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The East-West German Gap in Revenue Productivity: Just a Tale of Output Prices?*

Abstract

East German manufacturers' revenue productivity (value-added per worker) is some 8 (25) percent below West German levels, even three decades after German unification. Using firm-product-level data containing information on product quantities and prices, we analyse the role of product specialisation and reject the prominent ‚extended work bench hypothesis', stating a specialisation of Eastern firms in the intermediate input production as explanation for these sustained productivity differences. We decompose the East's revenue productivity disadvantage into Eastern firms selling at lower prices and producing more physical output for given amounts of inputs within ten-digit product industries. This suggests that Eastern firms specialise vertically in simpler product varieties generating less consumer value but being manufactured with less or cheaper inputs. Vertical specialisation, however, does not explain the productivity gap as Eastern firms are physically less productive for given product prices, implying a genuine physical productivity disadvantage of Eastern compared to Western firms.

Keywords: German unification, regional productivity gap, physical productivity, product prices, product specialisation

JEL Classification: D24, L2, L11, O47

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1. INTRODUCTION

AFTER THE FALL OF THE IRON CURTAIN AND GERMAN UNIFICATION IN 1990, it became apparent that the former centrally planned GDR economy could not compete in a market economy facing world market prices (e.g. Akerlof et al. 1991, Collier and Siebert 1991). Based on GDR data, Akerlof et al. (1991) estimate that only about 10 percent of the former GDR's workforce were employed at firms viable at world market prices. When West German dominated labor unions and employer associations agreed on raising East German wages by about 40 percent over the course of 1990, quickly reaching up to about 75 percent of West German standards, many East German firms had to lay off the majority of their workers or to close entirely. During the years 1990-1991, the East German economy experienced a breakdown unprecedented in modern economic history: it lost about one third of GDP and non-employment rose from zero to about 30 percent.[1]

While the dramatic magnitude of the breakdown of the East German economy came as a surprise for many observers, it was still believed that once state-of-the-art machinery had been installed and production patterns had been adjusted to world market standards, East Germany would continuously catch up to the West. And indeed, already in 1991, the former GDR reached about 40 percent of West German GDP per worker and, until the mid 1990s, East Germany sharply increased its GDP per worker reaching about two thirds of the West German productivity level (see Figure 1). However, after this initial success, convergence slowed down considerably. Despite massive and sustained state aid, e.g. in the form of place-based policies, the East German economy was largely unable to attract or create headquarters of global players and the innovation activity of private firms falls

[1] Non-employment includes unemployment and employment in publicly subsidized labor market programs. We refer to Sinn and Sinn (1994) and Burda and Hunt (2001) for an excellent description of the early years of transformation.

short of West German levels.[2] Even 30 years after the German reunification, East German GDP per worker is 20 percent below the West German level.

How can we explain this persistent East-West productivity gap given the identical institutional setting in both regions and free factor mobility between East and West Germany? Despite its clear policy relevance, the literature is far from providing a sufficient answer to this question. Existing research shows that East Germany is endowed with human capital comparable to West German standards (Burda and Hunt 2001) or even outperforms the West in terms of formal educational levels (Kluge and Weber 2018). As physical capital intensity seems to be higher in the East, too (Burda and Severgnini 2018), explanations for the persistent GDP per capita gap focus on manifested differences between both regions' revenue TFP-levels (Burda and Hunt 2001).

Only few papers have questioned whether the substantial differences in revenue productivity between both regions really mirror differences in physical productivity or differences in output prices and specialization patterns (e.g. Burda and Hunt 2001, Paqué 2009). Based on granular ten-digit product data, our study is first in exploring systematically differences in prices between East and West German products as an alternative explanation for the gap in revenue productivity. To this end, we also analyze whether Eastern firms produce completely different (horizontal specialization) or simpler varieties of the same products (vertical specialization) compared to Western firms.

[2] In 2016, only 36 out of the largest 500 German (multicorporate) enterprises were located in East Germany (7 percent). Compared to that, the East German population share is about 20 percent (Halle Institute for Economic Research 2019). Average R&D expenditures as shares of value-added over the period 1995-2017 are 0.23 and 0.31 percent in East and West Germany, respectively (Statistisches Bundesamt 2020, Bundesministerium für Bildung und Forschung 2020). Table 2 below shows also a lower extensive margin of firms investing in R&D in our sample.

Aggregate productivity differences due to differences in aggregate price levels between both regions may result from horizontal specialization patterns and a first common argument to be tested is whether East Germany, similar to other post-communist regions in Eastern Europe, (still) serves as an extended workbench of Western firms. The term "extended workbench" refers to firms producing standardized intermediate products of low complexity that, compared to more sophisticated final products, feature a lower scope for product differentiation, leading to lower price over marginal cost markups. Utilizing official micro data on German manufacturing firms containing information on firms' product prices and quantities at the ten-digit product level over 15 years, we can directly test the extended workbench hypothesis by controlling for differences in regional product portfolios. Effectively, we thereby compare firms producing products at the same position in the value chain. We find that East-West differences in firms' revenue productivity are unaffected by controlling for product fixed effects and, thus, find no support for horizontal specialization explaining the productivity gap. This also implies that if price differences matter for productivity differences, they matter in the form of vertical specialization within narrowly defined product classes

Secondly, and at the heart of this paper, Eastern firms may produce the same type of goods but are unable to command western prices, implying that customers receive less utility from consuming Eastern, compared to Western, varieties of a given product.[3] Such vertical specialization patterns are plausible as, after the fall of the iron curtain, East

[3] We look at manufacturing, and thus tradable, goods that can be sold to the same customers in different locations. Product price differences therefore reflect differences in consumer value rather than in regional purchasing power. We perceive firms' decision to produce for regional versus national or international markets as result and not source of differences in product valuation. In our final sample, 62 (79) percent of East (West) German manufacturing firms are exporters. Our results do not change once we control for firms' export status in our productivity regressions. This implies that any regional differences in consumer preferences are also unlikely to explain the documented price and productivity differences.

German firms entered the world market without any established brand names for their products[4] and with low perceived product quality (e.g. Collier and Siebert 1991). Thus, East German firms had either to specialize in cheaper products or to heavily invest into product quality, brand names, and reputation to catch up to their Western counterparts in terms of product appeal and output prices.

We show that even three decades after the fall of the iron curtain, Eastern firms still choose to specialize in cheaper varieties of a given product.[5] As cheaper products can typically be produced with fewer inputs (e.g. less investments into brand names, handmade and customized production versus assembly line production), there generally exists a tradeoff in revenue productivity between producing more goods versus producing goods with higher consumer utility and thus prices (Atkin, Khandelwal, and Osman 2019). As it is *ex ante* unclear whether this tradeoff in revenue productivity favors producers of high or low utility products, we additionally test whether the East German disadvantage in revenue productivity results from either the tradeoff working against low utility producers or from lacking physical productivity in the East.

We first document that, *within a given product category*, Eastern firms physically produce *more* goods for given amounts of inputs but earn lower revenues.[6] We then show, however, that Eastern firms' revenue productivity is lower because, when producing the same product for the same price segment, their physical productivity is 5-8 percent below

[4] Brand values have been close to zero as traditional customers of GDR firms were located in the Eastern European countries and these trade relations collapsed after the fall of the Iron Curtain. What is more, in the early 1990ies many East German consumers rejected East German products *per se* (Sinn and Sinn 1994).

[5] In section 4.2, we provide evidence that observed price difference result from lacking branding rather than from inferior product quality.

[6] We estimate log differences in our regressions and infer on the average percentage difference in physical productivity within product categories. Focusing on the average *within-product-category percentage* difference in physical productivity between East and West German firms addresses the issue of aggregating quantities across distinct products (which would be meaningless).

Western levels.[7] Simply switching to high-price products will barely help the East as we find that the quantity-price tradeoff only marginally benefits high-price producers. Hence, vertical specialization cannot explain the documented productivity gap.

Finally, we ask why East German producers survived in the long run despite lower productivity. We demonstrate that lower labor costs outweigh lower productivity such that there are only small differences in competitiveness between Eastern and Western firms. If at all, competitiveness is slightly higher in the East.

The remainder proceeds as follows: Section 2 reviews the literature, Section 3 presents the data and discusses descriptive evidence on output price differences between East and West Germany, Section 4 presents our empirical results and additional robustness and heterogeneity analyses. Section 5 concludes.

2. LITERATURE REVIEW

Our article speaks to the large literature on the economics of transformation of post-communist economies from which several studies also specifically address Germany and its reunification. Focusing on the type of capital investments, Snower and Merkl (2006) argue that young workers migrating to West Germany led to capital investments tailored to the comparative advantages of older workers, dampening labor productivity. They also conjecture that massive subsidy programs for the East helped to keep uncompetitive enterprises alive and lead to underutilization of production factors. Uhlig (2006) argues that, even when ignoring policy distortions, superior worker-firm match quality due to agglomeration advantages would permanently favor the West. Burda and Severgnini

[7] When looking at a value-added specification, the productivity gap is 26 percent, implying a scaling up by the inverse of 1 minus the output elasticity of intermediate inputs. See online Appendix D.

(2018), however, do not find much support for this conjecture. Instead, they confirm the notion of excess capital intensity put forward by Snower and Merkl (2006) and additionally explain persistent productivity differences with low concentration of managers, low startup intensity, and smaller firm size.

Focusing on the mode of competition, Aschhoff et al. (2007) show that R&D expenditures and innovative activities are lower in the East. They also report that East German firms compete more over prices and less over the technological sophistication of their products (Aschhoff et al. 2007: Table 5). This and the results on management capacity and start up intensity put forward by Burda and Severgnini (2018) point to a less complex mode of production in Eastern firms where, on average, produced goods are manufactured using less sophisticated inputs and yield lower prices.

