Labor Productivity, Job and Worker Flows in West and East-Germany

Preliminary and Incomplete

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Abstract

This paper analyzes non-convergence in factor productivity using the case of East and West-Germany. We show that labor productivity in East-Germany converged rapidly in the first years after reunification, but stays 30% below the West-German counterpart since 1994. Neither differences in legislation or factor inputs can explain this non-convergence. We use a new plant level data set on employment dynamics and show that part of the puzzle is less career mobility in the East. We rationalize this fact with a structural search model where workers invest less search effort because job turnover is higher in the East.

Keywords: Productivity convergence, Job and worker flows

JEL: O11, J24, J63

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1 Introduction

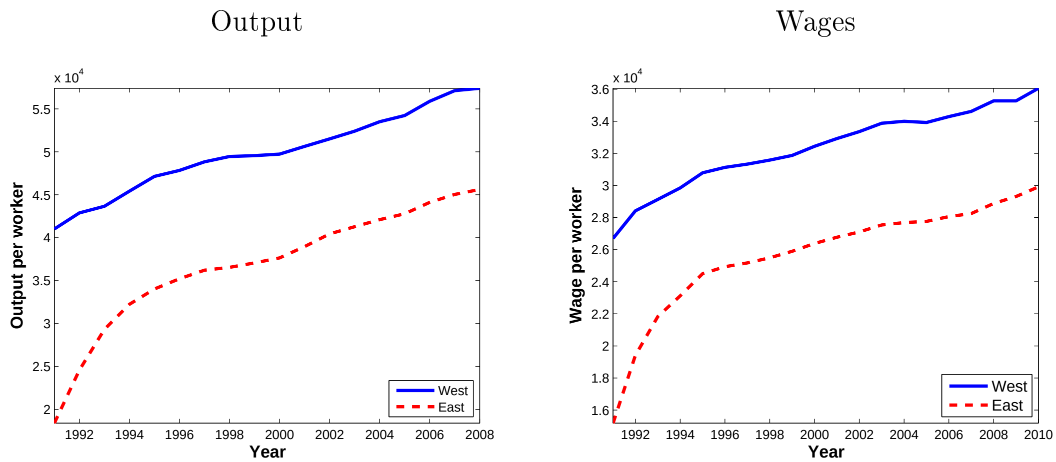
In 1991, centrally planned East-Germany reunited with West-Germany and became a market economy. Before that date, capital was in short supply, machines were outdated, and political pressure had plants overemploy labor in the East. Consequently, labor productivity did not even reach 50% of the West-German level in 1991 (see Figure I). During the first couple of years after reunification, labor productivity and wages grew quickly. However, this process ended soon, in about 1995. Since then, the relative labor productivity and wages in East Germany has stagnated at roughly 66% and 78% of the West German counterpart, respectively. On top, the East faces persistently higher unemployment rates.

Such pattern of regional non-convergence in labor markets is not particular to Germany and can be found in many other countries (Italy's "Mezzogiorno", the US' "Rust-belt", etc.). What makes the German case particularly interesting are three things: first, geographic distance and institutional differences are particularly small. Second, there is a well defined starting date from which on we should expect convergence (October 3, 1990), instead of observing a process of drifting apart, a point made by Uhlig (2006). Third, there is (new) excellent and detailed administrative data with information on job and worker flows at the plant level in both East and West-Germany.

We compare the data to empirical predictions of existing theories which aim to explain low labor productivity. We find that all of these theories have difficulties to explain the difference between East and West-Germany. The micro level plant data suggests that job flows are substantially higher in East-Germany, even ten years after reunification. The data also shows that career upgrading over a worker's life-cycle is less prominent in East than in West-Germany. We use an endogenous search model which links workers' search behavior to plants' employment dynamics. This chanell allone can account for 30 percent of the observed difference in labor productivity.

Burda (2006) explains slow convergence of labor productivity in Germany by capital adjustment frictions. Boeri and Terrell (2002) stress the importance of job reallocation for productivity growth in formerly state run economies. Our data sug-

Figure I: Output and Wages per Worker



Notes: The figure displays yearly output per worker and average wages in East and West-Germany.

gests that these factors only initially played an important role, but ceased to do so after 1995. East-Germany saw much higher plant entry rates, high job reallocation rates, and stronger capital accumulation relative to West-Germany during the initial years after reunification. However, entry rates and job reallocation rates stayed high in East-Germany and the capital stock kept converging, even surpassing the capital intensity of the West in the manufacturing sector in 2000. Despite this, productivity did not converge. We also show that labor inputs have a similar or even higher quality in East-Germany, and; hence, it is not unmeasured quality differences explaining the difference in productivity.

Therefore, our analysis concentrates on explaining differences in TFP instead of differences in factor inputs.[1] In fact, we show that the size distributions of plants in East-Germany is consistent with being generated from the West-German productivity distribution at lower 30% average productivity.

What can explain such large and persistent differences in average plant productiv-

[1] Hall and Jones (1999) show that differences in TFP explain a large fraction of world wide dispersion in labor productivity. They relate this to institutional differences that drive a wedge between private and social benefits of projects. What makes the German case particularly interesting is that we observe large differences in labor productivity, but the institutional frame is the same in the two regions.

ity? We find that differences in industry specialization are an unlikely explanation. Industry composition shows strong convergence after 1995. Moreover, labor productivity in East-Germany is lower in all major manufacturing and private service industries. Recently, Hsieh and Klenow (2012) explain differences in TFP between countries by their ability to allocate factors of production to the most productive start-ups. We show that start-up plants have today a similar size in East and West-Germany and grow at a similar pace over their first 20 years, providing little evidence that the East fails to select productive from unproductive plants.

While surviving plants grow similar in East and West-Germany, plant survival of entrants is substantially lower in the East. A plant founded at the beginning of the 2000's has a 36 percent lower probability to reach the age of 5 years in East than in West-Germany. This suggests that part of the higher job turnover in East-Germany after 1995 is driven by newly created jobs which last only for a few years. In fact, the amount of job turnover since reunification was sufficient to destroy and create every job 2.5 times in East-Germany.

An economy which creates a lot of low productive jobs which are quickly destroyed again afterwards is likely to affect career concerns for workers. This in turn affects their search behavior and thus the distribution of workers over plant sizes. To see this point, note that differences in worker allocation across plants can arise because workers are allocated differently at labor market entry, or because they sort differently afterwards. We show that this second component plays a role in understanding differences between East and West Germany. Workers are more successful to sort into large plants in the West over their life-cycle. Moreover, workers' wage growth over the life-cycle is larger in West than in East-Germany. Related to this, plants in West-Germany churn more workers than in East-Germany.

We use a structural search model to understand the quantitative importance of this latter channel. As in the data, plants have higher job destruction rates in the East. The shorter duration of matches disincentivizes workers to search for better employment on the job. As a result, workers in the East experience less job to job mobility. We find that this channel can explain up to 30 percent of the observed difference in labor productivity between East and West-Germany. Hence, high job reallocation is not the source of productivity growth, as in Boeri and Terrell (2002), but serves as a barrier to it.

The remainder of the paper is organized the following: The next section presents our data set. Thereafter, we show that several theories fail as plausible explanations for the persistent difference in labor productivity and wages. We show that a successful theory must rationalize permanent differences in unobserved factors in the production function. The next section introduces our formal model and discusses its quantitative implications. The last section concludes.

