. Sharply rising wages and collapsing demand for East German products forced nearly all firms to severely reduce labor input or to close down, resulting in skyrocketing unemployment rates. The number of people employed in the former GDR declined from 7.8 million in 1989, to 5.8 million in 1993 (Figure 1). Although many new businesses were established (Fritsch *et al.*, 2022), they could not compensate for the employment losses. Despite a variety of publicly funded support programs, the economy in the former GDR has not completely recovered from these shocks. Nearly three decades later, the former GDR's economic performance measured by labor productivity is about 80% of the level in the former FRG. Innovative activity is considerably weaker in the East, and the share of exports abroad is also lower than that in the former FRG (IWH, 2019).

There are huge regional differences in these developments (Figure 2). While some East German regions such as Dresden, Jena, and Leipzig show relatively strong growth, many other mostly rural areas (e.g., the areas south of Magdeburg, northeast of Dresden, and in the North) fall far behind. Strong positive regional spillover effects can be found for the city of Berlin. Some large investments made by Western firms after reunification tended to be concentrated in only a few industries that existed in well-established locations (e.g., automotive and chemical) and created very few regional development trends (IWH, 2019).



**Figure 2.** Average annual employment change 1989–2016 (left) and average annual change of GDP per capita 1992–2016 (right) in East German regions

#### 4. Data and definition of variables

The spatial framework of our analysis is based on labor market regions that are defined by NUTS3 codes ([Bundesinstitut für Bau-, Stadt- und Raumforschung \(BBSR\), 2012](#)) and represent functionally integrated spatial units with interwoven commuting patterns. We exclude Berlin from our analysis because of its unique occupation pattern.<sup>7</sup>

We analyze two dependent variables that describe regional development. The first measure is the average annual rate of employment change between September, 1989, and the year 2016. Employment data for East Germany in 1989 are from the Statistical Office of the GDR ([Rudolph, 1990](#)).<sup>8</sup> The second measure of regional development is the average annual growth rate of GDP per capita based on data of the statistical offices ([Statistische Ämter des Bundes und der Länder, 2019](#)). Our GDP data begin in 1992, because this is the first-year regional GDP figures are available for East and West German regions. While regional GDP per capita is a measure of regional wealth, employment is directly linked to the regional population's economic opportunities and does not necessarily imply high income.

Information on regional conditions across East German regions stems from the official employment and population figures of the GDR Statistical Offices as of September 30, 1989 (see [Rudolph, 1990](#), [Kawka, 2007](#), for a detailed data description).<sup>9</sup> Hence, our data on regional conditions are taken from a point in time where transition-induced turbulence was not yet present. In fact, our data reflect a snapshot of conditions immediately before turmoil kicked

<sup>7</sup> Since Berlin was divided into four occupation zones, only the Soviet-occupied part, East Berlin, belonged to the GDR. The other three occupation zones in Berlin, West Berlin, were given a special status and were closely linked to the West German Federal Republic both economically and politically. Since German unification in 1990, there are no reliable separate statistics for the economic situation in East and West Berlin (which would not be meaningful given the extensive integration of both parts). For this reason, Berlin is excluded in the empirical analyses.

<sup>8</sup> The employment data are not likely to have been falsified as was the case with the official productivity statistics ([Kawka, 2007](#)).

<sup>9</sup> Since administrative borders of the regions have changed since 1989, we used information adjusted to current borders as in [Kawka \(2007\)](#) and based on own calculations.



in. Although, mass demonstrations in early October led to the fall of the Berlin Wall on November 9, 1989, no one expected that German reunification would occur the following year and significantly change the framework conditions for start-up activity.<sup>10</sup>

To test Hypothesis I, we use the *self-employment rate* to represent the regional tradition or “culture” of entrepreneurship. It is measured as a ratio of the number of self-employed over the population between the ages of 18 and 64 years. To test Hypothesis II, we use the *share of employees with a university degree* over total regional employment to represent the general regional knowledge base. In a robustness check (Section 5.2), we use the number of patent applications per employee as an alternative measure of the regional knowledge base.<sup>11</sup>

We control for several other initial conditions across regions present on September 30, 1989. There were significant differences in regional industry structures before the fall of the Berlin Wall. Certain industries may be more vulnerable to the turbulence of the transition (Rudolph, 1990; for details on the transition shock for the economy, see Section 3). To address this concern, we control for:

- the *share of employees in manufacturing* to capture general economic structure at the end of socialist period and
- the *share of employees in large-scale manufacturing industries in total manufacturing employment* which indicates the composition of the local manufacturing sector.

We consider the regional employment shares in the chemical and energy sectors as large-scale industries since these industries may be particularly vulnerable to economic decline after 1990 as compared to other manufacturing industries, because of the difficulty competing with similar West German firms (Rudolph, 1990). Moreover, we run a robustness check where we include the employment shares in the nine local industry groups that we can distinguish in our data.<sup>12</sup>

Industry structure may also indirectly affect growth spurred by entrepreneurship. Because entry barriers in manufacturing are relatively high when compared to other industries (e.g., Geroski, 1995), we use the regional share of employees in manufacturing to capture this aspect. A stylized fact of empirical research also suggests that people working in small firms have a higher propensity to start an own business than people working in large firms (e.g., Parker, 2009; Elfenbein et al., 2010). We also control for *agglomeration (dis-) economies* measured by population density: the regional population divided by the area in square kilometers. This measure is included in order to account for diverse characteristics of the regional environment such as land prices, size of local markets, availability of inputs, etc. As previously noted, the role of agglomeration for regional growth in a post-socialist transformation environment is unclear (see Section 2.2).

As already mentioned in Section 2.1, a valuation of the regional capital stock in East Germany at the end of the socialist period is not appropriate. However, in order to control for post-unification capital inputs, some of the models in our robustness checks include measures for the *average investment among manufacturing firms in the year 1995*<sup>13</sup> and estimates for the *regional capital stock in 1996*.<sup>14</sup> Since capital inputs may be an outcome of initial regional conditions (hen-egg problem), our preferred estimates are those without post-unification capital

10 It is not possible to consider 1988 as a reference year because of a lack of data availability.

11 The patent data are taken from the Organisation for Economic Co-operation and Development RegPat database. For a description of the RegPat data see Maurat et al. (2008). Another indicator for regional knowledge may be the presence of research institutes and/or universities. The East German sectors of education and research were, however, radically reorganized in the early years of the transition process in order to integrate it into the West German system. This reorganization resulted in the closure of a number of institutions and a massive reduction in resources, including personnel and funding. In the first years after transition, research and development employment decreased, on average, by 20%–50% of what it was under communism (Meske, 2000). For this reason, regional institutions of education and research that existed at the end of the socialist period may not have a lasting effect on development after reunification.

12 The nine sectors are construction, energy, chemicals, metalworking, mechanical engineering, light industry, textiles, food and beverages, and others (agriculture, services, and public sector). Manufacturing employment is defined as total employment minus construction and “other” sectors.

13 Data are from the Federal Statistical Office. <https://www.destatis.de>.

14 Data on the regional capital stock in the year 1996 are estimates of the Halle Institute for Economic Research. For a brief description, see Kubis et al. (2008).

**Table 1.** Initial conditions and employment change 1989–2016 in East German regions

| Dependent variable: average annual employment change 1989–2016         | (1)                 | (2)                 | (3)                  | (4)                  |
|--|---------------------|---------------------|----------------------|----------------------|
| Self-employment rate 1989  | 0.016***<br>(0.005) | 0.014***<br>(0.005) | 0.019***<br>(0.003)  | 0.016***<br>(0.003)  |
| Share of employees with university degree 1989                         | 0.013***<br>(0.003) | 0.013***<br>(0.002) | 0.010***<br>(0.003)  | 0.009***<br>(0.002)  |
| Employment 1989  | 0.001<br>(0.002)    | 0.001<br>(0.002)    | –0.024***<br>(0.005) | –0.025***<br>(0.005) |
| Share of employees in manufacturing 1989                               | –0.006<br>(0.005)   | –0.006<br>(0.004)   | 0.002<br>(0.004)     | 0.003<br>(0.004)     |
| Share of large-scale industries in total manufacturing employment 1989 |                     | –0.001<br>(0.001)   |                      | –0.002*<br>(0.001)   |
| Population density 1989  | 0.003<br>(0.002)    | 0.002<br>(0.002)    | –0.001<br>(0.002)    | –0.002<br>(0.002)    |
| Average investment among manufacturing firms 1995                      |                     |                     | –0.001<br>(0.002)    | –0.001<br>(0.001)    |
| Capital stock 1996   |                     |                     | 0.022***<br>(0.005)  | 0.023***<br>(0.004)  |
| Federal State fixed effects  | Yes***              | Yes***              | Yes***               | Yes***               |
| Constant   | 0.064<br>(0.041)    | 0.049<br>(0.040)    | 0.321***<br>(0.061)  | 0.316***<br>(0.055)  |
| R <sup>2</sup>   | 0.617               | 0.632               | 0.756                | 0.782                |

Ordinary least squares (OLS) regressions with 53 observations (labor market regions); robust standard errors in parentheses.

\*\*\*: statistically significant at the 1% level;

\*\*: statistically significant at the 5% level;

\*: statistically significant at the 10% level.

inputs. Finally, we include dummies for Federal States to capture common characteristics (e.g., local policy) of neighboring labor market regions. The fixed effects for Federal States also control for the proximity of a region to the city of Berlin. This controls for the possibility that Berlin is an important source of development spillovers. Table A1 in the Appendix reports descriptive statistics for the variables in the analysis and Table A2 shows the correlations.

## 5. Empirical analysis

### 5.1 The role of initial conditions in East Germany

Table 1 shows the results of ordinary least squares (OLS) regressions for the relationship between regional initial conditions in 1989 and the employment change between 1989 and 2016. While all variables in models 1 and 2 reflect the conditions in the final year of the GDR, we include indicators for capital inputs during the transition process in models 3 and 4. As previously mentioned, the remaining capital stock of the GDR was in extremely bad shape (Sinn and Sinn, 1992), so that it is implausible that it contributed to development trends during transition. Nevertheless, we want to control for concomitant investment during the early transition phase.<sup>15</sup>

In line with our expectations, the relationship between employment change with the level of self-employment and the share of employees with a university degree in 1989 is positive and statistically significant. The employment share in large-scale industries is only weakly significant in model 4, where we control for capital inputs. While the average investment among manufacturing firms remains statistically insignificant, we find significantly positive coefficients for the estimates of the regional capital stock in 1996. Inclusion of the two variables for capital inputs leads to a slight decrease in the still highly significant coefficients for workforce qualification at

15 An assessment of spatial dependence in accordance with the test procedure proposed by Florax *et al.* (2003) reveals that neither a spatial lag nor spatial error model is appropriate. For spatial error models the *P*-value is never below 0.3 while for spatial lag models the lowest *P*-value is 0.17. For most models *P*-values float around the values 0.5–0.9.