So far, the academic literature ignored output price differences *for similar products* as a possible explanation for the East-West German revenue productivity gap. Most closely related to this, Burda and Hunt (2001) investigate output price changes in a macroeconomic growth accounting exercise and report that increasing East German output prices supported the convergence in revenue TFP in the first half of the 1990ies but not in the second half. Paqué (2009) argues that regional differences in physical productivity are unlikely given similar endowments and concludes that the revenue productivity gap must be due to output price differences. Although he does not utilize any micro data on quantities and prices, Paqué (2009) observes lower levels of export activities and R&D investments in the East. He argues that both is indicative of less sophisticated production processes, arguably explaining lower output prices in the East. Yet, neither Burda and Hunt (2001) nor Paqué (2009) ask whether price and associated

revenue productivity differences result from horizontal or vertical product specialization, which is a key aspect of our study.[8]

Finally, our study is also related to research on the prevalence and causes of large and persistent productivity dispersion across firms within narrowly defined industries (for a review see Syverson 2011 and Bartelsman and Wolf 2018).[9] Most of this literature focuses at industry-level measures of revenue productivity dispersion while abstracting from the role of firm-specific prices for shaping firm productivity differences. Notable exceptions are Foster et al. (2008) and Atkin et al. (2019) who respectively study producers of a selected set of homogenous products in the U.S. market and a sample of 219 Egyptian rug-making firms. Both studies document an inverse relation between firms' quantity-based productivity and output prices and find large firm productivity differences within these narrowly defined product markets that are larger for quantity- than for revenue-based productivity measures. Similar to Foster et al. (2008) and Atkin et al. (2019), we report large differences in revenue- and even larger differences in quantity-based productivity measures between East and West German firms active in the

[8] In fact, a few older policy reports argue for the relevance of price effects (e.g. Mueller 1998, Brenke et al. 1998). None of them, however, provides a systematic analysis of price effects as we do. The most detailed empirical analysis is Mueller (1998) showing that price differences for a small sample of industrial products have been substantial in 1995. Mueller (1998) estimates that value-added per worker in the manufacturing sector of the East German state of Saxony would jump up from 55 percent to 80 percent relative to the West German state of Bavaria once output price differences are corrected for. Similarly, Brenke et al. (1998:26) argue *'There are quite a few hints that East German producers specialize vertically. They prefer producing for the lower and middle price segments because they can't compete in quality, the latter often being a competition in reputation.'* (translation by the authors). The main notion of these studies is that any price differences as observed in the 1990ies should be transitory and likely reflect the desire of East German firms to build up reputation by entering new markets and temporarily competing via low prices (Brenke and Zimmermann (2009) make a similar argument).

[9] While the existence of large and persistent productivity differences across firms producing similar goods is well-documented, the literature departs on the interpretation of this finding. Hsieh and Klenow (2009) view dispersion in revenue productivity (TFPR) as a result of policy distortions that causes misallocation, while Asker et al. (2014) highlight the role of adjustment costs in generating dispersion in TFPR. Bartelsman et al. (2013) emphasize the existence of frictions, such as overhead costs as potential source of TFPR-dispersion and Bartelsman & Wolf (2018) note that entrepreneurial innovations that entails more experimentation can cause productivity dispersion among firms within narrowly defined industries.

same narrow product markets (our ten-digit classification divides products in 6,500 distinct categories). We interpret these findings as resulting from vertical product differentiation within extremely narrow product markets and provide novel large scale evidence on several thousand German manufacturing sector firms supporting the view of the specialized study by Atkin et al. (2019) that pure quantity-based productivity measures might be misleading when aiming at comparing the broad productive capabilities of firms, defined as firms' quality- or consumer value-weighted quantity productivity. Therefore, our study also informs the general debate on how to accurately measure firms' productivity and performance (see De Loecker 2011, Van Beveren 2012, and De Loecker et al. 2016 for a discussion).

3. DATA AND SOME FIRST IMPRESSIONS

3.1 The AFiD-Database

We use administrative firm-product-level panel data on German manufacturing sector firms with more than 19 employees (henceforth AFiD) over the years 1999 to 2014. The data is supplied by the statistical offices of Germany and is separated into two dataset.[10] One is a firm-level panel dataset containing, among others, information on firms' investments, costs, employment by full time equivalents (FTE), and realized revenues, including product market sales and revenue from other sources (e.g. offered services). The other dataset is a complementary firm-product-level panel containing the quantities

[10] Data source: Research Data Centre of the Federal Statistical Office of Germany and the Statistical Offices of the German Länder. Names of statistics used: *"AFiD-Modul Produkte", "AFiD-Panel Industriebetriebe", "AFiD-Panel Industrieunternehmen", "Investitionserhebung im Bereich Verarbeitendes Gewerbe, Bergbau und Gewinnung von Steinen und Erden", "Panel der Kostenstrukturerhebung im Bereich Verarbeitendes Gewerbe, Bergbau und Gewinnung von Steinen und Erden"*.

and sales values of products evaluated by firms at the factory gate. Products in AFiD are reported at an extremely fine ten-digit classification (called GP) from which the first nine digits correspond to the PRODCOM classification, while the last digit indicates whether the product was manufactured as contracted work. Table 1 provides a few examples of products available in our data. As can be seen, the individual product categories are extremely detailed (e.g. Long trousers for men, cotton (not contracted)). Yet, the product categories still allow for vertical product differentiation within ten-digit products. For instance, long trousers are specified by its material (e.g. cotton) but not by their numbers of trouser pockets, durability, or resilience. As we discuss, such within-product-category product differentiation is important for understanding price and productivity differences between East and West German firms.

Note also that product categories naturally differ in their scope of product differentiation. For instance, "Zinc, unwrought" likely features a lower scope for product differentiation than "Long trousers for men, cotton". Finally note that our product classification differentiates between contracted (were firms receive the materials and only manufacture the product on demand) and non-contracted (standard production for the market) products. This allows us to control for any such differences in the production processes between firms that may be related to firms' produced quantities, product prices, and productivity.

We use the firm-product-level dataset to compute output quantities and (factory gate) prices of firms. To define firms' total revenue and input usage associated with the generation of this revenue, we use the complementary firm-level dataset because the firm-product-level data does not include information on firms' input usage. Our revenue variable thus refers to realized revenues and includes revenues from firm activities other

than selling own manufactured products. Our quantity and price variables, however, refer exclusively to own manufactured products at the factory gate. This causes the identity $revenue = price * quantity$ to not exactly hold in our data. Yet, product sales values at the factory gate and total realized firm revenues are highly correlated (p=0.95). Nevertheless, in our regression analysis, the discrepancy between both output variables will cause minor inconsistencies when decomposing regional revenue-based productivity differences into quantity-based productivity and price differences. We therefore provide a robustness check in online Appendix B, where we replicate our main regressions of section 3 while controlling for firms' factory gate product market sales values over total realized revenue. Our results are unaffected from including this additional control variable.

In principle, AFiD covers the total population of German manufacturing sector firms with more than 19 employees. To limit administrative burden, however, some variables are only collected for a representative panel that encompasses roughly 40 percent of all firms and which rotates every four to five years. As this panel dataset includes information on intermediate input costs, which is key to study firm productivity, we focus our analysis exclusively on this representative sample of firms.

During our observation period, the product and industry classification changed in 2002 and 2008. As we aim to control for industry and product fixed effects in our cross-sectional comparison of firm productivity between East and West Germany, we follow the procedure described in Mertens (2020a) to recover a time-consistent classification of industries and products by reclassifying products based on product-level concordances and the observed product mix of firms during reclassification periods. To ensure that we compare firms producing varieties of the same product category with each other, we

exclude all product-level observations that cannot be classified into the 2002 vintage of the German GP classification scheme from our analysis. This results in a loss of about 2.5 percent of all product observations. After a basic outlier cleaning procedure of the firm data, we end up with 187.000 firm-year observations from which 157.000 (30.000) are located in West Germany (East Germany).[11]

3.2 East versus West German Firms: First Impressions

Table 2 presents descriptive statistics for our sample, separately for East and West German firms. Whereas West German firms display higher levels of revenue per FTE, East German firms produce more quantities per FTE and generate more revenue per wage unit (Euros). However, as these are unconditional statistics, their interpretation warrants some caution. Especially differences in quantity-based performance measure cannot be easily interpreted across different product-industries – a fact that we will consider in our regression analysis by controlling for product fixed effects. Concerning the input factor mix, we find that capital intensities are higher in Eastern firms, confirming aggregate results in Burda and Severgnini (2018).[12] In contrast, Western firms use more intermediate inputs per FTE and yet have a slightly higher value-added depth. Moreover, we find that, on average, West German firms are larger, produce a larger variety of products, possess higher product market shares, are more often engaged in export and R&D activities, and pay higher wages.

[11] We exclude the top and bottom one percent of outliers in revenue over production inputs, revenue growth, and value-added growth. Moreover, we exclude the top and bottom one percent of product observations with respect to the distribution of product price deviations from the average product price.

[12] We derive capital stocks using a similar method as in Mueller (2008). For a detailed explanation on deriving capital stocks with the AFiD-data please see the online Appendix of Mertens (2020b).

Going beyond mean comparisons, we present density plots for each of our performance measures in Figure 2. Panel A shows density plots for firm-level revenue per FTE and, correspondingly, Panel B plots the firm distribution of produced quantity per FTE. We used two-digit industry averages to demean firm-level revenue per FTE and thus report deviations from the mean, only. For physical output per FTE we accordingly present firm-level deviations from ten-digit product averages but plot only single-product firms. Latter accounts for differences in measurement units and product characteristics across different goods within firms. Focusing on single-products firms for our revenue per FTE measure, too, produces a graph that is qualitatively identical to Panel A of Figure 2 (see online Appendix C).

As Figure 2 shows, the West German advantage in revenue per FTE is not driven by a few exceptionally productive firms. Instead, the entire West German firm distribution is rightward shifted. Hence there are less low-productive *and* more highly productive firms in terms of revenue per FTE in West Germany than in East Germany. The rightward shift points at a pervasive and uniform cause for the productivity gap rather than at differences concentrated at specific points of the productivity distribution. Interestingly, Panel B shows that in terms of produced quantity over FTE, we find the opposite: The East German firm distribution is slightly rightward shifted compared to its West German counterpart. As revenue equals quantity times price, this already implies that product prices play a key role for understanding the gap in revenue productivity between East and West Germany.