2 Data

2.1 Data Sources

The labor productivity data displayed in Figure I is obtained from the German national income and product accounts, *Volkswirtschaftliche Gesamtrechnung (VGR)*. We supplement this data by the *Establishment Labor Flow Panel* (ELFLOP), a data set we compiled and that measures employment and labor flow data for the universe of German establishments. ELFLOP covers the time period 1975-2006 (West Germany until 1991-II the re-unified Germany thereafter, but regional information is available[2]). All data is available at a quarterly frequency. The data used to produce ELFLOP originate from the German notification procedure for social security. Essentially, this procedure requires employers to keep the social security agencies informed about their employees by reporting any start or end of employment and by annually confirming existing employment relationships.

The *Forschungsdatenzentrum der Bundesagentur für Arbeit* (German Bureau of Labor) uses the data collected through the notification procedure as input for its BLH (Employees And Benefits-Recipients History File), which in turn is ELFLOP's data source. The BLH is an individual-level data set covering all workers in Germany liable to social security. The main types of employees not covered are public officials (*Beamte*), military personnel and the self-employed. Also, marginal part-time work-

[2]We classify the city of Berlin as "East-Germany".

ers are only included in the BLH since 1999. To ensure consistency over time, all variables are therefore calculated on a *regular worker* basis: apprentices and interns, marginal part-time workers, workers in partial retirement (and a few other groups of minor importance) are being excluded from the data.[3]

The BLH provides us with a rich set of plant and worker observables. For the presence of this paper, we use information of the plants' industry classification,[4] the size, age and its position in the distribution of plants' average wages. Moreover, we use information on workers' education, work tasks and age. We refer to each of these different data organizations as *worker/plant characteristics*.

2.2 Stock Concepts, Data Cleaning and Aggregation

In the ELFLOP data, a worker is considered to be working for a given plant (establishment) in a given quarter, if she has been employed at this plant at the end of the quarter.[5] This definition yields the number of jobs at a plant at the end of a quarter, the number of hires (accession) of a plant (a worker that has not been working for that plant at the end of the previous quarter), as well as the number of separations (a worker that has been working for the plant at the end of the previous quarter). These are the basic data from which all other data are constructed.

We compute beginning of quarter, EB, and end of quarter employment, EE for each plant. When a plant decreases employment by N within a quarter, we count this as N job destructions JD. When employment it increases by N, we count N job creations JC. The sum of the two is job turnover. A plant may hire and fire workers within the same quarter. We are able to observe such behavior from the

[3] Also, workers working below 15 hours a week and earning less than roughly 315€(in 1999, lower values before) were exempt from social security taxation (geringfügige Beschäftigung) and hence not recorded.

[4] The industries are: Farming, Energy and Mining, Coakery, Rubber and Plastics, Glass Ceramics and Stone, Metal, Machines and Heavy industry, Wood Paper and Printing, Textile and Leather, Food and Tobacco, Construction, Hotel and Tourism, Wholesale, Carsales and Retail, Transport and Communication, Credit insurance, Professional services, Public administration, Education, Health, Other public services, Private households.

[5] It is relatively rare to observe workers leaving a job before the end of a month in the data. In facts most workers leave or join a plant at the end reps. beginning of a quarter.

administrative BLH data. When a new worker joints an establishment, we count this as an accession *ACC*. When he leaves the establishment, we count a job separation *SEP*. Again, the sum of the two is what we refer to as worker turnover. Thus, we have $ACC \geq JC$ and $SEP \geq JD$ for each establishment in each quarter.

We allow each worker/plant characteristic within each region to have an individual specific seasonal component and compute seasonally adjusted series, using the *X-12 ARIMA CENSUS* procedure. The raw data suffers from several worker reclassifications, due to changes in the social security system and industry reclassifications. We adjust every industry series using a semi-parametric approach described in Appendix A.

Our analysis deals mainly with long run trends. Again, we allow each worker/plant characteristic within each region to have an individual specific trend and cyclical component and decompose those, employing a HP-filter for the log series with a smoothing parameter of 10^5. Hence, the cyclical component has the interpretation of percentage deviations from a slowly moving trend. Finally, we create aggregate statistics by aggregating the long run components from all industries to the level of East and West-Germany.

Given the stock data, we define flow rates. We use as denominator the average of end of quarter employment and the backward computed beginning of period employment.[6] Illustrating this with the example of the job creation rate

$$JCR_t = \frac{JC_t}{EM_t}; \quad EM_t := [2EE_t - (JC_t + JD_t)]/2.$$

All other rates are defined analogously. The measure implies that all rates are bounded in the open interval (-2,2) with endpoints corresponding to death and birth of plants.[7]

[6] This backward calculation of beginning of period employment is necessary as we also work with data disaggregated by worker characteristics, such as age and education and we do not want to count a change in worker characteristics on a job as a worker/job flow, but since changes in worker characteristics occur (most importantly for age), at the plant level the stock-flow identity that last period's employment is equal to this period's employment minus net job creation does not hold for data disaggregated by worker characteristics.

[7] See Davis et al. (1996) for a more thoroughly discussion regarding the properties of this measure.

3 Understanding the Differences Between the East and West

This section characterizes plausible features of a theory that explains permanent differences in labor productivity for two regions with the same governmental institutions. We first rule out a set of well known explanations by showing that these are inconsistent with the data. Using a neo-classical framework, we argue that differences must come from unobservables in the production function, i.e., differences in TFP. Using our ELFLOP data, we show that job flows are substantially higher and worker churn is lower in East-Germany, which builds the foundation for our theory presented in the next section.

3.1 Capital and Labor Input

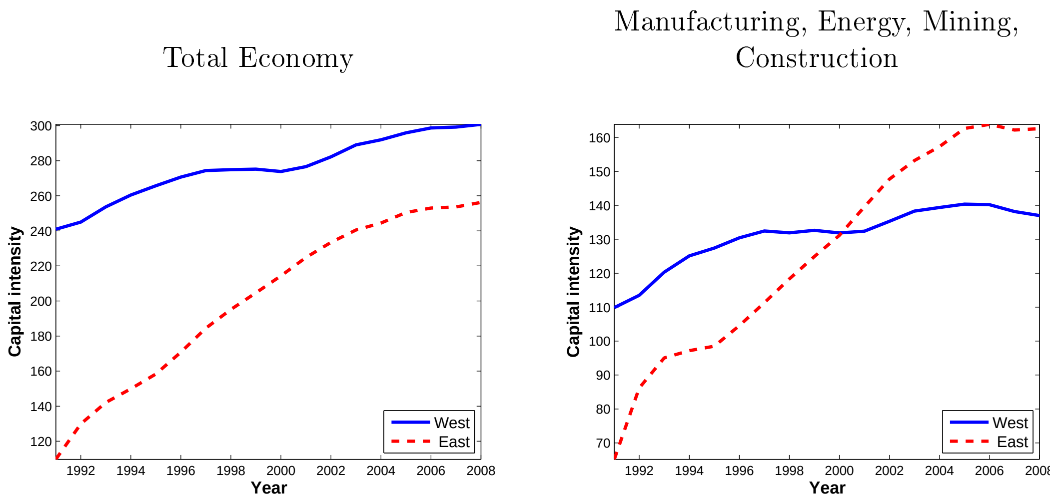
To fix ideas, consider a neo-classical production function with heterogeneous inputs:

$$F = A(\gamma L)^{\alpha}(\lambda K)^{1-\alpha},$$

where A is TFP, L and K are labor and capital input and γ and λ are the qualities of these inputs. Thinking in this framework, cross-region differences in labor productivity and compensation must root from differences in capital inputs, differences in the quality of the labor input, or differences in TFP. Burda (2006) puts forwards an explanation where capital as well as labor are imperfectly mobile across German regions, and since the East starts out with lower capital stocks, it remains to have lower capital intensities, hence, less productive labor. Figure II shows that the capital intensities in the East have converged to the West German levels over time. Particularly, it surpassed the level in West-Germany in the production sector in 2000. Even though the quality of the capital stock may be poorly measured, we find such explanation rather unattractive given that most capital was installed in recent years in the East.