**Table 2.** Initial conditions and change of GDP per capita 1992–2016 in East German regions

| Dependent variable: average annual change of GDP per capita 1992–2016  | (1)                  | (2)                  | (3)                  | (4)                  |
|--|----------------------|----------------------|----------------------|----------------------|
| Self-employment rate 1989  | 0.019***<br>(0.006)  | 0.018***<br>(0.006)  | 0.017***<br>(0.006)  | 0.015**<br>(0.007)   |
| Share of employees with university degree 1989                         | 0.020***<br>(0.005)  | 0.020***<br>(0.005)  | 0.018***<br>(0.005)  | 0.018***<br>(0.005)  |
| GDP level 1992   | -0.026***<br>(0.008) | -0.025***<br>(0.008) | -0.033***<br>(0.008) | -0.033***<br>(0.008) |
| Share of employees in manufacturing 1989                               | 0.006<br>(0.005)     | 0.006<br>(0.005)     | 0.006<br>(0.006)     | 0.006<br>(0.006)     |
| Share of large-scale industries in total manufacturing employment 1989 |                      | -0.001<br>(0.002)    |                      | -0.001<br>(0.002)    |
| Population density 1989  | -0.001<br>(0.002)    | -0.002<br>(0.002)    | -0.002<br>(0.002)    | -0.002<br>(0.002)    |
| Average investment among manufacturing firms 1995                      |                      |                      | -0.003<br>(0.002)    | -0.003<br>(0.002)    |
| Capital stock 1996   |                      |                      | 0.004<br>(0.002)     | 0.004*<br>(0.002)    |
| Federal State fixed effects  | Yes***               | Yes***               | Yes***               | Yes***               |
| Constant   | 0.081*<br>(0.043)    | 0.077*<br>(0.041)    | 0.038<br>(0.053)     | 0.029<br>(0.052)     |
| R <sup>2</sup>   | 0.557                | 0.563                | 0.591                | 0.599                |

OLS regressions with 53 observations (regions); robust standard errors in parentheses.

\*\*\*: statistically significant at the 1% level;

\*\*: statistically significant at the 5% level;

\*: statistically significant at the 10% level.

the end of the socialist period and to a moderate increase of the  $R^2$  value of 0.135 and 0.146, respectively. Population density in 1989 remains statistically insignificant in all models. Note that the correlation coefficient between population density and the share of employees with a university degree in East Germany is 0.433 (Table A2a in the Appendix). The low level of this statistical relationship clearly suggests that there is very little if any multicollinearity between the two variables that might cause an underestimation of the role of agglomeration economies.<sup>16</sup> Federal State fixed effects are highly significant in all models.

Models that include GDP growth between 1992 and 2016 (Table 2) lead to rather similar results. Both the self-employment rate and the share of employees with a university degree in 1989 are highly significant with a positive sign. The highly significant negative coefficients for GDP per capita in 1992 indicate the common convergence phenomenon that regions with low levels show higher growth rates. The indicators for industry structure and population density in 1989 remain insignificant. Also, the effects for the two measures for capital inputs are hardly significant (models 3 and 4), while the Federal State dummies are again highly significant.

The estimates confirm our two basic hypotheses that the main drivers of growth in East German regions during the transition period are the initial conditions of remaining self-employment and the general qualification level of the regional workforce measured moments before the GDR collapsed.

We run several robustness checks. First, we replace the employment share of manufacturing and large-scale industries by the employment shares of nine industries in order to rule out that our measure for entrepreneurial culture rather reflects industry differences with respect to the scope of self-employment (e.g., differences in market entry barriers after 1989). The results shown in Table A5 in the Appendix reveal that this fine-grained assessment of industry structures does not affect the impact of the self-employment rate in 1989. However, the general qualification level of

<sup>16</sup> Running the models shown in Tables 1 and 2 without population density does not lead to any meaningful changes of statistical significance and coefficient size for the share of employees with a university degree. Results are presented in Tables A3 and A4 in the Appendix.

the regional workforce becomes insignificant in the GDP regressions. This comes as no surprise as the required skill level is likely to vary across industries. The results of our basic models are robust for entrepreneurial culture and knowledge when removing the regions adjacent to Berlin to assuage concerns that there are specific Berlin effects driving our findings (Table A6).

Our results are also largely robust when running the baseline models for the sub-periods 1989/1992–2000, 1989/1992–2008, and 2000–2016. The coefficient estimates are strongest for the first sub-period and get smaller when including later years (Tables A7–A12 in the Appendix). This suggests that the initial levels of entrepreneurship and general knowledge play a particularly important role in periods of economic turmoil. Furthermore, the persistent annual growth effect of the initial self-employment rate and the share of highly qualified employees imply that the total growth effect of these factors becomes larger when extending the time period (see Table A13 in the Appendix). It is remarkable that a statistically significant effect of initial conditions on growth can be observed over a period of almost 30 years.

## 5.2 Robustness check: patenting as measure for regional knowledge

In the previous section, we measured the regional knowledge base as the share of employees with a university degree in Eastern German regions in 1989. We argued that this indicator reflects the share of the workforce with an above-average absorptive capacity and ability to cope with the challenges of a radical transition. In particular, this general qualification level may be more relevant than specialized and technology-specific knowledge that may have become obsolete when new technologies were introduced.

To test this expectation, we run the analysis using a measure of regional patenting activity (patents per employee) instead of the share of employees with a university degree (Table 3, panels A and C). This is based on the assumption that regional patenting activity reflects a more technology-specific knowledge. Since both measures are correlated, we ran regressions with both measures as a “horse race” regression (Table 3, panels B and D).<sup>17</sup> We find that patenting activity in East Germany at the end of the socialist regime is not significantly related to employment change or GDP growth in any of our empirical models (Table 3). This confirms our expectation that technology-specific knowledge was not of significant relevance for successfully coping with the challenges of transition.

## 5.3 Extension: a comparison with the well-established West German economy

Our models show that initial conditions in terms of entrepreneurship and knowledge play an important role for regional development in the turbulent times of a transition from a planned socialist economy to a market-based system in East Germany. This provokes the question whether the impact of entrepreneurship and knowledge is stronger as compared to their impact in the framework of a well-established market economy. Since German reunification had little impact on the West German economy, we can explore this pattern by running our models for both parts of the country.<sup>18</sup> The German case is well-suited for such a comparison because after reunification both parts of the country are subject to basically the same institutional frameworks. At the same time, East and West Germany are characterized by rather different developments and structural characteristics. Our idea of this extension is to demonstrate how the effects of entrepreneurship and general workforce qualification differ between the context of a stable market economy (West Germany) versus a turbulent transition environment (East Germany). Hence, we regard West Germany as an appropriate “control group” for such a test because of

<sup>17</sup> The correlation for East Germany is  $r = 0.61$ .

<sup>18</sup> It should be noted that reunification hardly had any negative effects on the West German economy and did not create any significant need for structural adjustments. It is, on the one hand, true that the German government transferred enormous amounts of money to the East that created a financial burden for West German citizens and firms. On the other hand, this financial burden was partly compensated by the additional demand of the East German population for Western products, as well as by the demand of East German firms and administration for machinery and the reconstruction of East German infrastructures. Moreover, in the first years after reunification a significant migration of relatively young and well-educated East Germans to the West benefited the booming West German economy.

**Table 3.** Initial conditions and change of employment/GDP per capita 1989/1992–2016 in East German regions including patenting activity

| Dependent variable: average annual employment change 1989–2016        | (1)                             | (2)                             | (3)                             | (4)                             |
|---|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| Panel A   |                                 |                                 |                                 |                                 |
| Self-employment rate 1989   | 0.012 <sup>***</sup><br>(0.004) | 0.009 <sup>**</sup><br>(0.005)  | 0.016 <sup>***</sup><br>(0.003) | 0.013 <sup>***</sup><br>(0.003) |
| Patents per employee 1989   | –0.000<br>(0.001)               | –0.000<br>(0.001)               | –0.000<br>(0.001)               | 0.000<br>(0.001)                |
| Further variables   | Model (1)<br>Table 1            | Model (2)<br>Table 1            | Model (3)<br>Table 1            | Model (4)<br>Table 1            |
| R <sup>2</sup>  | 0.482                           | 0.504                           | 0.682                           | 0.718                           |
| Panel B   |                                 |                                 |                                 |                                 |
| Self-employment rate 1989   | 0.016 <sup>***</sup><br>(0.004) | 0.014 <sup>***</sup><br>(0.005) | 0.019 <sup>***</sup><br>(0.003) | 0.016 <sup>***</sup><br>(0.003) |
| Share of employees with a university degree 1989                      | 0.014 <sup>***</sup><br>(0.003) | 0.013 <sup>***</sup><br>(0.003) | 0.010 <sup>***</sup><br>(0.003) | 0.009 <sup>***</sup><br>(0.002) |
| Patents per employee 1989   | –0.001<br>(0.001)               | –0.001<br>(0.001)               | –0.001<br>(0.001)               | –0.000<br>(0.001)               |
| Further variables   | Model (1)<br>Table 1            | Model (2)<br>Table 1            | Model (3)<br>Table 1            | Model (4)<br>Table 1            |
| R <sup>2</sup>  | 0.629                           | 0.639                           | 0.761                           | 0.784                           |
| Dependent variable: average annual change of GDP per capita 1992–2016 |                                 |                                 |                                 |                                 |
| Panel C   |                                 |                                 |                                 |                                 |
| Self-employment rate 1989   | 0.016 <sup>***</sup><br>(0.006) | 0.014 <sup>**</sup><br>(0.006)  | 0.013 <sup>**</sup><br>(0.006)  | 0.011 <sup>*</sup><br>(0.006)   |
| Patents per employee 1989   | 0.000<br>(0.001)                | 0.001<br>(0.001)                | 0.000<br>(0.001)                | 0.001<br>(0.001)                |
| Further variables   | Model (1)<br>Table 2            | Model (2)<br>Table 2            | Model (3)<br>Table 2            | Model (4)<br>Table 2            |
| R <sup>2</sup>  | 0.377                           | 0.390                           | 0.451                           | 0.471                           |
| Panel D   |                                 |                                 |                                 |                                 |
| Self-employment rate 1989   | 0.019 <sup>***</sup><br>(0.006) | 0.018 <sup>***</sup><br>(0.006) | 0.016 <sup>**</sup><br>(0.006)  | 0.015 <sup>**</sup><br>(0.007)  |
| Share of employees with a university degree 1989                      | 0.020 <sup>***</sup><br>(0.005) | 0.020 <sup>***</sup><br>(0.005) | 0.019 <sup>***</sup><br>(0.005) | 0.018 <sup>***</sup><br>(0.005) |
| Patents per employee 1989   | –0.000<br>(0.001)               | –0.000<br>(0.001)               | –0.000<br>(0.001)               | –0.000<br>(0.001)               |
| Further variables   | Model (1)<br>Table 2            | Model (2)<br>Table 2            | Model (3)<br>Table 2            | Model (4)<br>Table 2            |
| R <sup>2</sup>  | 0.560                           | 0.564                           | 0.593                           | 0.600                           |

OLS regressions with 53 observations (regions); robust standard errors in parentheses.

\*\*\*: statistically significant at the 1% level.

\*\*: statistically significant at the 5% level.

\*: statistically significant at the 10% level.

the structural differences that result from the different treatments to which the two parts of the country were exposed in the 40 years of separation.

Because of the depreciation of technology-specific knowledge in the East (Berentsen, 1992; Sinn and Sinn, 1992; Radosevic, 1999), there are good reasons to assume that the regional knowledge stock will have a stronger impact in West Germany. Assessing the differential impact of entrepreneurship in West Germany is more difficult because the self-employment rate in 1989 is less likely to measure an entrepreneurial culture as compared to the case of East Germany. In the West German context, self-employment in 1989 comprises a significant share of necessity entrepreneurship that is induced by unemployment or the threat thereof. In contrast and as discussed earlier, remaining self-employed under socialism indicates a relatively strong

entrepreneurial orientation given the strict anti-entrepreneurial stance in the former GDR. Thus, we expect that the self-employment rate plays a much more positive role for subsequent growth in the East German context. Furthermore, because reunification had only a slight impact on the West German economy, entrepreneurship is less likely to be a crucial resource for determining the trajectory of future development as compared to transition economies where entrepreneurs were central agents of mastering the radical changes in the economy (McMillan and Woodruff, 2002).

We ran our models for East and West German regions together, including interaction terms for all regional conditions in 1989, with a dummy variable that assumes the value of 1 for regions located in East Germany and 0 otherwise. For the sake of brevity, we only report the results for the self-employment rate in 1989 and the share of employees with a university degree. While the coefficients of the self-employment rate and the share of employees with a university degree indicate the role of these factors in West Germany, the coefficients of the interaction terms represent the differences in the effect of these factors between East and West Germany.