One of the main advantages of our data is its detailed information on firm-product prices and much of our regression analysis will focus on exploiting this information by decomposing observed differences in revenue productivity into differences in output

prices and quantity productivity. To illustrate how firms' product prices differ between both regions, Figure 3 and 4 plot the log difference in firms' average output prices between East and West Germany for each ten-digit product that is manufactured in both regions.[13] In Figure 3, we pool all industries, whereas in Figure 4, we separate our price comparisons by two-digit industries. In both Figures, the horizontal axis lists all products ordered by price-differences. Positive values imply that West German product prices are higher. To avoid aggregating product prices across the various products of a multi-product firm, Figures 3 and 4 are based on our sample of single-product firms, which explains why we observe only a few products in some industries.[14]

About 70 percent of all products manufactured in both regions are higher priced in Western firms. If we exclude industries for which we only observe a small number of different products, we do not find a single two-digit manufacturing industry in which East German firms produce, on average, higher priced goods than their Western counterparts. Note that price differences in Figure 3 refer to log differences. Hence, we document that, in the extreme cases, product prices differ by a factor of 250 between East and West German firms. To provide more insights on the price difference between East and West German firms, Table 3 lists the five products with the largest positive (i.e. higher prices in West German firms) and negative (i.e. higher prices in East German firms) price differences in our sample of single-product firms.[15]

[13] We first calculate price differences for each product-year-bin and subsequently average across all product-year-bins.

[14] In online Appendix C, we present the same graphs for all products of the German manufacturing sector in our data. The graphs are remarkably similar to Figures 3 and 4, implying that our single product sample reliably represents price differences between East and West German firms.

[15] Across all products in the German manufacturing sector, the three product categories displaying the highest price differences between East and West German firms are: i) Dynamic read-write memory, with a memory capacity of not more than 4 Mbit (log price difference of 6.80), ii) Polypeptide, protein, glycoprotein hormones (log price difference of -6.62), and iii) Fire extinguisher and fire-extinguishing systems with a weight of more than 21 kilograms (log price difference of -6.46).

We investigate further into these huge price differences in online Appendix E and show that i) our reported East-West price differences are not a result of our product reclassification and ii) regional product price differences in the raw data are even larger than in our single-product firm sample. As the statistical offices of Germany run careful checks on their data (we discussed our findings with them) in which they even consult with the reporting firms/plants in case of doubts on the reported prices, we are confident that misreporting plays only a minor role and cannot explain the observed product price differences. See online Appendix E for an in-depth discussion.

4. REGRESSION RESULTS

4.1 Main Results

Productivity

In the following, we use OLS-regressions to project our productivity measures (revenue per FTE and quantity per FTE) on a dummy variable indicating whether a firm is located in East or West Germany while controlling for capital over FTE and intermediate inputs over FTE ratios. Compared to control function approaches estimating TFP, our approach comes with the advantages of i) not demanding bootstrapping routines for calculating correct standard errors and ii) not requiring lagged values of certain variables and thus maximizing the available sample of firms. Importantly, our approach produces points estimates on our dummy-variable that are qualitatively identical to TFP estimates based on a control function approach as shown in online Appendix A.

The OLS coefficients on the East-dummies presented in Table 4 measure the East-West productivity gap in log points. The first column shows results for the full sample

covering some 190,000 observations. Controlling for firms' capital intensity and the value of intermediate inputs per FTE but without conditioning on sector or product dummies, East German firms are characterized by 8.1 percent (8.5 log points) lower revenue per FTE. As we aim to use product-level fixed effects in a single-product firm sample to compare firm productivity of manufacturers producing goods of the same ten-digit product category, column 2 tests whether our single-product firm sample yields results comparable to the full sample results in column 1. Reassuringly, we find almost identical results for all estimated coefficients. In online Appendix D, we discuss results for value-added labor productivity. There we document a productivity gap of 26 percent, which, as we show, equals an upscaling of the coefficient on the East-dummy of the revenue labor productivity specification by the invers of 1 minus the output elasticity of intermediates.

The extended work bench hypothesis states that West German and foreign owned firms outsourced their assembly lines to East Germany, such that the East is mostly concerned with producing standardized, low margin intermediate products, while Western firms produce and sell final products, potentially build from these intermediates. According to this hypothesis, the productivity disadvantage of the East is rooted in mark-up differences resulting from producing goods that, compared to the West, are more upstream in the value chain. Put it differently, the hypothesis states that the gap stems from Eastern firms structurally producing different (ten-digit) products than Western firms (i.e. are horizontally differentiated from Western firms) instead of producing different varieties of a given product (i.e. vertical differentiation within a given ten-digit category). If this would be true, controlling for detailed product fixed effects in our regressions should at least partially reduce the East-West productivity gap. Yet, controlling for product fixed effects leaves the coefficient on the East-dummy practically unchanged (Table 4, column

3), indicating that horizontal specialization and the extended workbench hypothesis cannot explain the East German productivity disadvantage[16] Additionally, the irrelevance of including product fixed effects for the East-West productivity gap implies that if price differences matter, they matter in the form of vertical specialization within narrowly defined product classes.

Column 4 of Table 4 presents our main estimates for physical output. Quantities are counted in their physical units (tons, liters, numbers). Our within-product estimator ensures that we always compare the same physical units when comparing firms' output.[17] The coefficient for East Germany is positive indicating that East German firms produce about 20 percent more physical output from the same amount of inputs. Even if one argues that some intermediate inputs are bought locally (e.g. legal, cleaning, or security services), may thus be cheaper in the East, and we therefore underestimate the amount of physical *inputs* in the East, it is very unlikely that this can explain a physical productivity advantage of more than 20 percent.

That East German firms produce more physical output per input unit implies that the gap in revenue productivity results from higher output prices of West German firms. This immediately leads to two further questions: Why is physical output higher in the East and why are prices lower? We argue that vertical product specialization is the answer to both questions. We assume that manufacturing goods are tradable, the same customer, independent of its location, can buy East and West German goods. Under this assumption,

[16] Including product fixed effects also controls for detailed sector differences. Hence, comparing results without and with product fixed effects implies moving from not controlling for sector differences at all to controlling for it in an extremely granular way. Our results therefore also indicate that sectoral compositions do not matter for the productivity gap.

[17] This is crucial and prevents us from showing physical productivity estimates without controlling for product fixed effects.

price differences for the same products must reflect differences in consumer utility attached to these products.

Differences in consumer utility may stem from differences in product quality (physical quality, design etc.) or valuable brand names generating customer utility. While we think it is interesting to know which one of these two aspects is more important and we present evidence on it in section 4.2, this distinction is immaterial for answering the two questions above as both views imply that the West is investing more into upgrading its products. If quality is relevant, the West produces fewer physical products because of these products being more sophisticated (e.g. handmade, customized, build from specific machinery). If, however, brand names would be relevant then the fraction of inputs devoted to replacement investments in the brand name capital stock (e.g. marketing expenditures) is higher in the West, which would explain the Western disadvantage in physical productivity. Hence, producing goods of higher consumer value is associated with lower production quantities and higher product prices. Our results show that Eastern and Western firms choose different strategies to deal with the tradeoff between quantity and prices and that substantial vertical differentiation exist even within narrowly defined product classes.

Columns 5 and 6 of Table 4 repeat the estimations reported in columns 3 and 4 adding product prices (in logs) as control variable. In column 5, the coefficient for the product price variable is positive and statistically significant but small. The coefficient implies that a 10 percent increase in product prices leads to an increase in revenue productivity of just 0.1 percent. This implies that the quantity-price tradeoff in revenue productivity only marginally favors high-price strategies, i.e. there is only a small gain in revenue productivity associated with producing high price products. Given the small coefficient,

it is unsurprising that the estimate for the East-West gap is unchanged when controlling for prices. Hence, there is a genuine revenue productivity advantage of the West even if one controls for output price differences. Reassuringly, column 6 shows that the apparent regional difference in physical productivity changes sign once we compare firms' producing product varieties of the same price level. This implies that Eastern firms are physically less productive than Western firms when producing goods at West German price levels. Put differently, Western firms can sell more quantities of a given price segment for a given good and a given amount of inputs.

The strong negative coefficient of the price variable in the physical production function estimation constitutes a convincing case for the quantity-price tradeoff postulated above: If output prices rise by 1 percent, produced quantity shrinks by nearly 1 percent, i.e. the price elasticity of physical output is about -1. As revenue equals quantity times prices, a price elasticity of physical output of nearly -1 directly implies that revenue is unaffected by controlling for prices, as shown in column 5.

To further scrutinize our interpretation that our results indeed reflect a quantity-price tradeoff, Table 5 presents our main estimates for two samples in which the maximum regional price difference within ten-digit product classes is limited to be not larger than tenfold and not larger than twofold, respectively. If our interpretation is valid, the only estimate that should change is the East coefficient for the regressions of quantity-based productivity without price controls. This is because the narrower the price range, we argue, the more similar the sophistication of the production process, leading to a smaller difference in output quantities. Table 5 provides strong support for our conjecture as all point estimates for the East dummy (and essentially all other estimates, too) remain unchanged except for the two critical estimates from the quantity-based productivity

specifications without conditioning on prices (columns 2 and 6). Here, the coefficient on the East dummy shrinks from 0.2 in the full sample to 0.11 in the sample with 10-fold price difference to -0.01 in the sample with 2-fold price differences. In results not reported, we find that the associated coefficients for a sample with a maximum 7.5-fold (5-fold, 3-fold) price range yield coefficients of 0.096 (0.085; 0.035). Hence, the East coefficient in the quantity productivity regression without price controls is a monotone function of the price range. All other results remain unchanged when conditioning our regressions on specific product price differences.