Most importantly, the measure allows for consistent aggregation.

Figure II: Capital Intensity

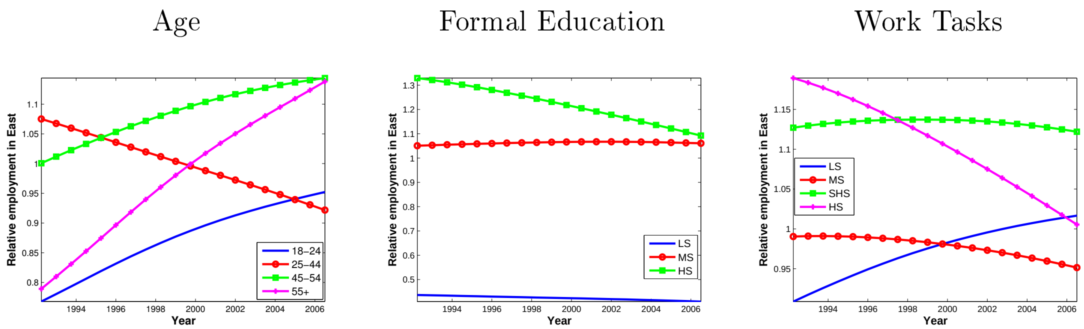


Notes: The figure displays the capital intensity in East and West-Germany. The left panel shows the capital intensity in the total economy. The right panel shows it for the production sector.

Can we explain the differences in labor productivity by differences in the quality of the labor input? In terms of general education levels, East Germany had a relatively highly educated work force in 1992. Figure III shows that the East German work force was both younger, had higher levels of formal education, and was more likely to execute jobs with higher levels of formal responsibility. Obviously this high level of education could both only be in terms to the technology the work force was trained to, i.e., the technology that was available during communist times, and it shows that likely the managerial overhead was larger in the East. The figures also show that the bias towards high skills has decreased over time, which by itself should have slowed down productivity increase in the East. At the end of our sample there is no strong bias of the East German workforce in terms of formal training and only a small bias in the age composition. There are still relatively more workers with some responsibility (semi-high skilled).

Hence, while it is true that the East has seen a constant outflow of especially younger and better trained workforce, see also Uhlig (2006), this seems rather a process of convergence with the West. It might have slowed down convergence in productivity, but we view it as not likely the sole explanation of the missing conver-

Figure III: Employment Share by Skills



Notes: Fraction of employed in the age groups 18-24, 25-44, 45-54, and 55+ that work in East Germany relative to the fraction total East German employment in total employment in Germany. The panels displays the fraction of employed in the East in a category of human capital relative to the fraction of East German employment in total German employment. The left panel refers to formal education: *LS:* without any tertiary education, *MS:* with professional training, *HS:* academic tertiary education. The right panel refers to the work tasks of the employed: *LS:* Agricultural occupations, elementary manual occupations, elementary personal services occupations, elementary administrative occupations, *MS:* Skilled manual occupations, skilled services occupations, skilled administrative occupations, *SHS:* Technicians, associate professionals, *HS:* Professional occupations, managers.

gence in productivity and profitability. Fuchs-Schündeln and Izem (2012) provides further evidence in this direction. They shows that firm differences and not worker differences explain the higher productivity of West relative to East plants that are located close to the former border.

3.2 TFP

The above analysis suggests that unobserved differences in the production function are driving the differences in labor productivity across the two regions. Unfortunately, we so not observe plants' TFP in our data. However, Haltiwanger et al. (1999) show that labor productivity, after controling for worker observables, is closely related to firm size, which we do observe.

Let us assume establishment size is completely determined by plant productivity, and plants draw their log productivity from $z_i \sim N(\mu, \sigma)$. The plant size, S_i, is then given by:

$$S_i = z_i^{\iota}.$$

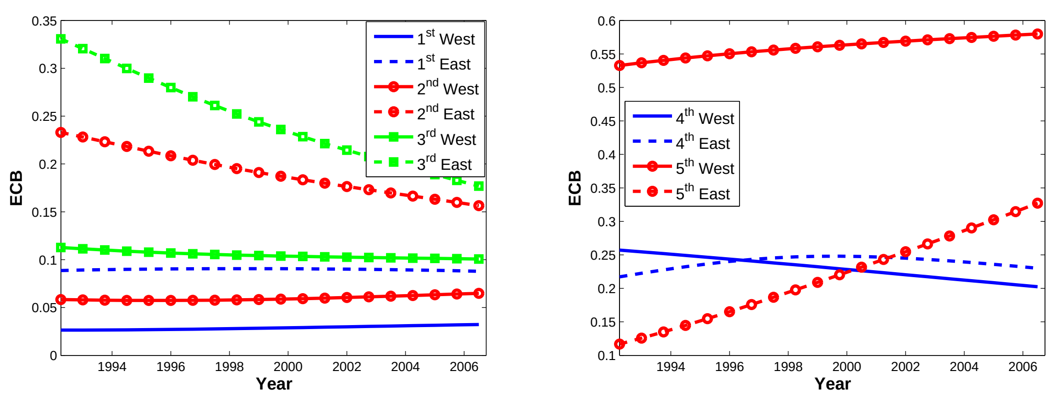
We set ι to 3 and match with μ the mean size of plants in West-Germany in 2006 and with σ the share of employment in plants of size $1-19$. The resulting CDF of employment over plant size is somewhat too steep compared to the data, but the overall fit is reasonable well. We now ask, how the size distribution in the East would look like when using the above model, but imposing that mean productivity is lower by 30% in the East, i.e., $\mu_E = 0.7\mu_W$.

Figure VI shows that this simple model performs well in reproducing the difference between the observed size distribution in East and West-Germany in 2006. Put differently, assuming that plants in East-Germany are 30 percent less productive than in the West is consistent with the respective observed size distributions of plants. The data contains a somewhat larger difference in the top category, suggesting that particularly the most productive plants are not active in East-Germany.

Figure IV: Employment shares

(A) Low paying plants

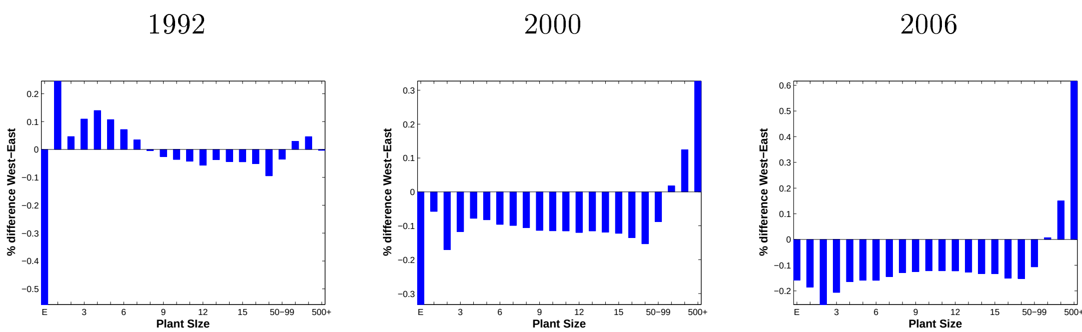
(B) High paying plants



Notes: *Panel A* displays the share of employment in low paying plants. *Panel B* displays the share of employment in high paying plants.

Our data also has information where plants are ranked in the average wage per worker distribution in Germany, conditional on their location. Figure IV shows that the largest difference in employment shares is at the top quintile. In East Germany, substantially less employment is located at these high paying plants. On the converse, low-paying plants account for a larger share of the East German employment. If we identify the highest paying plants with the plants that are most productive, then this figure means that in the East less workers work at the most productive plants in entire Germany.