While the regional conditions, in terms of self-employment rate and share of employees with university degree, are statistically significant for employment change in both parts of the country, the relatively high and statistically significant coefficients of the interaction terms clearly indicate particularly high relevance for East German regions (Table 4, panel A). Quite remarkably, the coefficients that represent the effect of the 1989 self-employment rate in West Germany for subsequent GDP growth (Table 4, panel B) are not statistically significant, while the effect of self-employment (coefficient of the basic variable plus the interaction term) is clearly positive in East German regions. This result is not surprising, because as mentioned earlier, the self-employment rate in the East in 1989 clearly measures entrepreneurship culture and entrepreneurial potential at the moment of transition, while a considerable part of self-employment captured by the respective rate in West Germany may reflect necessity-based firms.

While the regional knowledge base is positively related to employment change and GDP growth in East Germany, this relationship is not statistically significant for West Germany in models 3 and 4 where variables for the capital stock are included as controls. This result may suggest that the stock of knowledge in established market economies is related to and shaped by capital investment. In any case, what the results do show is that, in contrast to our expectations, our measure for regional knowledge does not have a stronger effect on employment change and GDP growth in West Germany. It appears that knowledge is a crucial factor in Eastern Germany, despite the depreciation of considerable parts of the knowledge stock over the course of transition. This is in line with our argument that the share of people with a high general level of human capital is conducive for regional development despite the depreciation of the knowledge stock in the face of a disruptive shock transition.<sup>19</sup>

## 6. Discussion

The results of our analysis clearly demonstrate the relevance of initial conditions, specifically the levels of entrepreneurship and knowledge, for regional growth in East Germany during the shock transformation from a socialist planned economy to a market-based economy. Measuring the initial conditions just before a significant historical shock and in the context of a sudden transition reduces certain endogeneity issues in the analysis of regional growth. In this context, the initial conditions cannot be the outcome of path-dependency and recent market-mediated interactions as the historical shock implied a radical exogenously induced transition of the economic system.

Both measures of initial conditions, the regional self-employment rate at the end of the socialist period in the year 1989 as well as the share of workforce with a university degree, have a significantly positive effect on regional development over a time period of 26 years. The self-employment rate in the context of a socialist regime is more reflective of an entrepreneurial culture and tradition than is the case in West Germany (for details, see Section 5.2,

<sup>19</sup> The results are robust when additionally introducing a dummy variable indicating regions adjacent to the former inner German border and interacting this variable with the East-West-dummy (see Table A15 in the Appendix). These variables capture border-specific effects caused by German separation and re-unification (e.g., Redding and Sturm, 2008). Interestingly, there is a negative border effect for West German regions and an overall positive effect for East German regions in most models.



**Table 4.** Regional conditions 1989 and change of employment/GDP per capita 1989/1992–2016 in East and West German regions

| Dependent variable: average annual employment change 1989–2016               | (1)                     | (2)                     | (3)                     | (4)                     |
|--|-------------------------|-------------------------|-------------------------|-------------------------|
| Panel A  |                         |                         |                         |                         |
| Self-employment rate 1989  | 0.004<br>(0.003)        | 0.004<br>(0.003)        | 0.005*<br>(0.003)       | 0.006**<br>(0.003)      |
| Self-employment rate 1989 X East (Yes = 1)                                   | 0.012**<br>(0.005)      | 0.010*<br>(0.005)       | 0.014***<br>(0.004)     | 0.010**<br>(0.004)      |
| Share of employees with a university degree 1989                             | 0.003**<br>(0.001)      | 0.003**<br>(0.001)      | 0.002<br>(0.001)        | 0.002<br>(0.001)        |
| Share of employees with a university degree 1989 X East (Yes = 1)            | 0.010***<br>(0.003)     | 0.010***<br>(0.003)     | 0.008***<br>(0.003)     | 0.008***<br>(0.003)     |
| Further variables X East (Yes = 1)   | Model (1)               | Model (2)               | Model (3)               | Model (4)               |
| R <sup>2</sup>   | Table 1&2<br>0.788      | Table 1&2<br>0.791      | Table 1&2<br>0.815      | Table 1&2<br>0.819      |
| <i>Dependent variable: average annual change of GDP per capita 1992–2016</i> |                         |                         |                         |                         |
| Panel B  |                         |                         |                         |                         |
| Self-employment rate 1989  | -0.006<br>(0.005)       | -0.005<br>(0.005)       | -0.003<br>(0.005)       | -0.002<br>(0.004)       |
| Self-employment rate 1989 X East (Yes = 1)                                   | 0.025***<br>(0.007)     | 0.022***<br>(0.008)     | 0.020***<br>(0.007)     | 0.017**<br>(0.008)      |
| Share of employees with a university degree 1989                             | 0.004***<br>(0.002)     | 0.005***<br>(0.002)     | 0.002<br>(0.002)        | 0.002<br>(0.002)        |
| Share of employees with a university degree 1989 X East (Yes = 1)            | 0.016***<br>(0.005)     | 0.015***<br>(0.005)     | 0.017***<br>(0.005)     | 0.016***<br>(0.005)     |
| Further variables X East (Yes = 1)   | Model (1)               | Model (2)               | Model (3)               | Model (4)               |
| R <sup>2</sup>   | Tables 1 and 2<br>0.635 | Tables 1 and 2<br>0.641 | Tables 1 and 2<br>0.668 | Tables 1 and 2<br>0.677 |

Notes: OLS regressions with 256 ( $N = 53$ : East;  $N = 203$ : West) observations (regions); robust standard errors in parentheses.

\*\*\*: statistically significant at the 1% level;

\*\*: statistically significant at the 5% level;

\*: statistically significant at the 10% level. For full results see Table A14 in the Appendix.

and Wyrwich, 2012), and the share of workers with a university degree reflects a more general level of human capital, rather than the technology-specific knowledge stock that depreciated over the course of transition (e.g., Bentley, 1992; Radosevic, 1999; Stokes, 2000). These relationships are rather robust for different sub-periods and specifications. Quite remarkably, we find that the impact of initial conditions becomes slightly stronger over time. Indicators of the regional industry structure in the year 1989 remain insignificant. Population density as an indicator for agglomeration effects is slightly significant in only a few models and, hence, does not seem to play an important role. The latter finding is not surprising given the fundamental urban adjustment processes in the aftermath of transition, which make it unlikely that growth-promoting agglomeration externalities occurred to a large degree (for details, see Section 3.2).

In West Germany, where there was already a well-established market economy in 1989, the self-employment rate and the share of employees with a university degree play a much less significant role for subsequent growth. The East German mark-up that we find for the share of highly qualified employees is quite remarkable since a considerable part of the knowledge stock of the socialist GDR depreciated after 1989 (for details, see Section 3.2). A possible explanation for this surprising finding is that the share of employees with a university degree represents the share of people with a highly absorptive learning capacity and the ability to recombine their human capital for productive use in a market economy. If higher levels of formal education indicate higher levels of human capital and prosperity-enhancing productivity at the individual level, this would translate into higher growth at the regional level. Finally, it is also astonishing that any

positive influence of the knowledge stock on GDP growth in West Germany vanishes once we control for capital input and investment, while the positive effect of knowledge remains stable in East German regions.

## 7. Summary and conclusions

### 7.1 Findings and policy implications

Our analysis of the development of East German regions after the regime switch from a socialist system to a market economy focuses on the impact of initial conditions at the end of the socialist era on subsequent growth. The basic idea behind our approach is that in the context of disruptive changes, the initial levels of entrepreneurship and knowledge are key resources for coping with the challenges of the transition. Focusing on initial conditions acknowledges that regional history is an important determinant of regional performance and shapes the response of the regional economy to external challenges. The results are robust when accounting for the regional capital input and investment made in the early transition period.

Our analysis clearly shows that using a Schumpeterian approach based on entrepreneurship and knowledge to examine and explain economic development is extremely appropriate in the context of a turbulent transition. More generally, we can demonstrate that entrepreneurship and knowledge play a decisive role for growth in a setting marked by a major exogenous shock that forces radical changes. These results suggest that entrepreneurship and knowledge can significantly contribute to enhancing the resilience of regions that are confronted with disruptive shocks. In fact, East German regions that were well equipped with both resources recovered more quickly from the devastating changes caused by the transformation process. The policy implications of these results are straightforward: In order to safeguard growth and welfare, countries and regions should attempt to create a favorable environment for new business formation and invest in their knowledge base.

### 7.2 Limitations and suggestions for further research

Our analysis is of course not without shortcomings. One shortcoming is that our measure for the regional knowledge base (the share of workforce with a university degree) is rather general. It indicates more the capacity to learn and absorb new knowledge than economically relevant knowledge and innovative activity. In contrast, patenting activity in the GDR that measures specific knowledge is not linked to post-reunification growth.

Since we have limited data on initial conditions, we cannot completely exclude that our results are subject to an omitted variable bias. Moreover, we are also not able to delve deeper into the role of regional industry structures in 1989 and other initial conditions; for example, the role of related and unrelated variety for economic development after 1989 (Boschma *et al.*, 2017). Due to the radical nature of the transition process, a large part of the change could be considered “unrelated”, in the sense the concept is normally used. For example, managers were confronted with completely new tasks, such as marketing. A skilled worker in a mechanical engineering plant suddenly needed to deal with new materials, with computerized machinery and new types of work organization, etc. The available information about the industry structure at the end of the socialist regime is not sufficiently detailed, and information for the first years after the transition is not reliable because of the introduction of a new statistical reporting system. Hence, our datasets do not allow us to address the “relatedness” issue in any detail.

Another limitation of our analysis is the focus on just one country, Germany. It is unclear to what extent the results hold for other former socialist countries of Central and Eastern Europe that also began a transformation to market economies in the early 1990s. Performing the same type of empirical analysis for these countries could indicate if our results can be generalized. Since these countries applied quite different transformation strategies (see, e.g., Åslund and Djankov, 2014, Kollmorgen, 2019), a cross-country comparison that includes an analysis of the interaction between these strategies and the initial levels of entrepreneurship and workforce qualification at the end of the socialist period may provide a more comprehensive picture.

Our finding that the initial regional conditions of the levels of entrepreneurship and knowledge were important indicators of a region’s ability to cope with the challenges of the extremely

disruptive East German transformation process leads us to wonder if this will hold true for other types of disruptive events, such as wars, natural disasters, or a global financial crisis. Do entrepreneurship and knowledge make regions more resilient to such shocks? Is it the actual level of self-employment or is it more an entrepreneurial tradition, culture, or orientation of the population that is important?

Another key question is: Why do certain regions have significantly higher levels of entrepreneurship and/or a more-developed knowledge base than others? Obviously, historical research on regions that have pronounced levels of these characteristics would be required. Yet another question is: Do these high levels of regional entrepreneurship and knowledge persist over time, and if so, to what extent and in what way? Previous research provides examples of regions where high levels of entrepreneurship survived major external shocks such as devastating wars, displacement of the local populations, or long periods when private economic initiative was illegal (Fritsch *et al.*, 2019). This suggests the presence of a culture of entrepreneurship and of a collective memory of such a culture. Much less is known, however, about the development of a regional knowledge base and persistence of innovative activity. Throwing more light on the questions posed above should help with the key policy problem of how to achieve sustainable improvements of regional levels of entrepreneurship, knowledge, and innovativeness. What can policy do to support these types of activity that are obviously so important for regional performance?