Competitiveness and Profitability

In the previous subsection we showed that Eastern firms are indeed less productive than their Western counterparts even once output prices are controlled for. This difference already exists for a long time, implying that East German firms can survive despite lower productivity. One obvious explanation for this is that hourly wages are lower in the East leading to similar unit labor costs in both parts of the country.[18]

In Table 6 we present estimates for the East-West gap in revenue over wage bill. Note that this measure is the inverse of unit labor costs with outputs evaluated at prices (i.e. the inverse revenue labor share), which is a broad measure of competitiveness. By analyzing this measure, we learn about how much revenue Eastern firms can generate from their labor expenditures for a given input mix relative to their Western counterparts (or, equivalently, how large the wages share in revenues is within Eastern, relative to Western, firms). Correspondingly, we measure input ratios as capital or intermediates over wage

[18] Between 2000 and 2014, East German hourly wages were 25 percent lower than West German hourly wages. Even in 2018, 30 years after reunification, East German wages only amount to 83 percent of West German wage standards (Arbeitskreis Volkswirtschaftliche Gesamtrechnung der Länder 2018a).

bills for this specification.[19] Throughout all specifications, we do not report economically significant differences in this measure of competitiveness between Eastern and Western firms, conditional on firms' monetary input mix. The estimates point to a difference of about 0.5 to 1 percent. These estimates are insensitive to the inclusion of product prices, the latter having a small effect close to zero implying that there is no quantity-value tradeoff in competitiveness, either. Hence, our results show that East German firms can keep up with the West German level of competitiveness at both, East and West German, prices. This implies that East German producers could sustain both high-price and low-price strategies but obviously the majority decides for the latter.

4.2 Robustness and Heterogeneity Analysis

In this subsection, we first provide evidence for our interpretation of the main results, i.e. that they are driven by price differences stemming from different levels of firms' product sophistication. This includes i) testing whether East-West differences in prices can instead be explained by regional differences in local purchasing power and ii) whether there are power imbalances allowing Western firms to pay their Eastern subsidiaries prices below the market value of Eastern products. Subsequently, we discuss iii) whether price gaps either result from differences in branding or quality. Along the way, we also explore heterogeneities in terms of broad types of products (consumption goods, investment goods, intermediate goods). We further test iv) whether results change over the course of the transformation process.

[19] As wages are lower in the East, the coefficients increase when defining input ratios using FTE.

Exporting versus selling locally?

As explained earlier, we analyze tradable goods and argue that they could be sold to the same customers, irrespective of whether being produced in East or West Germany. Based on this premise, we concluded that price differences must reflect differences in customer utility and cannot result from differences in local purchasing power. While this is true, East German firms may for whatever reason decide to sell locally despite producing goods of similar quality, be it because exploring export markets is costly (Melitz 2003) or because consumer preferences have a local component. And in fact, export intensity is lower in the East (69 versus 82 percent of firms export, see Table 2). Could revenue productivity differences thus be explained by local purchasing power although goods are tradeable?

To test this, we run regressions controlling for export status and other firm-level controls including an indicator variable for firms doing R&D, firms' size decile in terms of FTE, and the log of firms' number of produced products. As Table 7 shows, introducing these control variables leaves our results unaffected. In particular, we find that exporters do not have higher revenue productivity (conditional on product fixed effects (column 3), whereas exporters manufacture lower quantities for given amounts of inputs (column 4), indicating that they produce somewhat more sophisticated products. Again, supporting our interpretation of the quality-quantity tradeoff, conducting R&D is associated with lower quantities (column 4) but higher revenues (column 5). The main message, however, remains that controlling for export status is not changing our results. We therefore conclude that differences in local purchasing power cannot explain our documented product price differences.

How relevant are power imbalances?

If West German parent firms would pay their East German subsidiaries less than the market value for their products – be it intermediates or final products to be upgraded with West German brand names – measured value-added would be artificially moved to the West and the remaining productivity gap would just reflect imbalances of power.[20] We call such behavior 'transfer pricing' in the following. So far, we assumed competition of legally independent firms and cannot fully rule out the possibility of transfer pricing within legally dependent groups of firms. According to the IAB establishment panel, 13 percent of East German manufacturing establishments have West German owners in 2014.[21]

To check the plausibility of this conjecture, we ran two tests. First, we re-ran our regression analysis separately for firms producing final consumption goods versus intermediate goods (see Table 8).[22] For defining intermediate goods, we use the classification of goods into final consumption, intermediate, and investment goods as provided by the statistical office. As transfer pricing should be more relevant in intermediate goods industries, we should find a reduced productivity disadvantage for the intermediate goods sample as soon as we condition on prices. However, we do not find

[20] Note that potential transfer pricing between East and West German establishments belonging to the same West German firm is not invalidating our results as our analysis is at the firm rather than at the establishment level.

[21] The IAB establishment panel is a high-quality annual establishment survey covering about 16,000 German establishments and being representative for the population of German establishments employing at least one employee subject to social security contributions. While this data contains a lot of interesting information not contained in our data, it lacks information on product quantities and prices. See Ellguth et al. (2014) for a description of this data. Data on firms is not available in the IAB establishment panel.

[22] Recap that we use quantity and revenue information from different surveys, potentially leading to discrepancies between the East-dummy coefficient from the quantity-based specification that controls for prices and the revenue-based specifications (see section 3.1 and online Appendix B). Again, controlling for firms' product sales values at the factory gate over total realized revenue eliminates these discrepancies also for the sub-samples of Table 8 (results are available on request).

any notable differences between both regression samples: neither in terms of the productivity gap nor in how controlling for prices affects our results.[23] Second, we also re-ran our regressions for a sample of firms that does not purchase any commodities for resale (see online Appendix F). Again, we do not find any notable differences in our coefficients compared to our baseline regressions, which rules out that our estimated productivity differences are driven by Western firms purchasing final products at below market prices from Eastern firms for resale purposes.

Overall, we find little support for transfer pricing. However, we view the above checks as providing only suggestive evidence against transfer pricing being a main driver of our estimated productivity differences between East and West Germany and cannot completely rule out its relevance. For instance, West German producers of final consumption goods may still benefit from mark downs on East German inputs and, theoretically, West German owners may force East German producers to accept mark ups when buying intermediates from them. We cannot rule out these conjectures with our data and believe that further research into transfer pricing is warranted.

Branding or Quality?

Eastern prices are lower because of lower consumer utility attached to Eastern products. We argued before that less consumer utility might result from a lower product quality or less valuable brand names. While being less relevant for establishing productivity differences, the distinction between the two sources of price differences is interesting for decision makers aiming at reducing the price gap. As neither product

[23] We also checked the industry structure and found that the share of firms being mainly active in the intermediate goods industry is similar in both regions: 42 and 40 percent of Western and Eastern firms produce intermediate goods as their main product in terms of sales, respectively.

quality nor the brand capital stock is visible to us, we need to rely on indirect evidence. To this end we distinguish final consumption goods from investment goods and argue that brand names might be more important for private consumers than for professionals buying e.g. machinery for the shop floor. Professionals are assumed to be well informed about quality differences across suppliers' products and to act profit maximizing. As private consumers do not care about brand names of investment goods utilized to produce the final consumption goods, profit maximizing professionals should not care about brand names for investment goods. Hence, while price differences in the consumption good sector could stem from differences in both, branding and quality, any price differences in the investment good sector are more likely to stem from quality differences.

If we additionally assume that East-West differences in product quality are similar for consumption versus investment goods, we arrive at the following test environment. Remember that in our quantity productivity regressions in Table 4 we find a strong change in the East coefficient once we control for prices and we interpret this change as evidence for a simpler mode of production leading to higher quantities sold at lower prices. If we find the same strong change in the East coefficient also for the investment goods sample then, according to the above discussion, this is indicative of a quality gap. If we, in turn, find a much weaker change in the coefficient for investment goods compared to consumption goods, we additionally infer that the stronger change for consumption goods mostly results from less valuable brand names.[24]

Our regression results in Table 8 again do not reveal major differences in revenue productivity gaps by the type of good and, irrespective of the type of good produced, the

[24] The fraction of firms producing final consumption goods as their main product make up for 30.1 (27.6) percent of the total number of firms in East (West) Germany and the corresponding figure for investment goods is 29.4 (29.5) percent.

East German disadvantage is close to the 8 percent already reported in Table 4. Importantly, however, the gap in quantities is much larger for consumption goods than for investment goods as long as prices are not controlled for (30 percent versus 5 percent). Controlling for prices dramatically changes the East coefficient for the consumption good segment, but much less so for investment goods, such that both coefficients are similar again. Based on the above assumptions, our interpretation is that East-West price differences in the manufacturing sector are mostly driven by differences in branding and less so by product quality. Our analysis also reveals that productivity differences are pervasive in the sense that they exist alike for consumption and investment goods (and intermediate goods, too).

Convergence or Divergence?

The convergence in productivity as shown in Figure 1 may result from relative increases in physical productivity or prices in the East. Table 9 repeats our main analysis for the time periods 1999-2006 and 2007-2014. As shown, the East German disadvantage in revenue productivity declined (column 1 versus column 5), confirming the shrinking gap Figure 1 shows for the aggregate. The same holds true when conditioning on output prices (column 3 versus column 6). Interestingly, a comparison of columns 2 and 6 reveals a strong decline in the advantage East German firms had in terms of non-price-adjusted physical productivity. Hence, the productivity convergence (conditional on prices) has been accompanied by a reduction in quantities per input and an increase in prices in the East (all relative to the West). Concretely, the (revenue weighted) log price difference between East and West German products decreased from 0.54 (0.45) to 0.42 (0.40) over our observation period.

Finally, Table 10 shows that the East German advantage in competitiveness slightly increased. This implies that relative revenue productivity gains in Eastern firms, as documented above, were not proportionally shared with Eastern workers.