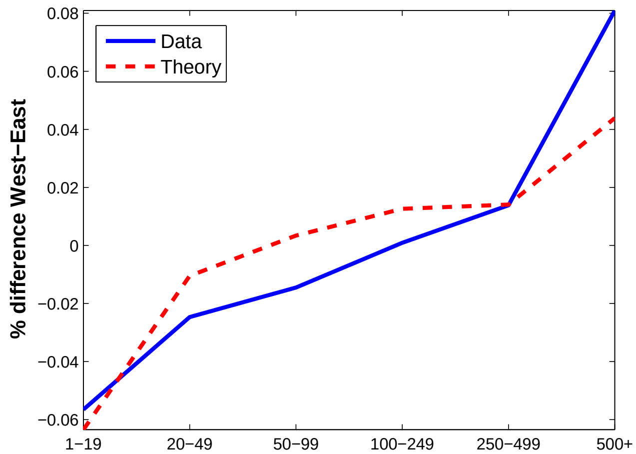
Figure V: Size Distribution



*Notes:*The figure compares the employment shares in different size bins between East and West-Germany. On the Y-axis is the excessive employment share of West-Germany for each size category. These categories are: Entry, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16-19, 20-49, 50-99, 100+.

Using the observed plant size distribution, we can come back to the issue of productivity convergence. Figure V shows that employment was allocated similarly in East and West-Germany across the plant size distribution in 1992. A markably difference was that the share of employment at entering plants was 55% larger in East than in West-Germany. By 2000, several of the large plants have exited the market in East-Germany with the size distribution shifted to the left compared to West-Germany. Still, employment at entering plants is a larger factor in the East than in the West. This gap almost closed by 2006 with the size distributions of West and East-Germany shifting yet further apart. Put differently, the observed shifts in the distribution are consistent with the initial convergence being driven by the exit of unproductive large plants. Since then, there appears to be no convergence in plant productivities between the two regions.

Figure VI: Employment Shares in East and West



*Notes:*The figure displays the difference in employment shares in East and West Germany for different plant size categories. *Data* refers to the data and *theory* to the simple model outlined in the main text where we impose a 30 percent lower productivity in the East.

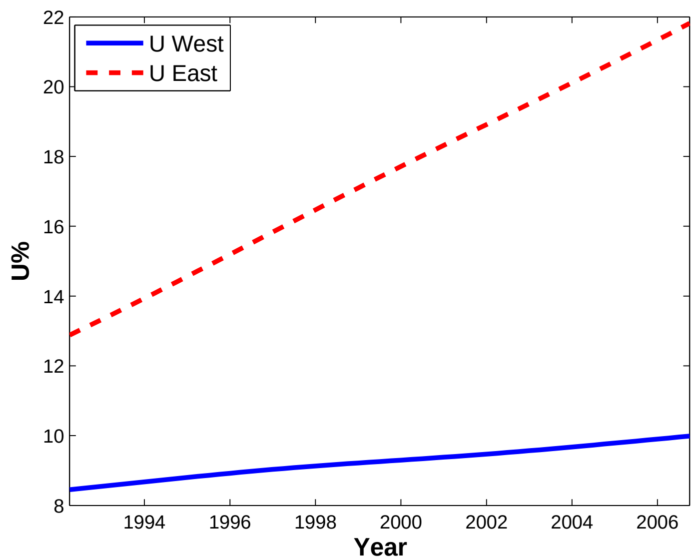
3.3 Understanding Aggregate Differences in TFP

3.3.1 Worker Power and Industry Composition

There is a range of fairly standard fairly frictionless setups that could generate lower labor productivity in the East as a long-run phenomenon. One example is lower unionization in the East, which there is, that leads to lower wages, which there is. Yet, the problem with such explanation is that it would predict lower unemployment rates in the East, of which as Figure VII shows the reverse is true. Unemployment rates in East Germany have been substantially higher and have been rising between 1990 and 2007 dramatically.

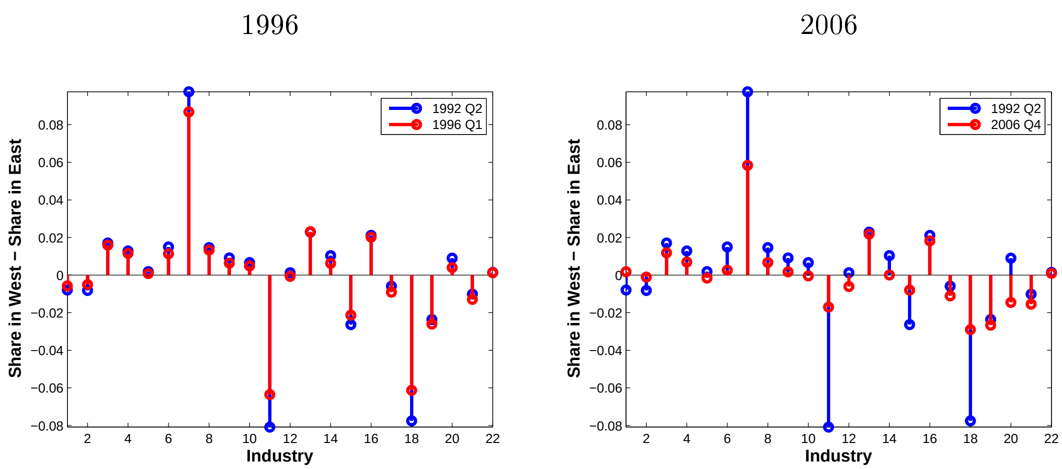
One may argue that the aggregate movements hide movements at the more disaggregate level, because the initial employment shares of industries in the East was substantially different from the West German ones. The latter is indeed the case as Figure VIII shows. In 1992, the East had much more employment in the *Construction Industry*, the *Public Administration* and much less in *Manufacturing*. Two points are

Figure VII: Unemployment Rate



Notes: The figure displays HP-filtered unemployment rates in East and West Germany.

Figure VIII: Industry Distribution



Notes: The figure displays the difference in employment shares for 22 major industries in 1992 and 2007.

to notice here. First, while some of the differences remain, they have become much muted by 2007. Second, there was little convergence until 1996, the time where we saw productivity convergence, but much more convergence, thereafter. Moreover, if we look at output per worker by industry, cf. Figure IX, we see that convergence has occurred only in the primary sectors but in no major goods producing or service sector.

3.3.2 Misallocation

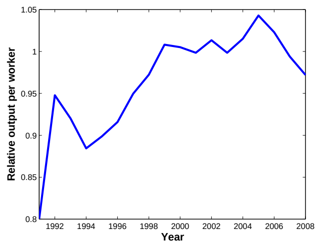
A recent literature argues that cross-country differences in institutions can explain differences in cross-country TFP, even with identical plant productivities, by inducing micro-misallocation of factors (see Restuccia and Rogerson (2008) for a survey). Hsieh and Klenow (2009) argue that these misallocations can explain 1/3 of productivity differences between the US, China and India. Given that institutions are identical between East and West-Germany, we find this an implausible explanation for our case. In a recent contribution, Hsieh and Klenow (2012) show that policies that hinder growth of plants, and thus reduce their investment in organizational capital, can lower average plant productivity and thus create cross-country differences in TFP. Subsidizes from the EU that are targeted to East-Germany usually decrease by plant size and may thus be a potential explanation.

Figure X shows that entering East German plants used to grow faster in early after unification and were larger than their West German counterparts, that the difference was small, however, and has vanished since. In this respect, we find no strong evidence that in East Germany there is less selection of successful start-up plants that hinder allocation of production factors to the most productive young plants and let unproductive plants die.[8] Moreover, in Appendix C, we show that plants in East and West-Germany also grow similar in terms of their workforce's relative skill composition with older plants having a higher averaged skill force. Thus, East-Germany seems to allocate higher skilled workers to surviving successful plants at a similar rate as West-Germany.