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## Appendix

**Table A1.** (a) Summary statistics: East Germany. (b) Summary statistics: West Germany

|  | Mean    | Minimum | Maximum   | Standard deviation |
|--|---------|---------|-----------|--------------------|
| <b>a</b>   |         |         |           |                    |
| Average annual change of GDP per capita 1992–2016                      | 1.045   | 1.029   | 1.075     | 0.009              |
| Average annual employment change 1989–2016                             | 0.988   | 0.975   | 1.003     | 0.007              |
| GDP change 1992–2016   | 2.56    | 1.83    | 4.54      | 0.51               |
| Employment change 1989–2016  | 0.72    | 0.51    | 1.07      | 0.13               |
| Self-employment rate 1989  | 0.02    | 0.01    | 0.03      | 0.01               |
| Share of employees with university degree 1989                         | 0.06    | 0.04    | 0.12      | 0.02               |
| Patents per employee 1989  | 0.58    | 0.04    | 3.84      | 0.77               |
| Share of employees in manufacturing 1989                               | 0.41    | 0.19    | 0.62      | 0.1                |
| Share of large-scale industries in total manufacturing employment 1989 | 0.16    | 0.02    | 0.64      | 0.14               |
| Population density 1989  | 4.99    | 3.85    | 7.29      | 0.64               |
| Employment 1989  | 148,000 | 40,800  | 589,000   | 105,000            |
| GDP level 1992   | 0.01    | 0.01    | 0.02      | 0                  |
| Average investment among manufacturing firms 1995                      | 2.46    | 1.67    | 3.79      | 0.45               |
| Capital stock 1996   | 2.55    | 1.11    | 4.38      | 0.76               |
| <b>b</b>   |         |         |           |                    |
| Average annual change of GDP per capita 1992–2016                      | 1.026   | 1.009   | 1.059     | 0.008              |
| Average annual employment change 1989–2016                             | 1.006   | 0.993   | 1.024     | 0.005              |
| GDP change 1992–2016   | 1.828   | 1.233   | 3.332     | 0.325              |
| Employment change 1989–2016  | 1.167   | 0.836   | 1.806     | 0.141              |
| Self-employment rate 1989  | 0.081   | 0.042   | 0.134     | 0.013              |
| Share of employees with university degree 1989                         | 0.027   | 0.009   | 0.089     | 0.014              |
| Patents per employee 1989  | 4.975   | 0.503   | 40.436    | 5.027              |
| Share of employees in manufacturing 1989                               | 0.269   | 0.056   | 0.547     | 0.085              |
| Share of large-scale industries in total manufacturing employment 1989 | 0.143   | 0.002   | 0.872     | 0.123              |
| Population density 1989  | 5.282   | 3.959   | 7.9       | 0.797              |
| Employment 1989  | 156,000 | 25,260  | 1,670,000 | 231,000            |
| GDP level 1992   | 0.032   | 0.017   | 0.056     | 0.006              |
| Average investment among manufacturing firms 1995                      | 1.79    | 0.906   | 3.025     | 0.318              |
| Capital stock 1996   | 3.111   | 1.534   | 6.385     | 0.956              |



**Table A2.** (a) Correlation matrix: East Germany. (b) Correlation matrix: West Germany

|  | [1]                 | [2]                 | [3]                 | [4]                 | [5]                 | [6]                | [7]                 | [8]                | [9]    | [10]               | [11]               | [12]               | [13]               |
|--|---------------------|---------------------|---------------------|---------------------|---------------------|--------------------|---------------------|--------------------|--------|--------------------|--------------------|--------------------|--------------------|
| <b>a</b>   |                     |                     |                     |                     |                     |                    |                     |                    |        |                    |                    |                    |                    |
| [1] Average annual change of GDP per capita 1992–2016                      | 1                   |                     |                     |                     |                     |                    |                     |                    |        |                    |                    |                    |                    |
| [2] Average annual employment change 1989–2016                             | 0.579 <sup>a</sup>  | 1                   |                     |                     |                     |                    |                     |                    |        |                    |                    |                    |                    |
| [3] GDP change 1992–2016   | 0.984 <sup>a</sup>  | 0.612 <sup>a</sup>  | 1                   |                     |                     |                    |                     |                    |        |                    |                    |                    |                    |
| [4] Employment change 1989–2016  | 0.547 <sup>a</sup>  | 0.998 <sup>a</sup>  | 0.582 <sup>a</sup>  | 1                   |                     |                    |                     |                    |        |                    |                    |                    |                    |
| [5] Self-employment rate 1989  | 0.465 <sup>a</sup>  | 0.249 <sup>c</sup>  | 0.49 <sup>a</sup>   | 0.218               | 1                   |                    |                     |                    |        |                    |                    |                    |                    |
| [6] Share of employees with university degree 1989                         | -0.007              | 0.452 <sup>a</sup>  | -0.019              | 0.478 <sup>a</sup>  | -0.309 <sup>b</sup> | 1                  |                     |                    |        |                    |                    |                    |                    |
| [7] Patents per employee 1989  | 0.041               | -0.149              | 0.072               | -0.149              | 0.079               | 0.034              | 1                   |                    |        |                    |                    |                    |                    |
| [8] Share of employees in manufacturing 1989                               | 0.14                | -0.121              | 0.143               | -0.138              | 0.392 <sup>a</sup>  | 0.032              | 0.125               | 1                  |        |                    |                    |                    |                    |
| [9] Share of large-scale industries in total manufacturing employment 1989 | -0.319 <sup>c</sup> | -0.391 <sup>a</sup> | -0.358 <sup>a</sup> | -0.379 <sup>a</sup> | -0.448 <sup>a</sup> | 0.032              | 0.093               | -0.059             | 1      |                    |                    |                    |                    |
| [10] Population density 1989   | -0.165              | 0.103               | -0.113              | 0.118               | 0.107               | 0.433 <sup>a</sup> | 0.001               | 0.632 <sup>a</sup> | -0.067 | 1                  |                    |                    |                    |
| [11] Employment 1989   | -0.143              | 0.259 <sup>c</sup>  | -0.12               | 0.28 <sup>b</sup>   | -0.133              | 0.486 <sup>a</sup> | -0.305 <sup>c</sup> | -0.017             | 0.067  | 0.377 <sup>a</sup> | 1                  |                    |                    |
| [12] GDP level 1992  | -0.327 <sup>b</sup> | 0.415 <sup>a</sup>  | -0.32 <sup>b</sup>  | 0.448 <sup>a</sup>  | -0.314 <sup>b</sup> | 0.74 <sup>a</sup>  | -0.17               | -0.08              | 0.081  | 0.433 <sup>a</sup> | 0.59 <sup>a</sup>  | 1                  |                    |
| [13] Average investment among manufacturing firms 1995                     | -0.193              | -0.101              | -0.204              | -0.085              | -0.53 <sup>a</sup>  | 0.094              | -0.192              | -0.366             | 0.303  | -0.293             | 0.211              | 0.096 <sup>c</sup> | 1                  |
| [14] Capital stock 1996  | -0.12               | 0.374 <sup>a</sup>  | -0.093              | 0.4 <sup>a</sup>    | -0.228              | 0.565 <sup>a</sup> | -0.319 <sup>c</sup> | -0.117             | 0.089  | 0.357 <sup>a</sup> | 0.971 <sup>a</sup> | 0.678 <sup>a</sup> | 0.255 <sup>c</sup> |
| <b>b</b>   |                     |                     |                     |                     |                     |                    |                     |                    |        |                    |                    |                    |                    |
| [1] Average annual change of GDP per capita 1992–2016                      | 1                   |                     |                     |                     |                     |                    |                     |                    |        |                    |                    |                    |                    |
| [2] Average annual employment change 1989–2016                             | 0.773 <sup>a</sup>  | 1                   |                     |                     |                     |                    |                     |                    |        |                    |                    |                    |                    |
| [3] GDP change 1992–2016   | 0.962 <sup>a</sup>  | 0.802 <sup>a</sup>  | 1                   |                     |                     |                    |                     |                    |        |                    |                    |                    |                    |

(continued)

Table A2. (Continued)

|  | [1]                 | [2]                 | [3]                 | [4]                 | [5]                 | [6]                | [7]                | [8]                 | [9]                | [10]               | [11]               | [12]               | [13]  |
|--|---------------------|---------------------|---------------------|---------------------|---------------------|--------------------|--------------------|---------------------|--------------------|--------------------|--------------------|--------------------|-------|
| [4] Employment change 1989–2016  | 0.771 <sup>a</sup>  | 1a                  | 0.8 <sup>a</sup>    | 1                   |                     |                    |                    |                     |                    |                    |                    |                    |       |
| [5] Self-employment rate 1989  | 0.118 <sup>c</sup>  | 0.155 <sup>b</sup>  | 0.104               | 0.156 <sup>c</sup>  | 1                   |                    |                    |                     |                    |                    |                    |                    |       |
| [6] Share of employees with university degree 1989                         | -0.18 <sup>b</sup>  | -0.018              | -0.152 <sup>b</sup> | -0.015              | -0.418 <sup>a</sup> | 1                  |                    |                     |                    |                    |                    |                    |       |
| [7] Patents per employee 1989  | -0.048              | 0.073               | -0.016              | 0.074               | 0.045               | 0.53 <sup>a</sup>  | 1                  |                     |                    |                    |                    |                    |       |
| [8] Share of employees in manufacturing 1989                               | 0.015               | -0.18 <sup>b</sup>  | 0.039               | -0.183 <sup>a</sup> | -0.345 <sup>a</sup> | 0.145 <sup>b</sup> | 0.312 <sup>a</sup> | 1                   |                    |                    |                    |                    |       |
| [9] Share of large-scale industries in total manufacturing employment 1989 | -0.192 <sup>a</sup> | -0.033              | -0.209 <sup>a</sup> | -0.032              | 0.067               | 0.129              | 0.178 <sup>b</sup> | -0.137 <sup>c</sup> | 1                  |                    |                    |                    |       |
| [10] Population density 1989   | -0.36 <sup>a</sup>  | -0.216 <sup>a</sup> | -0.347 <sup>a</sup> | -0.214 <sup>a</sup> | -0.417 <sup>a</sup> | 0.732 <sup>a</sup> | 0.469 <sup>a</sup> | 0.261 <sup>a</sup>  | 0.095              | 1                  |                    |                    |       |
| [11] Employment 1989   | -0.111              | 0.033               | -0.085              | 0.036               | -0.372 <sup>a</sup> | 0.739 <sup>a</sup> | 0.303 <sup>a</sup> | 0.003               | 0.051              | 0.692 <sup>a</sup> | 1                  |                    |       |
| [12] GDP level 1992  | -0.08               | -0.016              | -0.038              | -0.014              | -0.422 <sup>a</sup> | 0.58 <sup>a</sup>  | 0.378 <sup>a</sup> | 0.227 <sup>a</sup>  | -0.122             | 0.449 <sup>a</sup> | 0.599 <sup>a</sup> | 1                  |       |
| [13] Average investment among manufacturing firms 1995                     | 0.182 <sup>a</sup>  | 0.224 <sup>a</sup>  | 0.161 <sup>b</sup>  | 0.222 <sup>a</sup>  | -0.092              | -0.013             | -0.107             | -0.148 <sup>b</sup> | 0.139 <sup>b</sup> | -0.114             | -0.034             | -0.083             | 1     |
| [14] Capital stock 1996  | -0.093              | 0.066               | -0.065              | 0.07                | -0.366 <sup>a</sup> | 0.757 <sup>a</sup> | 0.3 <sup>a</sup>   | -0.065              | 0.06               | 0.68 <sup>a</sup>  | 0.973 <sup>a</sup> | 0.601 <sup>a</sup> | 0.017 |

Notes:

<sup>a</sup>Statistically significant at the 1% level.<sup>b</sup>Statistically significant at the 5% level.<sup>c</sup>Statistically significant at the 10% level.