5. CONCLUSIONS

We study the productivity gap between East and West Germany that prevails even 30 years after reunification. We document that revenue productivity, wages, and output prices are all lower in East compared to West Germany and that produced quantities per input unit are higher in the East. Price and quantity differences can be explained by vertical product specialization where Eastern products are manufactured in less complex production processes utilizing less or cheaper inputs, generating less consumer value, and ultimately yielding lower output prices. When conditioning on output prices, physical output of East German firms is lower than in Western firms. We show that East German industrial revenue productivity is below West German standards neither because Eastern firms manufacture different products (horizontal specialization) being located at a different position in the value chain (extended workbench hypothesis) nor because of vertical specialization on cheaper varieties of the same product. Revenue productivity is lower because physical productivity is lower when producing the same product for the same price segment. Simply switching to high-price products will barely help the East as we find that the quantity-price tradeoff only marginally benefits high-price producers. Eastern firms must thus find ways to improve physical productivity to catch up to their Western counterparts.

We show that due to lower East German wages, the prevailing division of labor between East and West Germany is associated with similar competitiveness despite

different revenue productivities in both parts of the country. Even if East German employers might be satisfied with the situation, one would expect workers to migrate to the West because of high wage differentials. A formal treatment of why the current situation constitutes a persistent spatial equilibrium is clearly beyond the scope of this study. To answer this question, one must understand why, within the same country and without any legal barriers to internal migration, regional wage differences exceeding 20 percent can be sustainable. One candidate explanation is that consumer prices are lower in the East so that real wages are more similar than nominal wages.[25] We think it is possible that any remaining differences in real wages are smaller than the social costs of leaving one's homeland.

[25] In 2008, the purchasing power of East German incomes amounted to 106 percent of West German incomes, i.e. each Euro household income purchases 6 percent more goods in East Germany than in West Germany (Vortmann et al. 2013).

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TABLES

TABLE 1

EXAMPLES OF INDUSTRY AND PRODUCT CLASSIFICATIONS

NACE rev. 1.1	Product code	Description
18		Manufacture of wearing apparel; dressing and dyeing of fur
1821		Manufacture of workwear
		Products
	182112410(0)	Long trousers for men, cotton (not contracted)
	182112510(0)	Overalls for men, cotton (not contracted)
	182112510(2)	Overalls for men, cotton (contracted production)
	182121350(2)	Coats for women, chemical fiber (contracted production)
27		Manufacture of basic metals
2743		Lead, zinc, and tin production
		Products
	274312300(0)	Zinc, unwrought, refined (not contracted)
	274311300(0)	Lead, unwrought, refined (not contracted)
	274311500(0)	Lead, unwrought, with antimony (not contracted)
	274328300(0)	Tin sheets and tapes, thicker than 0.2mm (not contracted)
	274328600(0)	Tin sheets and tapes, not thicker than 0.2mm (not contracted)

Notes: Table 1 presents examples of the products available in our data. The reported GP2002 product codes define 6,500 distinct products at the nine-digit level from which we find 5,927 in our database and 4,194 in our final sample of firms.

TABLE 2

SAMPLE SUMMARY STATISTICS, EAST AND WEST GERMAN FIRMS

	East Germany		West Germany	
	Mean	SD	Mean	SD
Variable	(1)	(2)	(3)	(4)
Log of revenue over FTE	11.58	0.68	11.83	0.61
Log of produced quantity over FTE	6.74	3.32	6.61	3.29
Log of revenue over wage bill	1.43	0.55	1.32	0.49
FTE	141.55	373.11	309.61	2,197.99
Log of capital over FTE	11.20	1.02	11.09	0.95
Log of intermediates over FTE	11.03	0.86	11.27	0.79
Wage bill over FTE (1999=100)	27,186	9.493	38,565	11.484
Export-dummy	0.62	0.49	0.79	0.40
R&D-dummy	0.28	0.45	0.34	0.47
Number of products	3.24	3.61	3.63	7.23
Value-added over revenue	0.40	0.15	0.41	0.14
Product market revenue over total revenue	0.89	0.25	0.88	0.26
Revenue weighted price deviation of average product prices	2.93	12.11	3.61	12.80
Revenue weighted product market shares (in terms of revenue)	8.40	16.66	11.30	18.21
Single-product observations (firms)	6,443 (1,449)		34,695 (6,906)	
All observations (firms)	29,747 (6,567)		156,836 (30,016)	

Notes: Table 2 presents sample summary statistics, separately for East and West German firms. Columns (1) and (2) show means and standard deviations of selected variables for East German firms, while columns (3) and (4) show corresponding means and standard deviations for West German firms.

TABLE 3

TOP PRODUCT PRICE DIFFERENCES BETWEEN EAST AND WEST GERMAN FIRMS

Panel A: Highest West German relative price advantage

Product code	Product	Log price difference
3320207000	Devices for radio remote control	5.46
3162115700	Burglar alarm devices, fire-alarm devices, and similar devices, not elsewhere specified	5.01
2923113200	Heat exchanger for ventilation systems	4.70
3120317900	Panels, plates, and similar equipment for electrical circuitry, build for an electrical voltage of not more than 1000 volt, not elsewhere specified	4.66
2956256330	Machinery for surface processing of metals, not elsewhere specified	4.25

Panel B: Highest East German relative price advantage

Product code	Product	Log price difference
3110423300	Transductor (e.g. voltage transductor) with an electrical capacity of not more than 1 kilovolt-ampere	-5.56
3310157930	Electromedical and electrosurgical instruments and equipment, not elsewhere specified	-3.80
2863144350	Builder's hardware, specifically door mounting	-3.77
2861112090	Knifes with fixed blades, not elsewhere specified	-3.69
3320538900	Equipment and instruments for physical or chemical tests, not elsewhere specified	-2.86

Notes: Table 3 shows the products with the highest average log price difference between West and East German firms. Panel A (B) displays the products with the highest West German (East German) relative price advantage. Positive values signal higher prices in West German firms. Germany's manufacturing sector. Single-product sample firms.

TABLE 4

REVENUE AND PHYSICAL PRODUCTIVITY, EAST VS. WEST GERMANY

	$log\left(\frac{Rev_{it}}{L_{it}}\right)$	$log\left(\frac{Rev_{it}}{L_{it}}\right)$	$log\left(\frac{Rev_{it}}{L_{it}}\right)$	$log\left(\frac{Q_{it}}{L_{it}}\right)$	$log\left(\frac{Rev_{it}}{L_{it}}\right)$	$log\left(\frac{Q_{it}}{L_{it}}\right)$
	(1)	(2)	(3)	(4)	(5)	(6)
$East_{it}$	-0.0849***	-0.0845***	-0.0796***	0.199***	-0.0768***	-0.0567***
	(0.0031)	(0.0060)	(0.0042)	(0.0365)	(0.0042)	(0.0129)
$log\left(\frac{K_{it}}{L_{it}}\right)$	0.0537***	0.0539***	0.0441***	0.0919***	0.0444***	0.0623***
	(0.0013)	(0.0022)	(0.0018)	(0.0156)	(0.0018)	(0.0061)
$log\left(\frac{M_{it}}{L_{it}}\right)$	0.711***	0.710***	0.717***	0.752***	0.719***	0.578***
	(0.0017)	(0.0034)	(0.0031)	(0.0024)	(0.0031)	(0.0131)
$log(P_{it})$					0.0108***	-0.979***
					(0.0015)	(0.0052)
Main product FE	NO	NO	YES	YES	YES	YES
Single-product sample	NO	YES	YES	YES	YES	YES
Observations	186,583	41,138	41,138	41,138	41,138	41,138
Number of firms	36,539	9,212	9,212	9,212	9,212	9,212
R-squared	0.922	0.917	0.958	0.924	0.958	0.986

Notes: Table 4 reports OLS-regression results for revenue- and quantity-based productivity measures. Column 1 uses the entire sample of firms. Columns 2-6 use a single-product firm sample. We always include year dummies and never include sector dummies. Standard errors are clustered at the firm level. Significance: *10 percent, **5 percent, ***1 percent.

TABLE 5

REVENUE AND PHYSICAL PRODUCTIVITY,
EAST VS. WEST GERMANY, SELECTED INTERVALS OF REGIONAL OUTPUT PRICE DIFFERENCES

	Not larger than tenfold price differences				Not larger than twofold price differences			
	$log\left(\frac{Rev_{it}}{L_{it}}\right)$	$log\left(\frac{Q_{it}}{L_{it}}\right)$	$log\left(\frac{Rev_{it}}{L_{it}}\right)$	$log\left(\frac{Q_{it}}{L_{it}}\right)$	$log\left(\frac{Rev_{it}}{L_{it}}\right)$	$log\left(\frac{Q_{it}}{L_{it}}\right)$	$log\left(\frac{Rev_{it}}{L_{it}}\right)$	$log\left(\frac{Q_{it}}{L_{it}}\right)$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$East_{it}$	-0.0775***	0.111***	-0.0755***	-0.0442***	-0.0740***	-0.0101	-0.0734***	-0.0446***
	(0.0044)	(0.0356)	(0.0045)	(0.0145)	(0.0054)	(0.0331)	(0.0053)	(0.0152)
$log\left(\frac{K_{it}}{L_{it}}\right)$	0.0446***	0.0704***	0.0447***	0.0656***	0.0447***	0.0783***	0.0448***	0.0688***
	(0.0026)	(0.0197)	(0.0025)	(0.0076)	(0.0031)	(0.0196)	(0.0031)	(0.0089)
$log\left(\frac{M_{it}}{L_{it}}\right)$	0.726***	0.851***	0.729***	0.643***	0.734***	0.831***	0.736***	0.650***
	(0.0041)	(0.0297)	(0.0041)	(0.0148)	(0.0050)	(0.0323)	(0.0051)	(0.0188)
$log(P_{it})$			0.0131***	-0.979***	-	-	0.0151***	-0.972***
			(0.0023)	(0.009)			(0.0030)	(0.0093)
Main product FE	YES	YES	YES	YES	YES	YES	YES	YES
Single-product sample	YES	YES	YES	YES	YES	YES	YES	YES
Observations	14,787	14,787	14,787	14,787	9,289	9,289	9,289	9,289
Number of firms	4,198	4,198	4,198	4,198	2,996	2,996	2,996	2,996
R-squared	0.953	0.926	0.953	0.985	0.956	0.943	0.957	0.987

Notes: Table 5 reports OLS-regression results for revenue- and quantity-based productivity measures, separately for a single-product firm sample that restricts East-West product price differences to be not larger than by a factor of ten (columns 1-4) and to be not larger than by a factor of two (columns 5-8). We always include year dummies and never include sector dummies. Standard errors are clustered at the firm level. Significance: *10 percent, **5 percent, ***1 percent.