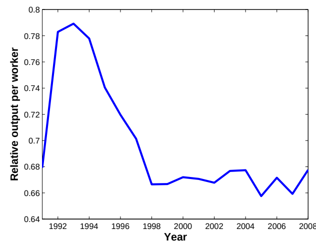
[8] The results stay the same when looking at the manufacturing and private service sector. Plants in the public service sector stay larger in East than in West-Germany at entry and grow at a similar pace.

Figure IX: Output per Worker by Industry

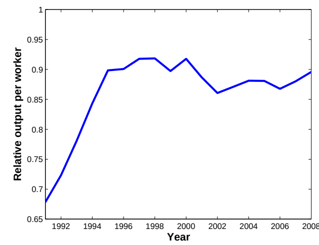
(A) Households



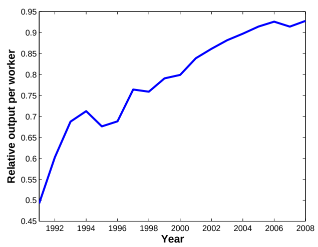
(B) Other Serv.



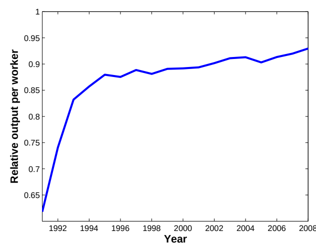
(C) Health



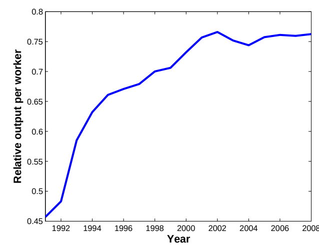
(D) Education



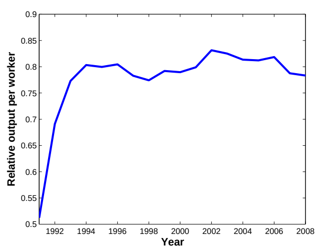
(E) Pub. Admin.



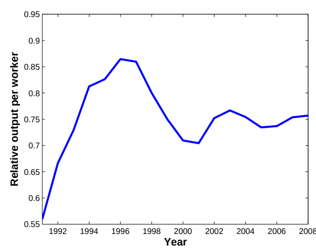
(F) Finance



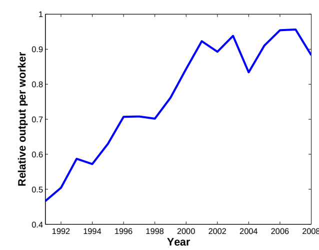
(G) Trade



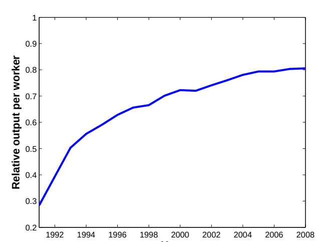
(H) Construction



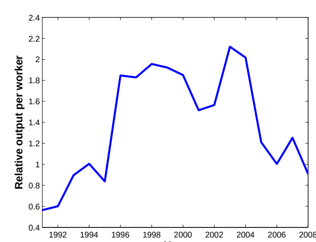
(I) Energy



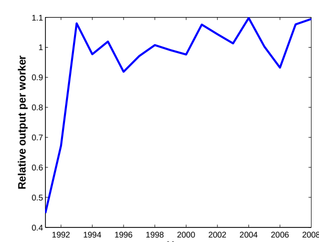
(J) Manufacturing



(K) Mining



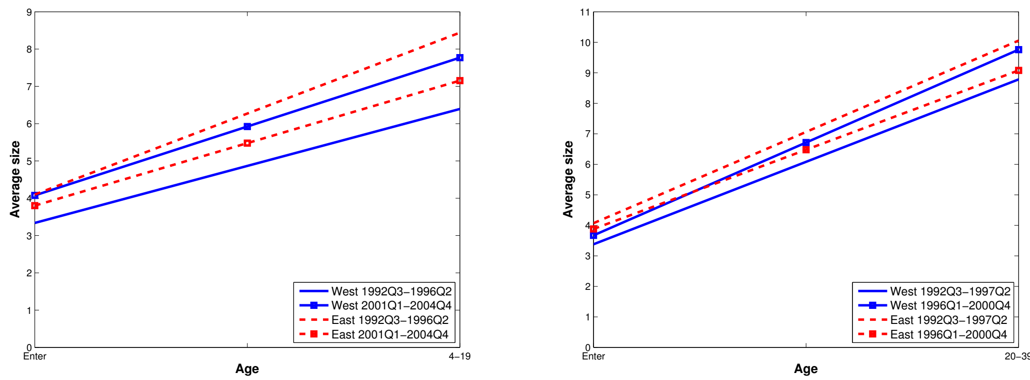
(L) Agriculture



Notes: The figure displays output per worker by industry in East and West-Germany. Employment shares of total economy in West and East: [0.025 0.03], [0.004 0.004], [0.23 0.15], [0.008 0.0115], [0.06 0.109], [0.253 0.232], [0.142 0.131], [0.071 0.093], [0.049 0.08], [0.093 0.095], [0.047 0.059], [0.019 0.006].

Figure X: Average Size from Entering to Later Stages

(A) Birth to Age $4-19$ (B) Birth to Age $20-39$



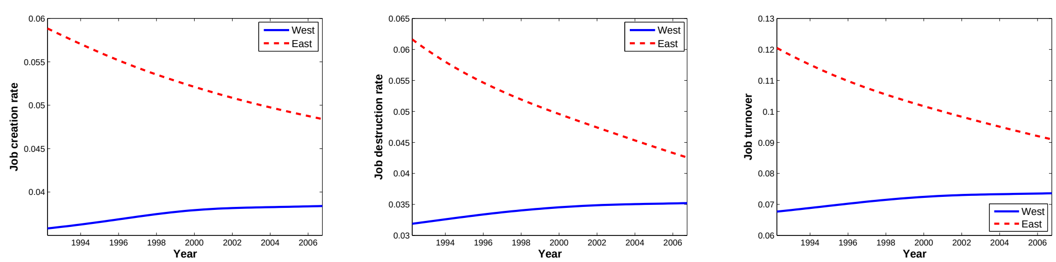
Notes: The figure displays for different time intervals the average size of plants over their life-cycle.

3.3.3 Job Turnover and Plant Survival

Boeri and Terrell (2002) stress the importance of job reallocation for productivity growth in former Soviet Republic countries. Even for the US, the evidence suggests that much of long run productivity growth is driven by the reallocation of jobs from less to more productive plants (see Foster et al. (2001)). In fact, Figure V seems to suggest that, at least partially, the initial growth in labor productivity in Germany was driven by massive plant entry and the exit of unproductive plants.