**Table A3.** Initial conditions and employment change 1989–2016 in East German regions without controlling for population density

| Dependent variable: average annual employment change 1989–2016         | (1)                 | (2)                 | (3)                  | (4)                  |
|--|---------------------|---------------------|----------------------|----------------------|
| Self-employment rate 1989  | 0.015***<br>(0.005) | 0.013**<br>(0.005)  | 0.019***<br>(0.003)  | 0.016***<br>(0.003)  |
| Share of employees with university degree 1989                         | 0.015***<br>(0.003) | 0.014***<br>(0.002) | 0.010***<br>(0.003)  | 0.009***<br>(0.003)  |
| Employment 1989  | 0.001<br>(0.002)    | 0.001<br>(0.002)    | –0.023***<br>(0.005) | –0.023***<br>(0.005) |
| Share of employees in manufacturing 1989                               | –0.004<br>(0.004)   | –0.004<br>(0.004)   | 0.001<br>(0.003)     | 0.001<br>(0.003)     |
| Share of large-scale industries in total manufacturing employment 1989 |                     | –0.002<br>(0.001)   |                      | –0.002*<br>(0.001)   |
| Average investment among manufacturing firms 1995                      |                     |                     | –0.001<br>(0.001)    | –0.000<br>(0.001)    |
| Capital stock 1996   |                     |                     | 0.021***<br>(0.004)  | 0.021***<br>(0.004)  |
| Federal State fixed effects  | Yes***              | Yes***              | Yes***               | Yes***               |
| Constant   | 0.077*<br>(0.043)   | 0.058<br>(0.041)    | 0.307***<br>(0.051)  | 0.291***<br>(0.047)  |
| R <sup>2</sup>   | 0.595               | 0.616               | 0.755                | 0.778                |

OLS regressions with 53 observations (regions); robust standard errors in parentheses.

\*\*\*Statistically significant at the 1% level.

\*\*Statistically significant at the 5% level.

\*Statistically significant at the 10% level.

**Table A4.** Initial conditions and change of GDP per capita 1992–2016 in East German regions without controlling for population density

| Dependent variable: average annual change of GDP per capita 1992–2016  | (1)                  | (2)                  | (3)                  | (4)                  |
|--|----------------------|----------------------|----------------------|----------------------|
| Self-employment rate 1989  | 0.019***<br>(0.006)  | 0.018***<br>(0.006)  | 0.017***<br>(0.006)  | 0.016**<br>(0.006)   |
| Share of employees with university degree 1989                         | 0.020***<br>(0.004)  | 0.019***<br>(0.004)  | 0.018***<br>(0.005)  | 0.017***<br>(0.005)  |
| GDP level 1992   | –0.027***<br>(0.008) | –0.027***<br>(0.008) | –0.035***<br>(0.007) | –0.035***<br>(0.007) |
| Share of employees in manufacturing 1989                               | 0.004<br>(0.005)     | 0.004<br>(0.005)     | 0.003<br>(0.005)     | 0.004<br>(0.005)     |
| Share of large-scale industries in total manufacturing employment 1989 |                      | –0.001<br>(0.002)    |                      | –0.001<br>(0.002)    |
| Average investment among manufacturing firms 1995                      |                      |                      | –0.003<br>(0.002)    | –0.002<br>(0.002)    |
| Capital stock 1996   |                      |                      | 0.003<br>(0.002)     | 0.004<br>(0.002)     |
| Federal State fixed effects  | Yes***               | Yes***               | Yes***               | Yes***               |
| Constant   | 0.068*<br>(0.039)    | 0.060<br>(0.038)     | 0.019<br>(0.048)     | 0.008<br>(0.049)     |
| R <sup>2</sup>   | 0.554                | 0.559                | 0.585                | 0.591                |

OLS regressions with 53 observations (regions); robust standard errors in parentheses.

\*\*\*Statistically significant at the 1% level.

\*\*Statistically significant at the 5% level.

\*Statistically significant at the 10% level.

**Table A5.** Initial conditions and change of employment/GDP per capita 1989/1992–2016 in East German regions: fine-grained assessment of industry structure

|   | (1)  | (2)                  | (3)   | (4)                 |
|---|--|----------------------|---|---------------------|
| Dependent variable                                | Average annual employment change 1989–2016 |                      | Annual average change of GDP per capita 1992–2016 |                     |
| Self-employment rate 1989                         | 0.012**<br>(0.004)                         | 0.014***<br>(0.003)  | 0.019***<br>(0.004)                               | 0.018***<br>(0.005) |
| Share of employees with university degree 1989    | 0.009***<br>(0.003)                        | 0.007***<br>(0.002)  | 0.007<br>(0.005)                                  | 0.005<br>(0.006)    |
| Employment 1989                                   | 0.003<br>(0.002)                           | –0.024***<br>(0.007) |   |                     |
| GDP level 1992                                    |  |                      | –0.003<br>(0.009)                                 | –0.011<br>(0.010)   |
| Local employment shares (nine industries)         | Yes***                                     | Yes***               | Yes***  | Yes***              |
| Population density 1989                           | 0.001<br>(0.002)                           | –0.002<br>(0.002)    | –0.002<br>(0.002)                                 | –0.002<br>(0.002)   |
| Average investment among manufacturing firms 1995 |  | –0.000<br>(0.002)    |   | –0.000<br>(0.002)   |
| Capital stock 1996                                |  | 0.022***<br>(0.006)  |   | 0.004*<br>(0.002)   |
| Federal State fixed effects                       | Yes***                                     | Yes***               | Yes***  | Yes***              |
| Constant  | 0.064<br>(0.041)                           | 0.049<br>(0.040)     | 0.321***<br>(0.061)                               | 0.316***<br>(0.055) |
| R <sup>2</sup>                                    | 0.617                                      | 0.632                | 0.756   | 0.782               |

OLS regressions with 53 observations (labor market regions); robust standard errors in parentheses.

\*\*\*: Statistically significant at the 1% level.

\*\*: Statistically significant at the 5% level.

\*: Statistically significant at the 10% level.

**Table A6.** Initial conditions and change of employment/GDP per capita 1989/1992–2016 in East German regions excluding regions adjacent to Berlin

|  | (1)                 | (2)                 | (3)                  | (4)                  |
|--|---------------------|---------------------|----------------------|----------------------|
| Panel A  |                     |                     |                      |                      |
| Dependent variable: average annual employment change 1989–2016         |                     |                     |                      |                      |
| Self-employment rate 1989  | 0.013**<br>(0.005)  | 0.013**<br>(0.006)  | 0.015***<br>(0.004)  | 0.014***<br>(0.004)  |
| Share of employees with university degree 1989                         | 0.010***<br>(0.003) | 0.010***<br>(0.003) | 0.009***<br>(0.003)  | 0.008***<br>(0.002)  |
| Employment 1989  | 0.002<br>(0.002)    | 0.002<br>(0.002)    | –0.017***<br>(0.005) | –0.018***<br>(0.005) |
| Share of employees in manufacturing 1989                               | –0.006<br>(0.004)   | –0.006<br>(0.004)   | 0.001<br>(0.004)     | 0.002<br>(0.004)     |
| Share of large-scale industries in total manufacturing employment 1989 |                     | –0.000<br>(0.001)   |                      | –0.001<br>(0.001)    |
| Population density 1989  | 0.003<br>(0.002)    | 0.003<br>(0.002)    | 0.000<br>(0.002)     | –0.000<br>(0.002)    |
| Average investment among manufacturing firms 1995                      |                     |                     | –0.001<br>(0.002)    | –0.001<br>(0.002)    |
| Capital stock 1996   |                     |                     | 0.016***<br>(0.005)  | 0.017***<br>(0.005)  |
| Federal State fixed effects  | Yes***              | Yes***              | Yes***               | Yes***               |
| Constant   | 0.030<br>(0.045)    | 0.028<br>(0.047)    | 0.229***<br>(0.062)  | 0.240***<br>(0.062)  |
| R <sup>2</sup>   | 0.647               | 0.649               | 0.732                | 0.742                |

(continued)

Table A6. (Continued)

|  | (1)                              | (2)                             | (3)                              | (4)                              |
|--|----------------------------------|---------------------------------|----------------------------------|----------------------------------|
| Panel B  |                                  |                                 |                                  |                                  |
| <i>Dependent variable: average annual change of GDP per capita 1992–2016</i> |                                  |                                 |                                  |                                  |
| Self-employment rate 1989  | 0.022 <sup>***</sup><br>(0.006)  | 0.022 <sup>***</sup><br>(0.007) | 0.020 <sup>***</sup><br>(0.005)  | 0.020 <sup>***</sup><br>(0.006)  |
| Share of employees with university degree 1989                               | 0.019 <sup>***</sup><br>(0.005)  | 0.019 <sup>***</sup><br>(0.005) | 0.017 <sup>***</sup><br>(0.004)  | 0.017 <sup>***</sup><br>(0.005)  |
| GDP level 1992   | -0.022 <sup>***</sup><br>(0.008) | -0.022 <sup>**</sup><br>(0.008) | -0.027 <sup>***</sup><br>(0.008) | -0.027 <sup>***</sup><br>(0.008) |
| Share of employees in manufacturing 1989                                     | 0.006<br>(0.005)                 | 0.006<br>(0.005)                | 0.008 <sup>*</sup><br>(0.005)    | 0.008<br>(0.005)                 |
| Share of large-scale industries in total manufacturing employment 1989       |                                  | 0.000<br>(0.001)                |                                  | 0.000<br>(0.001)                 |
| Population density 1989  | -0.000<br>(0.003)                | -0.000<br>(0.003)               | -0.001<br>(0.002)                | -0.001<br>(0.002)                |
| Average investment among manufacturing firms 1995                            |                                  |                                 | -0.004<br>(0.002)                | -0.004<br>(0.002)                |
| Capital stock 1996   |                                  |                                 | 0.004 <sup>*</sup><br>(0.002)    | 0.004 <sup>*</sup><br>(0.003)    |
| Federal State fixed effects  | Yes <sup>***</sup>               | Yes <sup>***</sup>              | Yes <sup>***</sup>               | Yes <sup>***</sup>               |
| Constant   | 0.098 <sup>**</sup><br>(0.043)   | 0.099 <sup>**</sup><br>(0.044)  | 0.070<br>(0.056)                 | 0.071<br>(0.056)                 |
| R <sup>2</sup>   | 0.570                            | 0.570                           | 0.624                            | 0.624                            |

OLS regressions with 43 observations (regions); robust standard errors in parentheses.

\*\*\*Statistically significant at the 1% level.

\*\*Statistically significant at the 5% level.

\*Statistically significant at the 10% level.

Table A7. Initial conditions and employment change 1989–2000 in East German regions

| <b>Dependent variable: average annual employment change 1989–2000</b>  | (1)                             | (2)                             | (3)                              | (4)                              |
|--|---------------------------------|---------------------------------|----------------------------------|----------------------------------|
| Self-employment rate 1989  | 0.022 <sup>***</sup><br>(0.007) | 0.019 <sup>**</sup><br>(0.008)  | 0.027 <sup>***</sup><br>(0.005)  | 0.023 <sup>***</sup><br>(0.006)  |
| Share of employees with university degree 1989                         | 0.017 <sup>***</sup><br>(0.004) | 0.017 <sup>***</sup><br>(0.004) | 0.012 <sup>***</sup><br>(0.004)  | 0.011 <sup>***</sup><br>(0.004)  |
| Employment 1989  | 0.000<br>(0.005)                | 0.001<br>(0.005)                | -0.044 <sup>***</sup><br>(0.010) | -0.046 <sup>***</sup><br>(0.010) |
| Share of employees in manufacturing 1989                               | -0.020 <sup>**</sup><br>(0.009) | -0.019 <sup>**</sup><br>(0.009) | -0.004<br>(0.008)                | -0.003<br>(0.008)                |
| Share of large-scale industries in total manufacturing employment 1989 |                                 | -0.002<br>(0.002)               |                                  | -0.003 <sup>*</sup><br>(0.001)   |
| Population density 1989  | 0.009 <sup>*</sup><br>(0.005)   | 0.008 <sup>*</sup><br>(0.005)   | 0.002<br>(0.004)                 | 0.001<br>(0.004)                 |
| Average investment among manufacturing firms 1995                      |                                 |                                 | -0.000<br>(0.003)                | 0.000<br>(0.003)                 |
| Capital stock 1996   |                                 |                                 | 0.039 <sup>***</sup><br>(0.008)  | 0.041 <sup>***</sup><br>(0.008)  |
| Federal State fixed effects  | Yes <sup>***</sup>              | Yes <sup>***</sup>              | Yes <sup>***</sup>               | Yes <sup>***</sup>               |
| Constant   | 0.053<br>(0.067)                | 0.033<br>(0.066)                | 0.520 <sup>***</sup><br>(0.113)  | 0.513 <sup>***</sup><br>(0.106)  |

(continued)

**Table A7.** (Continued)

| Dependent variable: average annual employment change 1989–2000 | (1)   | (2)   | (3)   | (4)   |
|--|-------|-------|-------|-------|
| $R^2$  | 0.632 | 0.641 | 0.774 | 0.794 |

OLS regressions with 53 observations (regions); robust standard errors in parentheses.