TABLE 6

COMPETITIVENESS,
EAST VS. WEST GERMANY

	$log\left(\frac{Rev_{it}}{w_{it}L_{it}}\right)$	$log\left(\frac{Rev_{it}}{w_{it}L_{it}}\right)$
	(1)	(2)
$East_{it}$	0.0069*	0.0075**
	(0.0038)	(0.0038)
$log\left(\frac{K_{it}}{w_{it}L_{it}}\right)$	0.0293***	0.0295***
	(0.0016)	(0.0016)
$log\left(\frac{M_{it}}{w_{it}L_{it}}\right)$	0.669***	0.670***
	(0.0032)	(0.0032)
$log(P_{it})$		0.0035***
		(0.0013)
Main product FE	YES	YES
Single-product sample	YES	YES
Observations	41,138	41,138
Number of firms	9,212	9,212
R-squared	0.950	0.950

Notes: Table 6 reports OLS-regression results for our competitiveness measure. We always include year dummies and never include sector dummies. Single-product firms. Standard errors are clustered at the firm level. Significance: *10 percent, **5 percent, ***1 percent.

TABLE 7

REVENUE AND PHYSICAL PRODUCTIVITY,
EAST VS. WEST GERMANY, ADDING ADDITIONAL CONTROLS

	$log\left(\frac{Rev_{it}}{L_{it}}\right)$	$log\left(\frac{Rev_{it}}{L_{it}}\right)$	$log\left(\frac{Rev_{it}}{L_{it}}\right)$	$log\left(\frac{Q_{it}}{L_{it}}\right)$	$log\left(\frac{Rev_{it}}{L_{it}}\right)$	$log\left(\frac{Q_{it}}{L_{it}}\right)$
	(1)	(2)	(3)	(4)	(5)	(6)
$East_{it}$	-0.0832***	-0.0845***	-0.0796***	0.188***	-0.0769***	-0.0555***
	(0.0032)	(0.0060)	(0.0042)	(0.0364)	(0.0042)	(0.0131)
$log\left(\frac{K_{it}}{L_{it}}\right)$	0.0537***	0.0534***	0.0435***	0.0982***	0.0439***	0.0633***
	(0.0013)	(0.0022)	(0.0018)	(0.0155)	(0.0018)	(0.0062)
$log\left(\frac{M_{it}}{L_{it}}\right)$	0.708***	0.708***	0.716***	0.762***	0.718***	0.579***
	(0.0018)	(0.0034)	(0.0031)	(0.0024)	(0.0032)	(0.0131)
$log(P_{it})$					0.0107***	-0.979***
					(0.0015)	(0.0051)
$Dummy\_export_{it}$	0.0092***	0.0015	-0.0025	-0.0942***	-0.0038	0.0227
	(0.0026)	(0.0045)	(0.0036)	(0.0317)	(0.0036)	(0.0140)
$log(Numb\_prods)_{it}$	-0.0172***					
	(0.0014)					
$Dummy\_RD_{it}$	0.0349***	0.0453***	0.0107***	-0.104***	0.0098***	-0.0142
	(0.0023)	(0.0042)	(0.0031)	(0.0297)	(0.0031)	(0.0109)
$FTE\_Size\_Decile_{it}$	-0.0007	-0.0021***	0.0004	0.0009	0.0004	-0.0024
	(0.0004)	(0.0008)	(0.0006)	(0.0057)	(0.0006)	(0.0023)
Main product FE	NO	NO	YES	YES	YES	YES
Single-product sample	NO	YES	YES	YES	YES	YES
Observations	186,583	41,138	41,138	41,138	41,138	41,138
Number of firms	36,539	9,212	9,212	9,212	9,212	9,212
R-squared	0.923	0.918	0.958	0.924	0.958	0.986

Notes: Table 7 reports OLS-regression results for revenue- and quantity-based productivity measures. Columns 2-6 use a single-product firm sample. We always include year dummies and never include sector dummies. Standard errors are clustered at the firm level. Significance: *10 percent, **5 percent, ***1 percent.

TABLE 8

REVENUE AND PHYSICAL PRODUCTIVITY, EAST VS. WEST GERMANY, FOR DIFFERENT TYPES OF PRODUCTS

	Consumption goods				Intermediate goods				Investment goods			
	$ln\left(\frac{Rev_{it}}{L_{it}}\right)$ (1)	$ln\left(\frac{Q_{it}}{L_{it}}\right)$ (2)	$ln\left(\frac{Rev_{it}}{L_{it}}\right)$ (3)	$ln\left(\frac{Q_{it}}{L_{it}}\right)$ (4)	$ln\left(\frac{Rev_{it}}{L_{it}}\right)$ (5)	$ln\left(\frac{Q_{it}}{L_{it}}\right)$ (6)	$ln\left(\frac{Rev_{it}}{L_{it}}\right)$ (7)	$ln\left(\frac{Q_{it}}{L_{it}}\right)$ (8)	$ln\left(\frac{Rev_{it}}{L_{it}}\right)$ (9)	$ln\left(\frac{Q_{it}}{L_{it}}\right)$ (10)	$ln\left(\frac{Rev_{it}}{L_{it}}\right)$ (11)	$ln\left(\frac{Q_{it}}{L_{it}}\right)$ (12)
$East_{it}$	-0.0781***	0.314***	-0.0777***	-0.0252	-0.0801***	0.212***	-0.0751***	-0.0538***	-0.0851***	0.0486	-0.0844***	-0.0872***
	(0.0088)	(0.0866)	(0.0089)	(0.0336)	(0.00523)	(0.0440)	(0.0052)	(0.0159)	(0.0104)	(0.0928)	(0.0103)	(0.0284)
$ln(\frac{K_{it}}{L_{it}})$	0.0321***	0.0682*	0.0322***	0.0260	0.0492***	0.105***	0.0498***	0.0725***	0.0391***	0.0633	0.0390***	0.0693***
	(0.0038)	(0.0354)	(0.0038)	(0.0179)	(0.0023)	(0.0185)	(0.0023)	(0.0065)	(0.0040)	(0.0414)	(0.0040)	(0.0134)
$ln(\frac{M_{it}}{L_{it}})$	0.753***	0.660***	0.753***	0.519***	0.711***	0.895***	0.716***	0.619***	0.688***	0.467***	0.688***	0.553***
	(0.0070)	(0.0519)	(0.0071)	(0.0347)	(0.0039)	(0.0300)	(0.0038)	(0.0142)	(0.0068)	(0.0574)	(0.0068)	(0.0255)
$ln(P_{it})$	-	-	0.0118	-0.984***	-	-	0.0183***	-0.970***	-	-	0.0056**	-0.985***
			(0.0036)	(0.0146)			(0.0022)	(0.0071)			(0.0026)	(0.0088)
Main product FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Single-product sample	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	8,483	8,483	8,483	8,483	24,004	24,004	24,004	24,004	8,591	8,591	8,591	8,591
R-squared	0.971	0.907	0.971	0.971	0.957	0.927	0.957	0.987	0.940	0.885	0.940	0.985
Number of firms	1,748	1,748	1,748	1,748	5,294	5,294	5,294	5,294	2,185	2,185	2,185	2,185

Notes: Table 8 reports OLS-regression results for revenue- and quantity-based productivity measures separately for consumption goods (columns 1-4), intermediate goods (columns 5-8), and investment goods (columns 9-12). We always include year dummies and never include sector dummies. Single-product firms. Standard errors are clustered at the firm level. Significance: *10 percent, **5 percent, ***1 percent.

TABLE 9

REVENUE AND PHYSICAL PRODUCTIVITY, EAST VS. WEST GERMANY, FOR DIFFERENT TIME PERIODS

	Period 1999-2006				Period 2007-2014			
	$log\left(\frac{Rev_{it}}{L_{it}}\right)$	$log\left(\frac{Q_{it}}{L_{it}}\right)$	$log\left(\frac{Rev_{it}}{L_{it}}\right)$	$log\left(\frac{Q_{it}}{L_{it}}\right)$	$log\left(\frac{Rev_{it}}{L_{it}}\right)$	$log\left(\frac{Q_{it}}{L_{it}}\right)$	$log\left(\frac{Rev_{it}}{L_{it}}\right)$	$log\left(\frac{Q_{it}}{L_{it}}\right)$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$East_{it}$	-0.0928***	0.244***	-0.0897***	-0.0793***	-0.0705***	0.164***	-0.0679***	-0.0409***
	(0.0054)	(0.0473)	(0.0054)	(0.0188)	(0.0054)	(0.0440)	(0.0054)	(0.0140)
$log\left(\frac{K_{it}}{L_{it}}\right)$	0.0467***	0.0784***	0.0468***	0.0632***	0.0452***	0.0922***	0.0456***	0.0601***
	(0.0022)	(0.0192)	(0.0022)	(0.0078)	(0.0025)	(0.0207)	(0.0025)	(0.0074)
$log\left(\frac{M_{it}}{L_{it}}\right)$	0.699***	0.702***	0.700***	0.556***	0.729***	0.830***	0.731***	0.607***
	(0.0038)	(0.0033)	(0.0038)	(0.0193)	(0.0039)	(0.0295)	(0.0040)	(0.0153)
$log(P_{it})$			0.0094***	-0.984***			0.0126***	-0.975***
			(0.0018)	(0.0071)			(0.0020)	(0.0061)
Main product FE	YES	YES	YES	YES	YES	YES	YES	YES
Single-product sample	YES	YES	YES	YES	YES	YES	YES	YES
Observations	21,128	21,128	21,128	21,128	19,754	19,754	19,754	19,754
Number of firms	6,168	6,168	6,168	6,168	6,052	6,052	6,052	6,052
R-squared	0.962	0.928	0.962	0.985	0.965	0.932	0.965	0.989

Notes: Table 9 reports OLS-regression results for revenue- and quantity-based productivity measures, separately for the periods 1999-2006 (columns 1-4) and 2007-2014 (columns 5-6). We always include year dummies and never include sector dummies. Single-product firms. Standard errors are clustered at the firm level. Significance: *10 percent, **5 percent, ***1 percent.