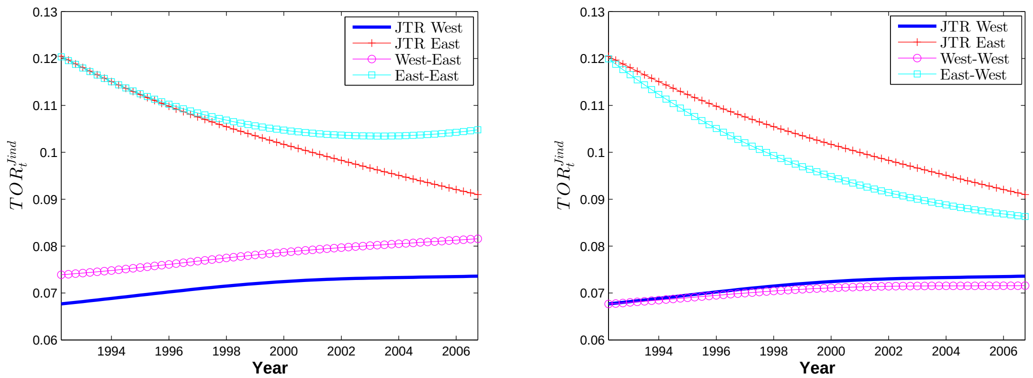
Figure XI: Job Flows

(A) Job Creation Rate (B) Job Destruction Rate (C) Job Turnover Rate



Notes: *Panel A* displays the long run trend in the job creation rate. *Panel B* shows the long run trend in the job destruction rate. *Panel C* shows the long run trend in the job turnover rate.

Figure XII: Decomposing Job Turnover Rates



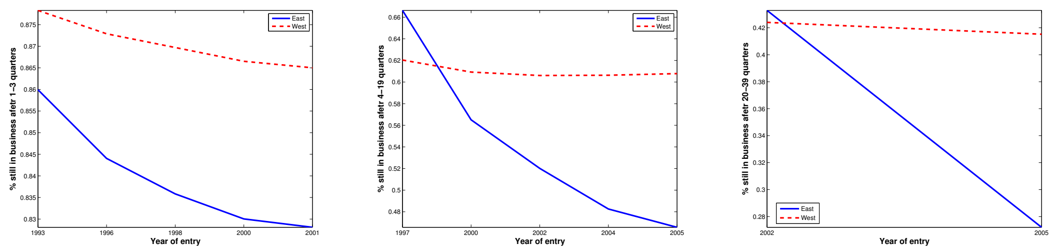
Notes: *Panel A* displays the long run trend in the job turnover rate. It displays the original series and the series where the distribution of employment over industries is fixed at the distribution of industries in 1992 in East-Germany. *Panel B* displays the original series and the series where the distribution of industries is fixed at the distribution of West-German industries in 1992.

Figure XI shows; however, that too low job reallocation in the East does not appear to be the reason for the missing productivity convergence afterwards. The figure displays the long run trend in the job creation rate, the job destruction rate and job turnover rate. We find that job flow rates were much higher in East-Germany than in West-Germany in 1992 and throughout until 2006. There is some trend towards convergence, but as figure XII shows, this convergence is mostly driven by the convergence in industry structure, where industries with high turnover have declined most strongly over the 15 years of the sample. Keeping the East-German industry composition fixed to its 1992 values, convergence in job turnover seizes to exits around 2000, while fixing the industry structure to the 1992 West-German structure, convergence basically stops in around 2002. Details on how these measures are constructed can be found in the appendix. In total, the amount of job turnover in East-Germany was sufficient to destroy and create every job 2.5 times since 1990.

Figure XIII looks at the importance of entering plants for the higher job turnover in East-Germany. It shows that survival rates of newly entering plants are different in East than in West-Germany. While plants entering just after reunification show very similar patterns across the two regions, plants entering at later stages have

Figure XIII: Plants' Survival Probabilities

(A) $1-3$ (B) $4-19$ (C) $20-39$



Notes: The figure displays for different entry times the average probability of plant survival.

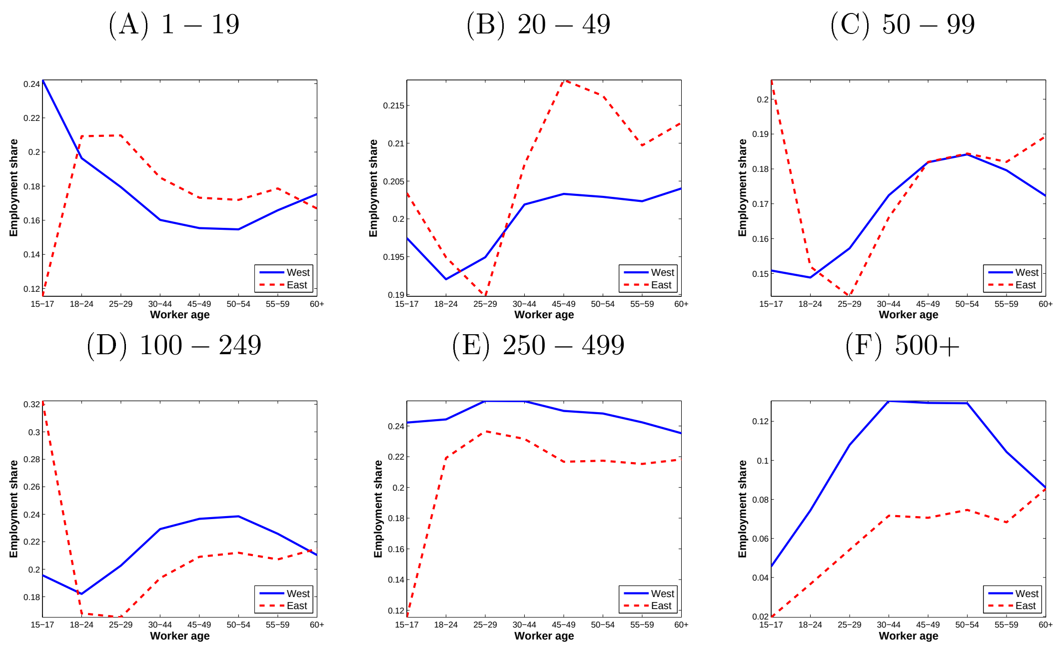
lower surviving probabilities than their West counterparts. Differences are still small $1-3$ quarters after entering the market, but become large thereafter. For example, plants that entered in 2005 are 14 percentage points more likely to survive for $4-19$ quarters in West than in East-Germany. In Appendix D, we show that these differences become even larger when looking only at the private sector, particularly at the manufacturing sector. While visible, the differences are mitigated in the public service sector.

In sum, the data on job turnover suggests the following story: Just after reunification, many new plants entered the market and replaced low productive incumbents. These newely created plants had high survival probabilities leading to rapid productivity growth in East-Germany. After this initial period, entry and job turnover stayed high in East-Germany, but many of the newely created jobs only last for a short period of time.

3.3.4 The Role of Workers' Life-Cycle

Aggregate differences in TFP depend on the distribution of job productivities workers face when entering the labor market, but also the speed they find better jobs over their life-cycle. Put differently, the distribution of job offers to workers may be very similar in two regions, but the endogenous distribution of workers may be very different. We investigate the importance of differences in the wage offer distribution and subsequent career developments by looking at the share of workers at different ages at different plant sizes. Figure XIV shows the distribution of workers with different ages over the plants' size distribution in 2006. While more young workers are at young ages at the largest plants, suggesting that the wage offer distribution is shifted to the right in the West, a significant difference in the equilibrium size (productivity) distribution comes from more workers sorting into these large (productive) plants in West-Germany at prime-age. In East-Germany, workers seem less sucessfull to sort away from small plants over their life-cycle.