\*\*\*Statistically significant at the 1% level.

\*\*Statistically significant at the 5% level.

\*Statistically significant at the 10% level.

**Table A8.** Initial conditions and employment change 1989–2008 in East German regions

| Dependent variable: average annual employment change 1989–2008         | (1)                             | (2)                             | (3)                              | (4)                              |
|--|---------------------------------|---------------------------------|----------------------------------|----------------------------------|
| Self-employment rate 1989  | 0.020 <sup>***</sup><br>(0.005) | 0.017 <sup>***</sup><br>(0.006) | 0.022 <sup>***</sup><br>(0.004)  | 0.019 <sup>***</sup><br>(0.004)  |
| Share of employees with university degree 1989                         | 0.015 <sup>***</sup><br>(0.003) | 0.014 <sup>***</sup><br>(0.003) | 0.011 <sup>***</sup><br>(0.003)  | 0.010 <sup>***</sup><br>(0.003)  |
| Employment 1989  | 0.000<br>(0.003)                | 0.001<br>(0.003)                | –0.029 <sup>***</sup><br>(0.007) | –0.030 <sup>***</sup><br>(0.007) |
| Share of employees in manufacturing 1989                               | –0.011 <sup>*</sup><br>(0.005)  | –0.010 <sup>*</sup><br>(0.005)  | 0.000<br>(0.005)                 | 0.001<br>(0.004)                 |
| Share of large-scale industries in total manufacturing employment 1989 |                                 | –0.002<br>(0.001)               |                                  | –0.002 <sup>*</sup><br>(0.001)   |
| Population density 1989  | 0.005 <sup>*</sup><br>(0.003)   | 0.004 <sup>*</sup><br>(0.002)   | 0.000<br>(0.002)                 | –0.000<br>(0.002)                |
| Average investment among manufacturing firms 1995                      |                                 |                                 | –0.001<br>(0.002)                | –0.001<br>(0.002)                |
| Capital stock 1996   |                                 |                                 | 0.027 <sup>***</sup><br>(0.006)  | 0.028 <sup>***</sup><br>(0.006)  |
| Federal State fixed effects  | Yes <sup>***</sup>              | Yes <sup>***</sup>              | Yes <sup>***</sup>               | Yes <sup>***</sup>               |
| Constant   | 0.065<br>(0.047)                | 0.048<br>(0.046)                | 0.377 <sup>***</sup><br>(0.073)  | 0.371 <sup>***</sup><br>(0.067)  |
| $R^2$  | 0.632                           | 0.646                           | 0.779                            | 0.805                            |

OLS regressions with 53 observations (regions); robust standard errors in parentheses.

\*\*\*Statistically significant at the 1% level.

\*\*Statistically significant at the 5% level.

\*Statistically significant at the 10% level.

**Table A9.** Initial conditions and employment change 2000–2016 in East German regions

| Dependent variable: average annual employment change 2000–2016         | (1)                             | (2)                             | (3)                             | (4)                             |
|--|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| Self-employment rate 1989  | 0.012 <sup>***</sup><br>(0.004) | 0.010 <sup>**</sup><br>(0.004)  | 0.014 <sup>***</sup><br>(0.004) | 0.013 <sup>***</sup><br>(0.004) |
| Share of employees with university degree 1989                         | 0.010 <sup>***</sup><br>(0.003) | 0.009 <sup>***</sup><br>(0.003) | 0.010 <sup>***</sup><br>(0.003) | 0.010 <sup>***</sup><br>(0.003) |
| Employment 2000  | 0.001<br>(0.002)                | 0.002<br>(0.002)                | –0.007<br>(0.008)               | –0.010<br>(0.008)               |
| Share of employees in manufacturing 1989                               | 0.003<br>(0.003)                | 0.003<br>(0.003)                | 0.004<br>(0.004)                | 0.005<br>(0.003)                |
| Share of large-scale industries in total manufacturing employment 1989 |                                 | –0.001<br>(0.001)               |                                 | –0.001<br>(0.001)               |

(continued)



Table A9. (Continued)

| Dependent variable: average annual employment change 2000–2016 | (1)               | (2)               | (3)               | (4)                |
|--|-------------------|-------------------|-------------------|--------------------|
| Population density 1989  | –0.001<br>(0.001) | –0.001<br>(0.001) | –0.002<br>(0.002) | –0.002<br>(0.002)  |
| Average investment among manufacturing firms 1995              |                   |                   | –0.002<br>(0.002) | –0.001<br>(0.001)  |
| Capital stock 1996   |                   |                   | 0.008<br>(0.008)  | 0.011<br>(0.007)   |
| Federal State fixed effects                                    | Yes ***           | Yes ***           | Yes ***           | Yes ***            |
| Constant   | 0.064*<br>(0.035) | 0.054<br>(0.033)  | 0.155*<br>(0.087) | 0.177**<br>(0.084) |
| R <sup>2</sup>   | 0.378             | 0.393             | 0.408             | 0.433              |

OLS regressions with 53 observations (regions); robust standard errors in parentheses.

\*\*\*Statistically significant at the 1% level.

\*\*Statistically significant at the 5% level.

\*Statistically significant at the 10% level.

Table A10. Initial conditions and change of GDP per capita 1992–2000 in East German regions

| Dependent variable: average annual change of GDP per capita 1992–2000  | (1)                  | (2)                  | (3)                  | (4)                  |
|--|----------------------|----------------------|----------------------|----------------------|
| Self-employment rate 1989  | 0.031**<br>(0.013)   | 0.025*<br>(0.014)    | 0.029**<br>(0.013)   | 0.021<br>(0.013)     |
| Share of employees with university degree 1989                         | 0.038***<br>(0.010)  | 0.037***<br>(0.009)  | 0.033***<br>(0.011)  | 0.031***<br>(0.010)  |
| GDP level 1992   | –0.061***<br>(0.017) | –0.059***<br>(0.016) | –0.078***<br>(0.014) | –0.077***<br>(0.012) |
| Share of employees in manufacturing 1989                               | –0.001<br>(0.012)    | 0.001<br>(0.011)     | –0.002<br>(0.012)    | –0.000<br>(0.011)    |
| Share of large-scale industries in total manufacturing employment 1989 |                      | –0.004<br>(0.003)    |                      | –0.005<br>(0.003)    |
| Population density 1989  | –0.001<br>(0.005)    | –0.003<br>(0.005)    | –0.002<br>(0.005)    | –0.004<br>(0.004)    |
| Average investment among manufacturing firms 1995                      |                      |                      | 0.000<br>(0.005)     | 0.001<br>(0.005)     |
| Capital stock 1996   |                      |                      | 0.009*<br>(0.004)    | 0.010**<br>(0.004)   |
| Federal State fixed effects  | Yes ***              | Yes ***              | Yes ***              | Yes ***              |
| Constant   | 0.068<br>(0.090)     | 0.052<br>(0.081)     | –0.048<br>(0.093)    | –0.083<br>(0.085)    |
| R <sup>2</sup>   | 0.547                | 0.566                | 0.595                | 0.627                |

OLS regressions with 53 observations (regions); robust standard errors in parentheses.

\*\*\*Statistically significant at the 1% level.

\*\*Statistically significant at the 5% level.

\*Statistically significant at the 10% level.

Table A11. Initial conditions and GDP change 1992–2008 in East German regions

| Dependent variable: average annual change of GDP per capita 1992–2008 | (1)                 | (2)                 | (3)                 | (4)                 |
|---|---------------------|---------------------|---------------------|---------------------|
| Self-employment rate 1989   | 0.023***<br>(0.008) | 0.021**<br>(0.008)  | 0.019**<br>(0.007)  | 0.016*<br>(0.008)   |
| Share of employees with university degree 1989                        | 0.026***<br>(0.006) | 0.025***<br>(0.006) | 0.023***<br>(0.006) | 0.022***<br>(0.006) |

(continued)

Table A11. (Continued)

| Dependent variable: average annual change of GDP per capita 1992–2008  | (1)                              | (2)                              | (3)                              | (4)                              |
|--|----------------------------------|----------------------------------|----------------------------------|----------------------------------|
| GDP level 1992   | –0.041 <sup>***</sup><br>(0.011) | –0.040 <sup>***</sup><br>(0.011) | –0.052 <sup>***</sup><br>(0.010) | –0.052 <sup>***</sup><br>(0.010) |
| Share of employees in manufacturing 1989                               | 0.011<br>(0.007)                 | 0.012 <sup>*</sup><br>(0.007)    | 0.011<br>(0.007)                 | 0.012<br>(0.007)                 |
| Share of large-scale industries in total manufacturing employment 1989 |                                  | –0.001<br>(0.002)                |                                  | –0.002<br>(0.002)                |
| Population density 1989  | –0.001<br>(0.003)                | –0.002<br>(0.003)                | –0.002<br>(0.003)                | –0.003<br>(0.003)                |
| Average investment among manufacturing firms 1995                      |                                  |                                  | –0.004<br>(0.003)                | –0.003<br>(0.003)                |
| Capital stock 1996   |                                  |                                  | 0.006 <sup>***</sup><br>(0.003)  | 0.006 <sup>***</sup><br>(0.003)  |
| Federal State fixed effects  | Yes <sup>***</sup>               | Yes <sup>***</sup>               | Yes <sup>***</sup>               | Yes <sup>***</sup>               |
| Constant   | 0.063<br>(0.059)                 | 0.057<br>(0.056)                 | –0.009<br>(0.067)                | –0.021<br>(0.067)                |
| R <sup>2</sup>   | 0.560                            | 0.564                            | 0.605                            | 0.613                            |

OLS regressions with 53 observations (regions); robust standard errors in parentheses.

\*\*\*Statistically significant at the 1% level.

\*\*Statistically significant at the 5% level.

\*Statistically significant at the 10% level.