TABLE 10

COMPETITIVENESS,
EAST VS. WEST GERMANY, FOR DIFFERENT PERIODS

	Period 1999-2006		Period 2007-2014	
	$log\left(\frac{Rev_{it}}{w_{it}L_{it}}\right)$	$log\left(\frac{Rev_{it}}{w_{it}L_{it}}\right)$	$log\left(\frac{Rev_{it}}{w_{it}L_{it}}\right)$	$log\left(\frac{Rev_{it}}{w_{it}L_{it}}\right)$
	(1)	(2)	(3)	(4)
$East_{it}$	0.0005	0.0011	0.011**	0.0115**
	(0.0048)	(0.0048)	(0.0048)	(0.0048)
$log\left(\frac{K_{it}}{w_{it}L_{it}}\right)$	0.0333***	0.0334***	0.0288***	0.0292***
	(0.0019)	(0.0019)	(0.0022)	(0.0022)
$log\left(\frac{M_{it}}{w_{it}L_{it}}\right)$	0.650***	0.651***	0.681***	0.683***
	(0.0039)	(0.0040)	(0.0040)	(0.0040)
$log(P_{it})$		0.0025		0.0046***
		(0.0016)		(0.0018)
Main product FE	YES	YES	YES	YES
Single-product sample	YES	YES	YES	YES
Observations	21,128	21,128	19,754	19,754
Number of firms	6,168	6,168	6,052	6,052
R-squared	0.954	0.954	0.959	0.959

Notes: Table 10 reports OLS-regression results for our competitiveness measure for different time periods. We always include year dummies and never include sector dummies. Single-product firms. Standard errors are clustered at the firm level. Significance: *10 percent, **5 percent, ***1 percent.

FIGURES

EAST GERMAN VALUE-ADDED PER EMPLOYEE IN PERCENT
(WEST GERMANY = 100)

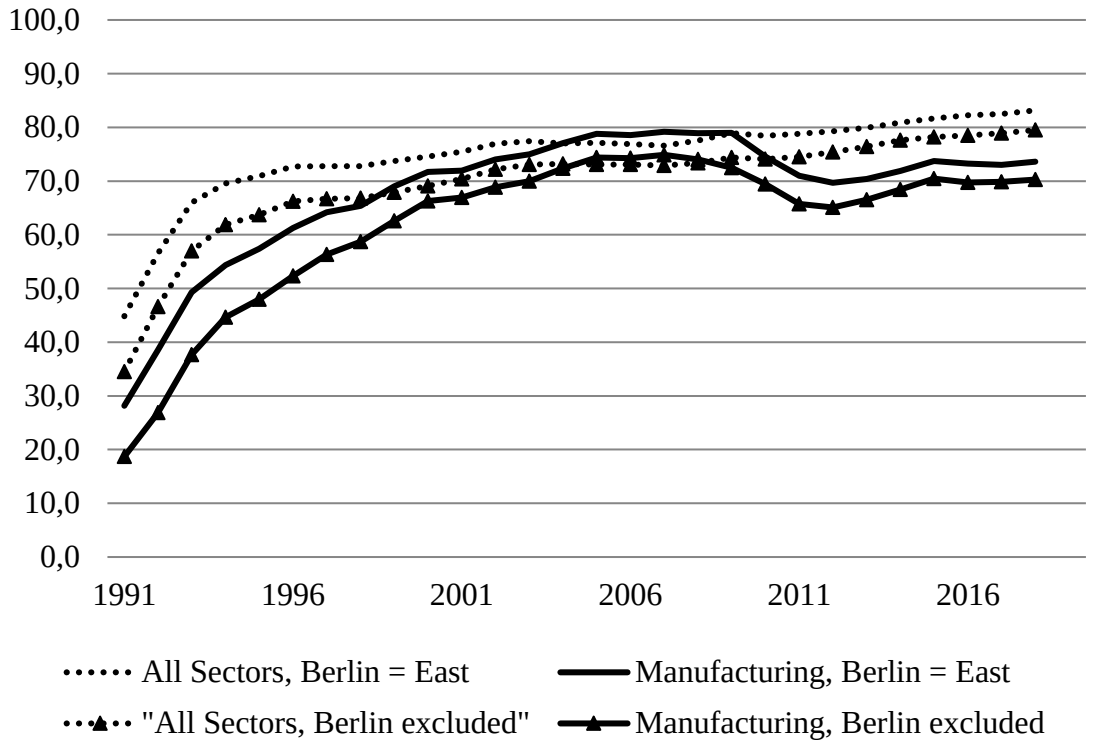

FIGURE 1 – East German value-added per employee in percent, relative to West Germany (West Germany = 100). Data comes from the national accounts of the German Länder (Arbeitskreis Volkswirtschaftliche Gesamtrechnung der Länder (2018b). Current prices.

FIRM PRODUCTIVITY MEASURES: EAST VS. WEST GERMANY

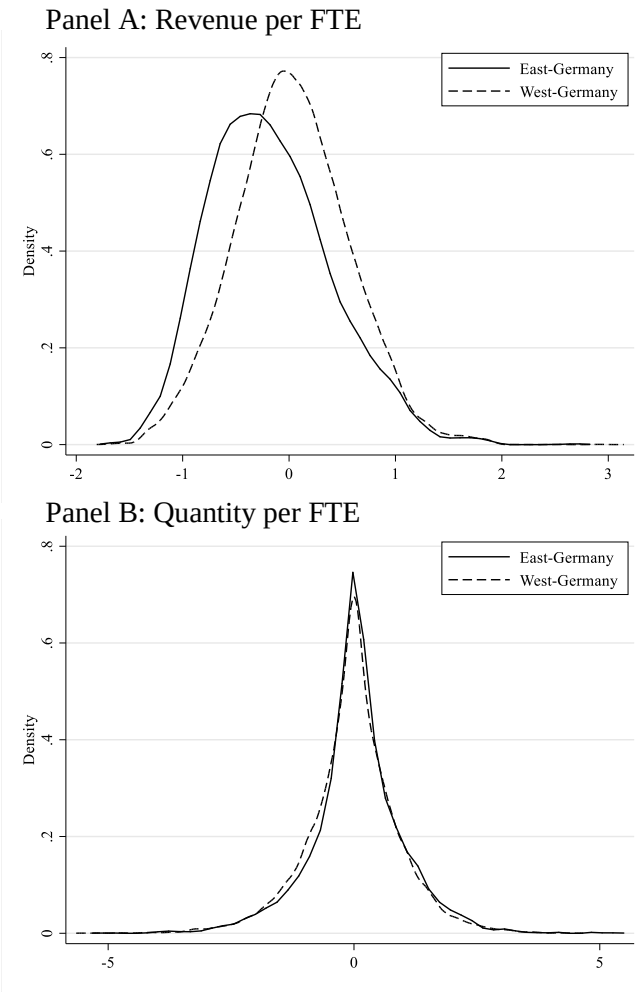

FIGURE 2 – Distribution of firm-level revenue over FTE (Panel A) and produced quantity over FTE (Panel B) separately for East and West German firms. Panel A is based on our full sample of firms. Panel B is based on our single-product firm sample. The solid (dashed) line refers to East German (West German) firms. Germany's manufacturing sector. Top and bottom two percent are trimmed.

FIRM PRICE DIFFERENCES: EAST VS. WEST GERMANY

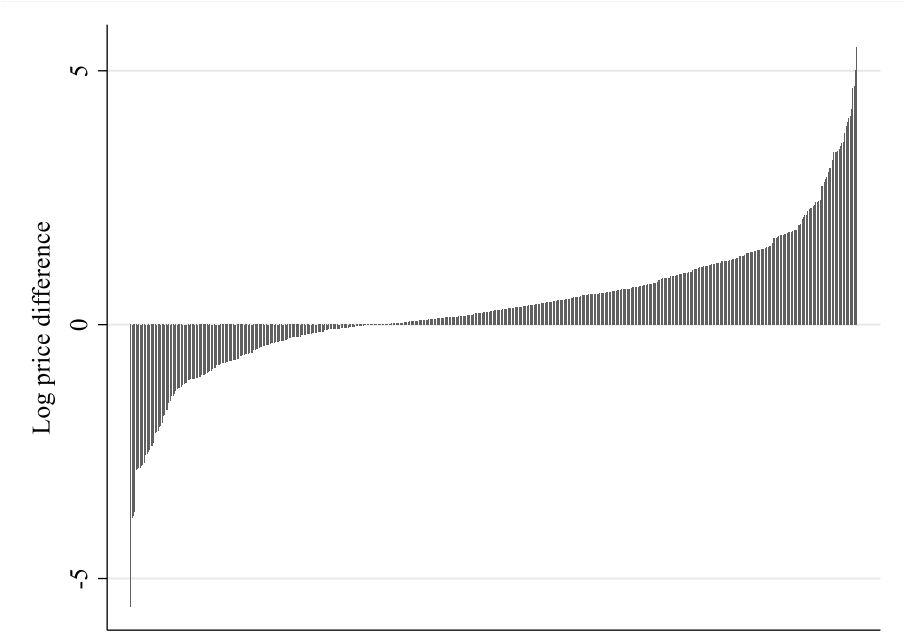

FIGURE 3 – Firm-level log price differences between East and West German firms manufacturing the same ten-digit product. The horizontal axis displays all products manufactured in both regions ordered according to price differences. Positive values indicate higher prices in West Germany. Germany's manufacturing sector. Single-product sample firms.