Figure XIV: Worker Sorting over the Life-Cycle



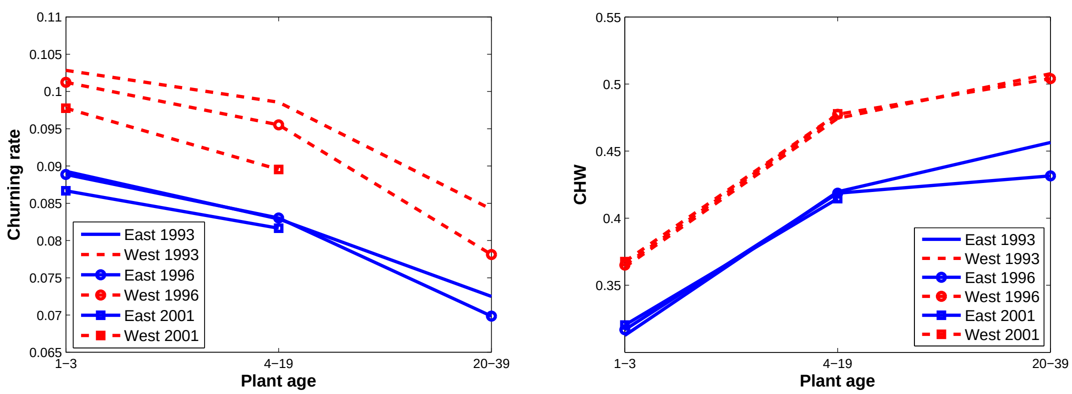
Notes: The figure displays for different worker groups their share of employment at plants with different sizes.

Using German wage data, we can map these differences into wage outcomes for workers. We run a simple mincerian wage equation of log wages on households observables, workers' age and age square. We allow the age coefficents to differ by region. We find that wages grow by about 800 Euros less in East than in West-Germany. The equation is silent about the reasons for the lower wage growth. Our results above; however, suggest that it partially results from less worker mobility over the life-cycle.

Figure XV studies worker reallocation over the life-cycle from the plant's perspective. The churning rate is about 10 percent higher in plants located in the West relative to the East. It shows a downward trend over time, which is similar among the two regions. One way of interpretation is that in the West, plants replace a larger share of their workforce by more suitable matches. Similarly, the share of worker turnover explained by churning is 12 percent lower in the East.[9] Put differently, relatively many worker flows result from jobs being created and destroyed in East-Germany, while match upgrading (either from the perspective of the plant or the worker) is relatively more important in West-Germany.

Figure XV: Churn Behavior and Plant Age

(A) Churning Rate (B) Worker Flows and Churn



Notes: The figure displays for plants entering at different time periods the churning rate and the share of worker flows explained by churn.

4 A Formal Model

This section presents our formal model which rationalizes the above presented stylized facts: Lower productivity and wages, high unemployment and low churning in the East. As in the data, we model the job destruction rate as higher in East than

[9] Again looking by sector, the higher churning rate is driven by a higher churning rate in private, and a lesser extend in public services. It is actually higher in manufacturing in East-Germany. A larger share of worker flows being explained by churn is robust across all three sectors.

in West-Germany. Put differently, we do not adress the source of the difference. One could think of this as reflecting plants in the East to miss the financial means to survive difficult times because household wealth is lower. Alternatively, it may result from missing networks as in Uhlig (2006). The lower plant survival rate is consistent with both of these stories. Our contribution is showing that we can rationalize a substantial fraction of the productivity difference between the two regions as a result from changes in workers' search behavior that results from different job flow rates.

4.1 Model set-up

The economy is populated by a continuum of workers with mass one that are either employed,e_t, or unemployed, u_t. In both cases, workers can choose the probability λ to find an open vacancy. Exerting costs is costly for the worker but the costs may depend on the employment status:

$$\begin{aligned} c_E =& f(\lambda) \\ c_U =& g(\lambda) \end{aligned}$$

Both f and g are increasing and convex functions. Jobs have idiosyncratic productivity x, paying a wage $w(x)$. Search is random and offers a drawn from a distribution with CDF $\Gamma(x)$ and finite support $[\underline{x}, \overline{x}]$. Reflecting the common institutional setting, we assume that this distribution is common in the two regions. The decision of the unemployed worker reads:

$$U = \max_{\lambda} \Big\{ b - c_U(\lambda) + \beta \Big[(1-\lambda) U + \lambda \int_{\underline{x}}^{\overline{x}} V(x) d\Gamma(x) \Big] \Big\},$$

where b is the flow value of unemployment, β is the worker's discount factor, and $V(x)$ is the value of being employed at a plant with productivity x. We make the implicit assumption that only job offers exist that are prefered to unemployment.

The value of employment reads:

$$V(x) = \max_{\lambda}\Big\{w(x) - c_E(\lambda) \\ + \beta\Big[(1-\delta(x,R))\Big((1-\lambda)V(x) + \lambda\Omega(x)\Big) + \delta(x,R)U\Big]\Big\},$$

where $\delta(x, R)$ is the job destruction rate which depends on plant productivity and the region R and $\Omega(x)$ is the value of getting an outside job offer:

$$\Omega(x) = \lambda(V(x)\Gamma(x) + \int_{y=x}^{\overline{y}} V(y)d\Gamma(y)).$$

Because δ is higher in the East by assumption, the East also features a higher unemployment rate. Consequently, these workers have less time to sort into highly productive plants. Additional, on-the-job search is less attractive when job destruction is high. A high job destruction rate reduces the gains from being employed in a high relative to a low productive plant. Therefore, workers perform less on-the-job search in the East. As in the data, workers sort less into more productive plants and the average plant productivity becomes even lower.

4.2 Calibration and Results (Incomplete)

Our calibration strategy is to match moments from job and worker flows in West-Germany. Our target is the year 2000, where we stop to see convergence in job flow rates conditional on the industry mix. We then ask how much of the productivity difference we can explain when imposing a job destruction rate that is, as in the data, larger for each plant size.

We find that average productivity is 10 percent lower in East than in West-Germany. Put differently, of the 30 percent productivity difference, we can explain 1/3 by differences in workers' search behavior resulting from higher job turnover in East-Germany. In this sense, high job turnover rates seem not to be a driving force of productivity growth in East-Germany after 1995 but rather a barrier to growth.

5 Conclusion

- Besides common legislation and institutions, labor productivity and wages are 30% lower in East than in West-Germany since 1994 and show no convergence.
- Neither missing convergence in capital intensity, labor force training, industry composition, or a failure to allocate resources to the most productive growing plants can explain these persistent differences.
- Using a newly composed data-set, we show that job and worker flows are larger in the East, a relatively high share of worker flows in the East result from jobs being created and destroyed, and a relatively low share of workers work at high productive plants in the East.
- We rationalize these facts using a model with endogenous on-the-job search.

A Structural Break Adjustment

This section describes how we perform structural break adjustment. Call any seasonal adjusted series Y. For each Y we detect the number of structural breaks and assign a dummy variable to each D_{it} that takes the value 1 during the break. We have the following model for the DGP in mind:

$$Y_t = \beta_0 + \beta_1 D_{1t} + ... + \beta_n D_{nt} + f_t + \epsilon_t$$

where n is the number of structural breaks, ϵ_t is some short time fluctuation and f_t is a smooth time trend that is estimated semi-parametrically. To be more specific, we employ a local linear Gaussian kernel regression of the original series where points in the structural break receive zero weight. We then compute the residual

$$Y_t - f_t = \beta_0 + \beta_1 D_{1t} + ... + \beta_n D_{nt}$$

We regress this residual on the defined set of dummy variables to obtain their predicted effects $\hat{\beta}_i$. The structural break adjusted series is then computed by

$$Y_t^{sb} = Y_t - \hat{\beta}_1 D_{1t} - ... - \hat{\beta}_n D_{nt}$$

B Constructing Constant Industry Distributions

This section describes how we compute the time series for fixed industry shares that we use in Figure XII. Call the trend component (in levels) of a HP-filtered series of industry j X_t^j. Moreover, compute for each industry in each region its relative dynamic employment share:

$$ec_t^j = \frac{em_t^j}{EM_t}$$

We now weight the current period series by initial relative employment shares:

$$X_t^{ind} = \sum_{j=1}^{J} (ec_1^j * X_t^j),$$

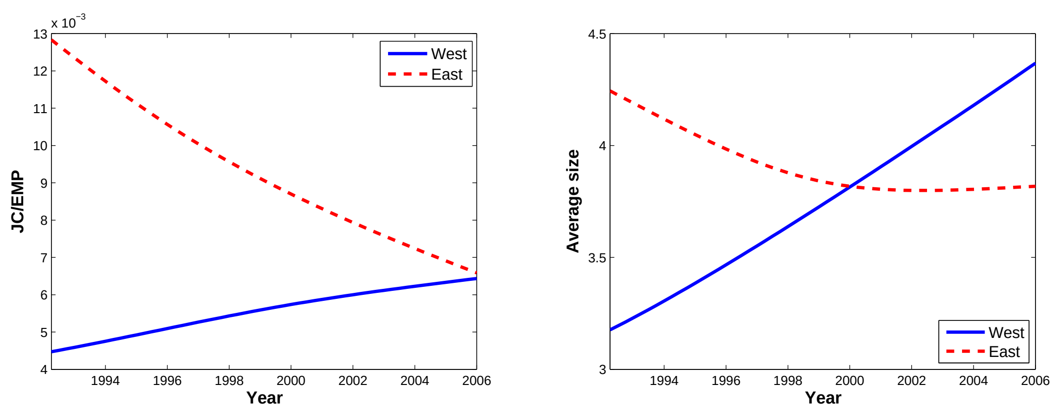
where ec_1^j is either the employment composition from East or West-Germany.

C Plant Entry

This section looks at the aspect of plants newly entering the market in East and West-Germany. The top panel of Figure XVI looks at average plant entry in East and West-Germany. The share of jobs created by new entering plants relative to total employment was twice as high in East-Germany just after reunification, but it falls throughout the sample converging to the level of West-Germany by 2006. The average entrant was larger in East-Germany after reunification, but average size falls throughout the sample in East-Germany, while it is increasing in West-Germany, leading to larger entrants in West-Germany at the end of the sample.

Figure XVI: Entering Plants

(A) Entering Share of Employment (B) Average Size Entering



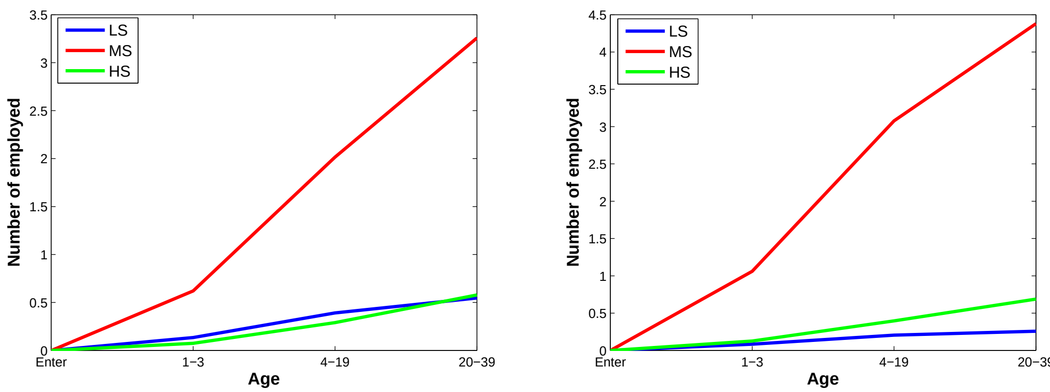
Notes: The figure shows the share of employment created by newly entering plants and the average size of entering plants in East and West-Germany.

In the main text, we show that plant growth is very similar in East and West-

Germany over the first ten years of a plant's life. We extend this analysis here showing that the growth among different skilled workers is very similar among the two regions.

Figure XVII: Employment Growth by Education

(A) West (B) East

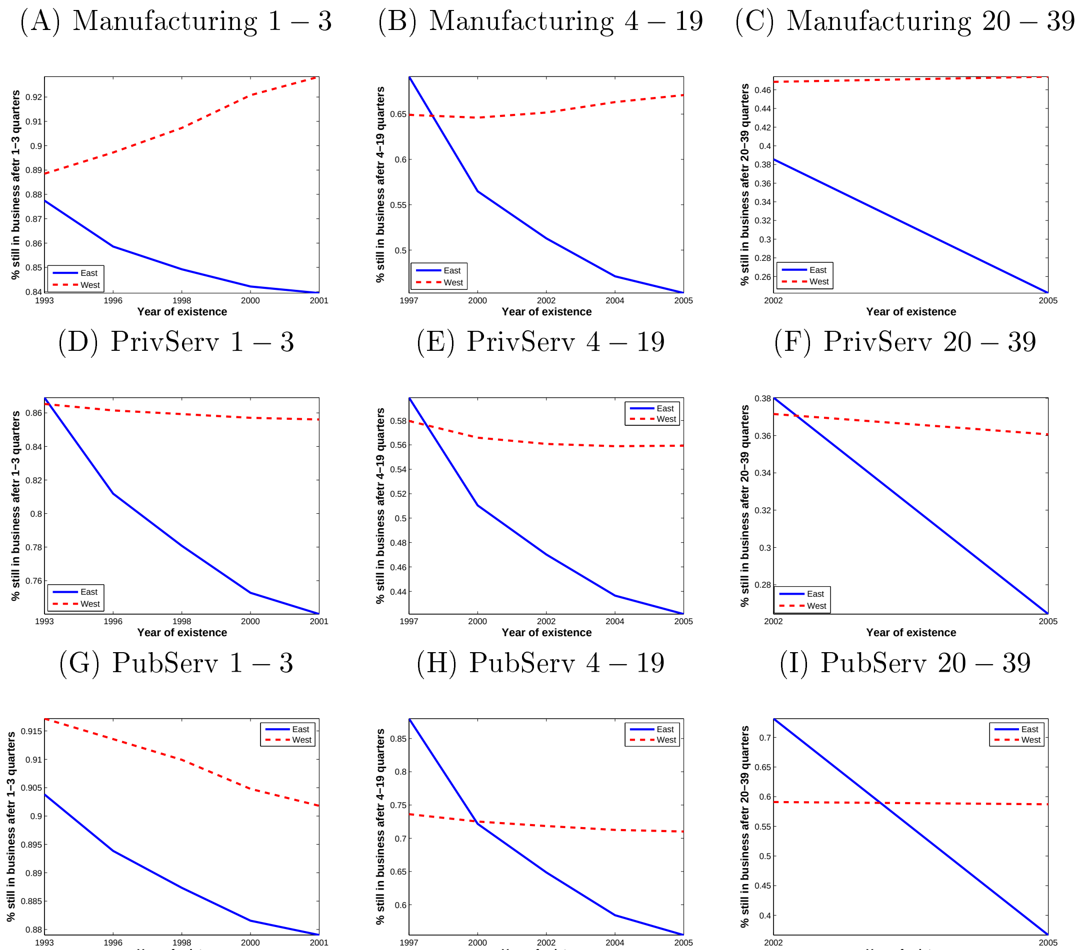


Notes: The figure shows the average amount of additional workers of different education levels for plants born in 1992, conditional on their age. HS: Academic training, MS: Professional training, LS: No formal training.

Figure XVII displays the average amount of additional workers of different education levels over the first ten years of a plant created in 1992. The amount of additional workers with a professional training is somewhat larger in the East, representing that these plants grew somewhat faster, but the profiles are very similar across the two regions. We find the same result when looking at work tasks instead of workers' education. Therefore, we cannot find evidence that plants in the East are less successful in allocating higher skilled workers to surviving plants than in West-Germany.

D Cohort Behavior by Sector

Figure XVIII: Survival Rates by Sector



Notes:

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