Table A12. Initial conditions and GDP change 2000–2016 in East German regions

| Dependent variable: average annual change of GDP per capita 2000–2016  | (1)                             | (2)                            | (3)                             | (4)                            |
|--|---------------------------------|--------------------------------|---------------------------------|--------------------------------|
| Self-employment rate 1989  | 0.014 <sup>***</sup><br>(0.005) | 0.014 <sup>**</sup><br>(0.005) | 0.012 <sup>**</sup><br>(0.005)  | 0.012 <sup>**</sup><br>(0.006) |
| Share of employees with university degree 1989                         | 0.011 <sup>**</sup><br>(0.005)  | 0.011 <sup>**</sup><br>(0.005) | 0.010 <sup>**</sup><br>(0.005)  | 0.010 <sup>**</sup><br>(0.005) |
| GDP level 2000   | –0.009<br>(0.009)               | –0.009<br>(0.009)              | –0.008<br>(0.010)               | –0.008<br>(0.010)              |
| Share of employees in manufacturing 1989                               | 0.009 <sup>*</sup><br>(0.005)   | 0.009 <sup>*</sup><br>(0.005)  | 0.010 <sup>*</sup><br>(0.005)   | 0.010 <sup>*</sup><br>(0.005)  |
| Share of large-scale industries in total manufacturing employment 1989 |                                 | –0.000<br>(0.001)              |                                 | 0.000<br>(0.001)               |
| Population density 1989  | –0.001<br>(0.002)               | –0.001<br>(0.002)              | –0.002<br>(0.002)               | –0.002<br>(0.002)              |
| Average investment among manufacturing firms 1995                      |                                 |                                | –0.004 <sup>**</sup><br>(0.002) | –0.004 <sup>*</sup><br>(0.002) |
| Capital stock 1996   |                                 |                                | 0.001<br>(0.002)                | 0.001<br>(0.002)               |
| Federal State fixed effects  | Yes <sup>***</sup>              | Yes <sup>***</sup>             | Yes <sup>***</sup>              | Yes <sup>***</sup>             |
| Constant   | 0.096 <sup>**</sup><br>(0.040)  | 0.096 <sup>**</sup><br>(0.040) | 0.101 <sup>*</sup><br>(0.054)   | 0.104 <sup>*</sup><br>(0.055)  |
| R <sup>2</sup>   | 0.346                           | 0.346                          | 0.386                           | 0.386                          |

OLS regressions with 53 observations (regions); robust standard errors in parentheses.

\*\*\*Statistically significant at the 1% level.

\*\*Statistically significant at the 5% level.

\*Statistically significant at the 10% level.

**Table A13.** Total employment/GDP growth between 1989/1992 and 2016

|  | (1)                  | (2)                  | (3)                  | (4)                  |
|--|----------------------|----------------------|----------------------|----------------------|
| <i>Panel A: Employment change 1989–2000</i>      |                      |                      |                      |                      |
| Self-employment rate 1989                        | 0.226***<br>(0.068)  | 0.194**<br>(0.077)   | 0.277***<br>(0.055)  | 0.234***<br>(0.057)  |
| Share of employees with a university degree 1989 | 0.185***<br>(0.043)  | 0.179***<br>(0.041)  | 0.128***<br>(0.038)  | 0.118***<br>(0.035)  |
| R <sup>2</sup>                                   | 0.657                | 0.665                | 0.790                | 0.808                |
| <i>Panel B: Employment change 1989–2008</i>      |                      |                      |                      |                      |
| Self-employment rate 1989                        | 0.354***<br>(0.097)  | 0.304***<br>(0.106)  | 0.399***<br>(0.068)  | 0.339***<br>(0.067)  |
| Share of employees with a university degree 1989 | 0.277***<br>(0.051)  | 0.269***<br>(0.048)  | 0.206***<br>(0.051)  | 0.192***<br>(0.046)  |
| R <sup>2</sup>                                   | 0.654                | 0.668                | 0.794                | 0.819                |
| <i>Panel C: Employment change 1989–2016</i>      |                      |                      |                      |                      |
| Self-employment rate 1989                        | 0.416***<br>(0.115)  | 0.357***<br>(0.125)  | 0.473***<br>(0.083)  | 0.402***<br>(0.083)  |
| Share of employees with a university degree 1989 | 0.337***<br>(0.064)  | 0.327***<br>(0.061)  | 0.257***<br>(0.065)  | 0.240***<br>(0.059)  |
| R <sup>2</sup>                                   | 0.636                | 0.651                | 0.771                | 0.797                |
| <i>Panel D: Employment change 1989–2016</i>      |                      |                      |                      |                      |
| Self-employment rate 1989                        | 0.184***<br>(0.060)  | 0.156**<br>(0.060)   | 0.210***<br>(0.066)  | 0.192***<br>(0.064)  |
| Share of employees with a university degree 1989 | 0.143***<br>(0.041)  | 0.139***<br>(0.040)  | 0.147***<br>(0.041)  | 0.144***<br>(0.040)  |
| R <sup>2</sup>                                   | 0.379                | 0.394                | 0.409                | 0.434                |
| <i>Panel E: GDP change 1992–2000</i>             |                      |                      |                      |                      |
| Self-employment rate 1989                        | 0.196**<br>(0.095)   | 0.149<br>(0.097)     | 0.184**<br>(0.090)   | 0.126<br>(0.090)     |
| Share of employees with a university degree 1989 | 0.238***<br>(0.064)  | 0.231***<br>(0.060)  | 0.201***<br>(0.069)  | 0.187***<br>(0.062)  |
| R <sup>2</sup>                                   | 0.534                | 0.559                | 0.590                | 0.631                |
| <i>Panel F: GDP change 1992–2008</i>             |                      |                      |                      |                      |
| Self-employment rate 1989                        | 0.320***<br>(0.113)  | 0.286**<br>(0.122)   | 0.266**<br>(0.109)   | 0.221*<br>(0.118)    |
| Share of employees with a university degree 1989 | 0.351***<br>(0.078)  | 0.346***<br>(0.079)  | 0.306***<br>(0.087)  | 0.295***<br>(0.087)  |
| R <sup>2</sup>                                   | 0.545                | 0.552                | 0.595                | 0.607                |
| <i>Panel G: GDP change 1992–2016</i>             |                      |                      |                      |                      |
| Self-employment rate 1989                        | 0.428***<br>(0.129)  | 0.384***<br>(0.136)  | 0.371***<br>(0.131)  | 0.318**<br>(0.138)   |
| Share of employees with a university degree 1989 | 0.393***<br>(0.099)  | 0.387***<br>(0.098)  | 0.349***<br>(0.109)  | 0.337***<br>(0.106)  |
| R <sup>2</sup>                                   | 0.538                | 0.546                | 0.577                | 0.590                |
| <i>Panel H: GDP change 2000–2016</i>             |                      |                      |                      |                      |
| Self-employment rate 1989                        | 0.232***<br>(0.080)  | 0.235***<br>(0.082)  | 0.187**<br>(0.086)   | 0.193**<br>(0.088)   |
| Share of employees with a university degree 1989 | 0.155*<br>(0.080)    | 0.156*<br>(0.081)    | 0.149*<br>(0.080)    | 0.150*<br>(0.080)    |
| R <sup>2</sup>                                   | 0.368                | 0.368                | 0.407                | 0.407                |
| Panels A–D: Further variables                    | Model (1)<br>Table 1 | Model (2)<br>Table 1 | Model (3)<br>Table 1 | Model (4)<br>Table 1 |
| Panels E–H: Further variables                    | Model (1)<br>Table 2 | Model (2)<br>Table 2 | Model (3)<br>Table 2 | Model (4)<br>Table 2 |

OLS regressions with 53 observations (regions); robust standard errors in parentheses.

\*\*\*Statistically significant at the 1% level.

\*\*Statistically significant at the 5% level.

\*Statistically significant at the 10% level.

**Table A14.** Regional conditions, 1989 and employment/GDP growth 1989/1992–2016 in East and West German regions—full results<sup>a</sup>

|   | (1)                  | (2)                  | (3)                  | (4)                  |
|---|----------------------|----------------------|----------------------|----------------------|
| Dependent variable: average annual employment change 1989–2016                          |                      |                      |                      |                      |
| Panel A   |                      |                      |                      |                      |
| Self-employment rate 1989   | 0.004<br>(0.003)     | 0.004<br>(0.003)     | 0.005*<br>(0.003)    | 0.006**<br>(0.003)   |
| Self-employment rate 1989 X East (Yes = 1)  | 0.012**<br>(0.005)   | 0.010*<br>(0.005)    | 0.014***<br>(0.004)  | 0.010**<br>(0.004)   |
| Share of employees with a tertiary degree 1989  | 0.003**<br>(0.001)   | 0.003**<br>(0.001)   | 0.002<br>(0.001)     | 0.002<br>(0.001)     |
| Share of employees with a tertiary degree 1989 X East (Yes = 1)                         | 0.010***<br>(0.003)  | 0.010***<br>(0.003)  | 0.008***<br>(0.003)  | 0.008***<br>(0.003)  |
| Employment 1989   | 0.002***<br>(0.001)  | 0.002***<br>(0.001)  | –0.002<br>(0.002)    | –0.003<br>(0.002)    |
| Employment in 1989 X East (Yes = 1)   | –0.001<br>(0.002)    | –0.001<br>(0.002)    | –0.021***<br>(0.006) | –0.022***<br>(0.005) |
| Share of employees in manufacturing 1989  | –0.001<br>(0.002)    | –0.001<br>(0.002)    | –0.000<br>(0.002)    | –0.000<br>(0.001)    |
| Share of employees in manufacturing 1989 X East (Yes = 1)                               | –0.005<br>(0.005)    | –0.005<br>(0.004)    | 0.003<br>(0.004)     | 0.004<br>(0.004)     |
| Share of large-scale industries in total manufacturing employment 1989                  |                      | –0.000<br>(0.000)    |                      | –0.001<br>(0.000)    |
| Share of large-scale industries in total manufacturing employment 1989 X East (Yes = 1) |                      | –0.001<br>(0.001)    |                      | –0.001<br>(0.001)    |
| Population density 1989   | –0.004***<br>(0.001) | –0.004***<br>(0.001) | –0.004***<br>(0.001) | –0.004***<br>(0.001) |
| Population density 1989 X East (Yes = 1)  | 0.007***<br>(0.002)  | 0.006***<br>(0.002)  | 0.003*<br>(0.002)    | 0.003<br>(0.002)     |
| Average investment among manufacturing firms 1995                                       |                      |                      | 0.003*<br>(0.001)    | 0.003***<br>(0.001)  |
| Average investment among manufacturing firms 1995 X East (Yes = 1)                      |                      |                      | –0.004*<br>(0.002)   | –0.004*<br>(0.002)   |
| Capital stock 1996  |                      |                      | 0.004*<br>(0.002)    | 0.004*<br>(0.002)    |
| Capital stock 1996 X East (Yes = 1)   |                      |                      | 0.018***<br>(0.005)  | 0.019***<br>(0.005)  |
| Federal State fixed effects   | Yes***               | Yes***               | Yes***               | Yes***               |
| R <sup>2</sup>  | 0.788                | 0.791                | 0.815                | 0.819                |
| Dependent variable: average annual change of GDP per capita 1992–2016                   |                      |                      |                      |                      |
| Panel B   |                      |                      |                      |                      |
| Self-employment rate 1989   | –0.006<br>(0.005)    | –0.005<br>(0.005)    | –0.003<br>(0.005)    | –0.002<br>(0.004)    |
| Self-employment rate 1989 X East (Yes = 1)  | 0.025***<br>(0.007)  | 0.022***<br>(0.008)  | 0.020***<br>(0.007)  | 0.017***<br>(0.008)  |
| Share of employees with a tertiary degree 1989  | 0.004***<br>(0.002)  | 0.005***<br>(0.002)  | 0.002<br>(0.002)     | 0.002<br>(0.002)     |
| Share of employees with a tertiary degree 1989 X East (Yes = 1)                         | 0.016***<br>(0.005)  | 0.015***<br>(0.005)  | 0.017***<br>(0.005)  | 0.016***<br>(0.005)  |
| GDP level 1992  | –0.005<br>(0.004)    | –0.006<br>(0.004)    | –0.008**<br>(0.004)  | –0.009**<br>(0.004)  |
| GDP level 1992 X East (Yes = 1)   | –0.021**<br>(0.009)  | –0.020**<br>(0.008)  | –0.025***<br>(0.009) | –0.024***<br>(0.008) |
| Share of employees in manufacturing 1989  | 0.000<br>(0.002)     | –0.000<br>(0.002)    | 0.003<br>(0.002)     | 0.002<br>(0.002)     |
| Share of employees in manufacturing 1989 X East (Yes = 1)                               | 0.006<br>(0.006)     | 0.006<br>(0.005)     | 0.003<br>(0.006)     | 0.004<br>(0.006)     |

(continued)

Table A14. (Continued)

|   | (1)                  | (2)                  | (3)                  | (4)                  |
|---|----------------------|----------------------|----------------------|----------------------|
| Share of large-scale industries in total manufacturing employment 1989                  |                      | -0.001<br>(0.001)    |                      | -0.001*<br>(0.001)   |
| Share of large-scale industries in total manufacturing employment 1989 X East (Yes = 1) |                      | 0.000<br>(0.002)     |                      | 0.000<br>(0.002)     |
| Population density 1989   | -0.004***<br>(0.001) | -0.004***<br>(0.001) | -0.005***<br>(0.001) | -0.005***<br>(0.001) |
| Population density 1989 X East (Yes = 1)  | 0.003<br>(0.003)     | 0.003<br>(0.003)     | 0.003<br>(0.003)     | 0.003<br>(0.002)     |
| Average investment among manufacturing firms 1995                                       |                      |                      | 0.005**<br>(0.002)   | 0.005**<br>(0.002)   |
| Average investment among manufacturing firms 1995 X East (Yes = 1)                      |                      |                      | -0.008**<br>(0.003)  | -0.008***<br>(0.003) |
| Capital stock 1996  |                      |                      | 0.003***<br>(0.001)  | 0.003***<br>(0.001)  |
| Capital stock 1996 X East (Yes = 1)   |                      |                      | 0.001<br>(0.002)     | 0.001<br>(0.002)     |
| Federal State fixed effects   | Yes***               | Yes***               | Yes***               | Yes***               |
| R <sup>2</sup>  | 0.635                | 0.641                | 0.668                | 0.677                |

aThe results reveal that the effect of population density is even more negative in West Germany as compared to East Germany. This is in line with Suedekum (2006). The positive interaction effect for West Germany should not be interpreted as a positive effect of agglomeration. For example, in model I panel A, the general effect for West Germany is negative (-0.095\*\*\*). The East interaction is positive (0.183\*\*\*). This yields a general East effect of 0.08 (-0.095 + 0.183 = 0.08). This is the same coefficient—by definition (for details see, Brambor *et al.*, 2006)—like in model 1, Table 1. Interaction effects for other control variables need to be interpreted in the same way.

OLS regressions with 256 (N = 53: East; N = 203: West) observations (regions); robust standard errors in parentheses.

\*\*\*Statistically significant at the 1% level.

\*\*Statistically significant at the 5% level.

\*Statistically significant at the 10% level.

Table A15. Regional conditions, 1989 and employment/GDP change 1989/1992–2016 in East and West German regions controlling for border effects—full results

|   | (1)                 | (2)                 | (3)                  | (4)                  |
|---|---------------------|---------------------|----------------------|----------------------|
| Dependent variable: average annual employment change 1989–2016                          |                     |                     |                      |                      |
| Panel A   |                     |                     |                      |                      |
| Self-employment rate 1989   | 0.002<br>(0.003)    | 0.002<br>(0.003)    | 0.003<br>(0.003)     | 0.003<br>(0.003)     |
| Self-employment rate 1989 X East (Yes = 1)  | 0.015***<br>(0.005) | 0.012**<br>(0.005)  | 0.016***<br>(0.004)  | 0.013***<br>(0.004)  |
| Share of employees with a tertiary degree 1989  | 0.003*<br>(0.001)   | 0.003**<br>(0.001)  | 0.001<br>(0.001)     | 0.002<br>(0.001)     |
| Share of employees with a tertiary degree 1989 X East (Yes = 1)                         | 0.010***<br>(0.003) | 0.010***<br>(0.003) | 0.008***<br>(0.003)  | 0.008***<br>(0.003)  |
| Employment in 1989  | 0.002***<br>(0.001) | 0.002***<br>(0.001) | -0.004*<br>(0.002)   | -0.004*<br>(0.002)   |
| Employment in 1989 X East (Yes = 1)   | -0.001<br>(0.002)   | -0.001<br>(0.002)   | -0.021***<br>(0.006) | -0.021***<br>(0.005) |
| Share of employees in manufacturing 1989  | -0.001<br>(0.001)   | -0.001<br>(0.001)   | 0.000<br>(0.002)     | 0.000<br>(0.002)     |
| Share of employees in manufacturing 1989 X East (Yes = 1)                               | -0.006<br>(0.005)   | -0.005<br>(0.004)   | 0.002<br>(0.004)     | 0.003<br>(0.004)     |
| Share of large-scale industries in total manufacturing employment, 1989                 |                     | -0.000<br>(0.000)   |                      | -0.000<br>(0.000)    |
| Share of large-scale industries in total manufacturing employment 1989 X East (Yes = 1) |                     | -0.001<br>(0.001)   |                      | -0.001<br>(0.001)    |

(continued)

Table A15. (Continued)

|   | (1)                              | (2)                              | (3)                              | (4)                              |
|---|----------------------------------|----------------------------------|----------------------------------|----------------------------------|
| Population density 1989   | -0.004 <sup>***</sup><br>(0.001) | -0.004 <sup>***</sup><br>(0.001) | -0.004 <sup>***</sup><br>(0.001) | -0.004 <sup>***</sup><br>(0.001) |
| Population density 1989 X East (Yes = 1)  | 0.007 <sup>***</sup><br>(0.002)  | 0.006 <sup>***</sup><br>(0.002)  | 0.004 <sup>*</sup><br>(0.002)    | 0.003<br>(0.002)                 |
| Average investment among manufacturing firms 1995                                       |                                  |                                  | 0.002 <sup>*</sup><br>(0.001)    | 0.002 <sup>*</sup><br>(0.001)    |
| Average investment among manufacturing firms 1995 X East (Yes = 1)                      |                                  |                                  | -0.003<br>(0.002)                | -0.003 <sup>*</sup><br>(0.002)   |
| Capital stock 1996  |                                  |                                  | 0.005 <sup>***</sup><br>(0.002)  | 0.005 <sup>***</sup><br>(0.002)  |
| Capital stock 1996 X East (Yes = 1)   |                                  |                                  | 0.017 <sup>***</sup><br>(0.005)  | 0.018 <sup>***</sup><br>(0.005)  |
| Region adjacent to former inner-German border (Yes = 1)                                 | -0.004 <sup>***</sup><br>(0.001) | -0.004 <sup>***</sup><br>(0.001) | -0.004 <sup>***</sup><br>(0.001) | -0.004 <sup>***</sup><br>(0.001) |
| Region adjacent to former inner-German border (Yes = 1) X East (Yes = 1)                | 0.004 <sup>*</sup><br>(0.002)    | 0.004 <sup>*</sup><br>(0.002)    | 0.005 <sup>***</sup><br>(0.002)  | 0.005 <sup>***</sup><br>(0.002)  |
| Federal State fixed effects   | Yes <sup>***</sup>               | Yes <sup>***</sup>               | Yes <sup>***</sup>               | Yes <sup>***</sup>               |
| R <sup>2</sup>  | 0.788                            | 0.791                            | 0.815                            | 0.819                            |
| <i>Dependent variable: average annual change of GDP per capita 1992–2016</i>            |                                  |                                  |                                  |                                  |
| Panel B   |                                  |                                  |                                  |                                  |
| Self-employment rate 1989   | -0.010 <sup>**</sup><br>(0.005)  | -0.009 <sup>*</sup><br>(0.005)   | -0.007<br>(0.005)                | -0.006<br>(0.005)                |
| Self-employment rate 1989 X East (Yes = 1)  | 0.030 <sup>***</sup><br>(0.007)  | 0.027 <sup>***</sup><br>(0.008)  | 0.024 <sup>***</sup><br>(0.007)  | 0.021 <sup>***</sup><br>(0.007)  |
| Share of employees with a tertiary degree 1989  | 0.004 <sup>***</sup><br>(0.002)  | 0.005 <sup>***</sup><br>(0.001)  | 0.002<br>(0.002)                 | 0.002<br>(0.002)                 |
| Share of employees with a tertiary degree 1989 X East (Yes = 1)                         | 0.016 <sup>***</sup><br>(0.005)  | 0.015 <sup>***</sup><br>(0.005)  | 0.016 <sup>***</sup><br>(0.005)  | 0.015 <sup>***</sup><br>(0.005)  |
| GDP level 1992  | -0.006 <sup>*</sup><br>(0.004)   | -0.007 <sup>*</sup><br>(0.003)   | -0.009 <sup>**</sup><br>(0.004)  | -0.009 <sup>***</sup><br>(0.004) |
| GDP level 1992 X East (Yes = 1)   | -0.019 <sup>**</sup><br>(0.009)  | -0.018 <sup>**</sup><br>(0.009)  | -0.023 <sup>***</sup><br>(0.009) | -0.022 <sup>***</sup><br>(0.008) |
| Share of employees in manufacturing 1989  | 0.001<br>(0.002)                 | 0.001<br>(0.002)                 | 0.003<br>(0.002)                 | 0.003<br>(0.002)                 |
| Share of employees in manufacturing 1989 X East (Yes = 1)                               | 0.005<br>(0.005)                 | 0.005<br>(0.005)                 | 0.002<br>(0.006)                 | 0.003<br>(0.006)                 |
| Share of large-scale industries in total manufacturing employment 1989                  |                                  | -0.001<br>(0.001)                |                                  | -0.001 <sup>*</sup><br>(0.001)   |
| Share of large-scale industries in total manufacturing employment 1989 X East (Yes = 1) |                                  | -0.000<br>(0.002)                |                                  | -0.000<br>(0.002)                |
| Population density 1989   | -0.005 <sup>***</sup><br>(0.001) | -0.005 <sup>***</sup><br>(0.001) | -0.006 <sup>***</sup><br>(0.001) | -0.006 <sup>***</sup><br>(0.001) |
| Population density 1989 X East (Yes = 1)  | 0.003<br>(0.002)                 | 0.003<br>(0.003)                 | 0.003<br>(0.002)                 | 0.003<br>(0.002)                 |
| Average investment among manufacturing firms 1995                                       |                                  |                                  | 0.004 <sup>*</sup><br>(0.002)    | 0.004 <sup>*</sup><br>(0.002)    |
| Average investment among manufacturing firms 1995 X East (Yes = 1)                      |                                  |                                  | -0.007 <sup>**</sup><br>(0.003)  | -0.007 <sup>**</sup><br>(0.003)  |
| Capital stock 1996  |                                  |                                  | 0.003 <sup>***</sup><br>(0.001)  | 0.003 <sup>***</sup><br>(0.001)  |
| Capital stock 1996 X East (Yes = 1)   |                                  |                                  | 0.001<br>(0.002)                 | 0.001<br>(0.002)                 |

(continued)



**Table A15.** (Continued)

|   | (1)                  | (2)                  | (3)                  | (4)                  |
|---|----------------------|----------------------|----------------------|----------------------|
| Region adjacent to former inner-German border<br>(Yes = 1)                  | -0.007***<br>(0.002) | -0.007***<br>(0.002) | -0.006***<br>(0.002) | -0.006***<br>(0.002) |
| Region adjacent to former inner-German border<br>(Yes = 1) X East (Yes = 1) | 0.006**<br>(0.002)   | 0.006**<br>(0.002)   | 0.005**<br>(0.002)   | 0.005**<br>(0.002)   |
| Federal State fixed effects   | Yes***               | Yes***               | Yes***               | Yes***               |
| R <sup>2</sup>  | 0.670                | 0.675                | 0.694                | 0.702                |

OLS regressions with 256 ( $N = 53$ ; East;  $N = 203$ ; West) observations (regions); robust standard errors in parentheses.

\*\*\*Statistically significant at the 1% level.

\*\*Statistically significant at the 5% level.

\*Statistically significant at the 10% level.