FIRM PRICE DIFFERENCES: EAST VS. WEST GERMANY, BY INDUSTRY

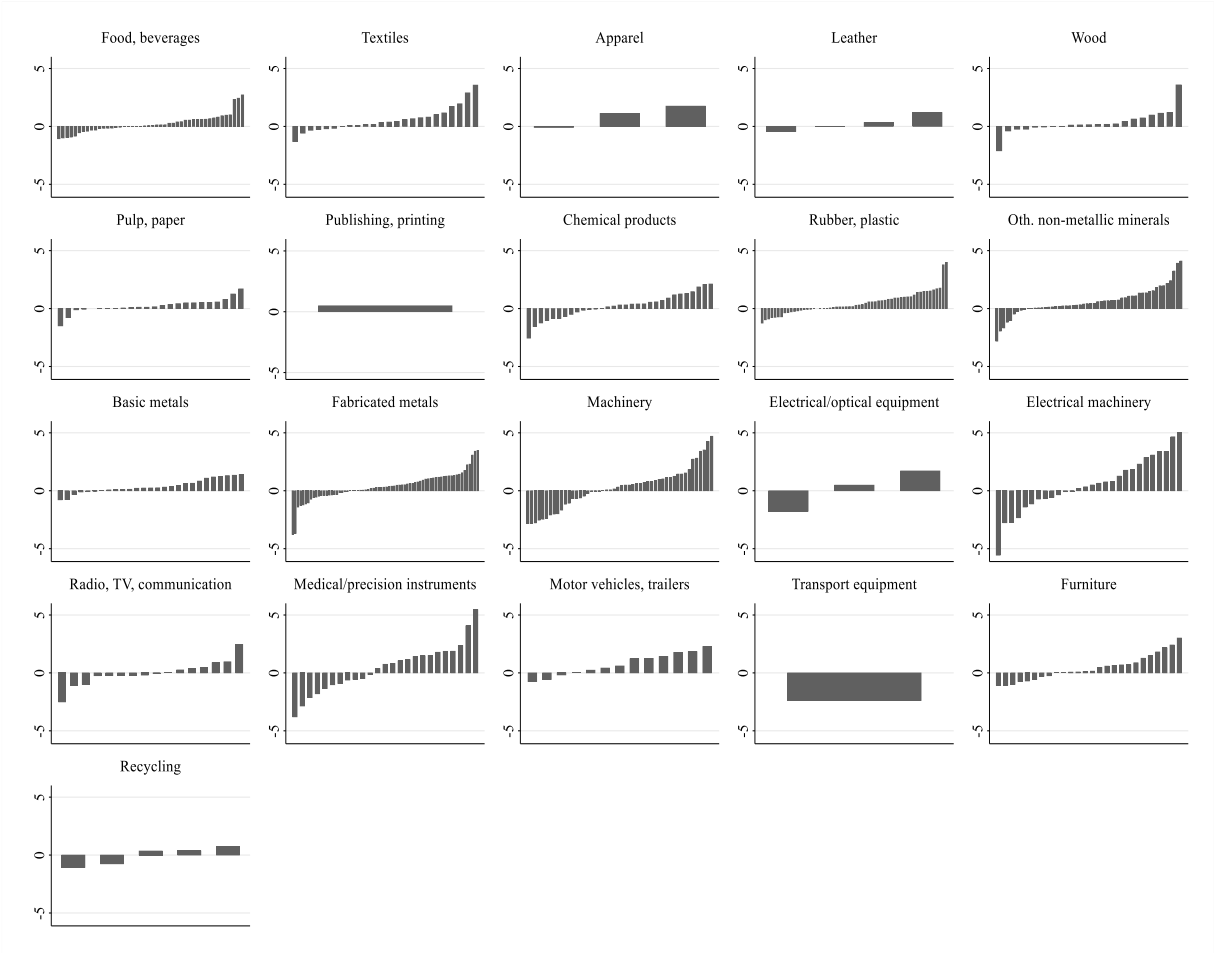

FIGURE 4 – Firm-level log price differences between East and West German firms manufacturing the same ten-digit product, separately by two-digit industries. The horizontal axis displays all products manufactured in both regions ordered according to price differences. Positive values indicate higher prices in West Germany. Germany's manufacturing sector. Single-product sample firms.

ONLINE APPENDIX – NOT FOR PUBLICATION

Appendix A: Main results using (semi-)parametric productivity estimates

In the main text, we rely on a simple labor productivity specification to compare the productivity of East and West German firms characterized by the same input factor mix. Here, we show i) that using a more sophisticated total factor productivity measure that is first derived as a residuum from a firm-level Cobb-Douglas production function and subsequently regressed on our East-dummy and ii) that a one-step approach where we directly include the East-dummy into firms' production function and infer on the East-West productivity gap from the coefficient of this dummy both produce results that are extremely similar to our baseline specification. The advantage of our baseline procedure is, however, that it, compared to the two-step approach, allows straight forward calculations of correct standard errors and that it, compared to the one-step approach, allows us to use a larger firm sample (see below).

Two-step approach

We rely on the following empirical Cobb-Douglas production function in logs (indicated by lower case letters):

$$y_{it} = \theta^l l_{it} + \theta^m m_{it} + \theta^k k_{it} + \omega_{it} + \varepsilon_{it}, \quad \text{(A.1)}$$

where $y_{it} = \{r_{it}, q_{it}\}$ refers to revenue deflated by an industry-level deflator (r_{it}) or observed quantities (q_{it}), depending on whether we estimate revenue- or quantity-based TFP. In the following, we first describe our approach for estimating the revenue-based productivity measure. Subsequently, we discuss the adjustment of our approach to derive a quantity-based TFP measure. l_{it}, k_{it}, and m_{it} denote firms' FTE, capital stock, derived from a perpetual inventory method where we deflate nominal values with industry-level

deflators, and intermediate input expenditures, deflated by an industry-level deflator. ω_{it} denotes Hicks-neutral productivity and is assumed to follow a Markov process. ε_{it} is an error term.

Importantly, ω_{it} is unobserved by the econometrician but observed by the firm. Hence, firms' flexible input decisions depend on ω_{it}, making the estimation of (A.1) by OLS infeasible, if firms employ flexible inputs in their production process. We assume that only intermediate inputs respond to productivity shocks while input decisions for labor and capital are uncorrelated with innovations in productivity. These assumptions ease identification and are motivated by the comparably high degree of employment protection in Germany (OECD 2018).

To account for the endogeneity issue resulting from the dependence of observed intermediate inputs on unobserved productivity shocks, we employ a control function approach in the spirit of Olley & Pakes (1996). Specifically, we invert firms input decision for energy inputs and raw materials, which are components of total intermediate inputs and which we denote by e_{it}, to formulate a control function for productivity:

$$\omega_{it} \equiv g_{it}(.) = g_{it}(e_{it}, k_{it}, l_{it}, \mathbf{z}_{it}), \tag{A.2}$$

where $\boldsymbol{z}_{it}$ captures state variables of the firm that in addition to capital and labor affect firms' input decision for raw materials and energy inputs.[26] In our case, this includes firms' number of products, a dummy for being an exporter, a dummy for indicating whether firms do any research and development, and a categorial variable indicating the German state (i.e. the Bundesland) in which the firms' headquarter is located. Notably,

[26] An implicit assumption we invoke to invert firms' demand function for e_{it} is that e_{it} is strictly monotonically increasing in ω_{it}.

we do not *demand* that variables in $\boldsymbol{z}_{it}$ affect demand for e_{it}. By adding variables to the state variable vector of firms, we only *allow* for these variables to affect demand for e_{it}.

As ω_{it} follows of a Markov process, we can specify its law of motion by: $\omega_{it} = h_{it}(\omega_{it-1}) + \xi_{it} = h_{it}(.) + \xi_{it}$. Substituting this law of motion and (A.2) into the production function gives:

$$y_{it} = \theta^l l_{it} + \theta^m m_{it} + \theta^k k_{it} + h_{it}(.) + \xi_{it} + \varepsilon_{it}, \tag{A.3}$$

which constitutes the basis for our estimation. We approximate $h_{it}(.)$ by a third order polynomial in l_{it}, k_{it}, and m_{it} and add variables in $\boldsymbol{z}_{it}$ linearly. We estimate (A.3) separately for each two-digit industry using a one-step approach as in Wooldridge (2009) by instrumenting m_{it} with its lag (as its contemporaneous value depends on ξ_{it}). In our estimation of (A.3), we control for a full set of time dummies.

After having estimated (A.3), we can derive TFP as a residuum. In case of a revenue-based productivity measure (i.e. where y_{it} stands for deflated revenue, r_{it}), which we denote by $TFPR_{it}$, we thus have:

$$TFPR_{it} = r_{it} - (\theta^l l_{it} + \theta^m m_{it} + \theta^k k_{it}). \tag{A.4}$$

When deriving a quantity-based productivity measure $TFPQ_{it}$, our dependent variable of the production function is quantities, q_{it}. As in the main text, we only derive $TFPQ_{it}$ for single-product firms as we cannot aggregate quantities across multiple products of a firm. Notably, we follow De Loecker et al. (2016) and additionally include output prices, p_{it} in the production function when defining a quantity-based production model (i.e. with q_{it} on the left hand side). We do this because under specific assumptions discussed in De Loecker et al. (2016), we can use output prices to proxy for unobserved input price variation that might be correlated with q_{it} and firms' input decisions (most notably, that

manufacturing expensive products demands firms to use expensive inputs for all production inputs). Hence, we specify the following quantity-based production function that we estimated, as in the revenue-based case, following Wooldridge (2009) and instrumenting m_{it} and p_{it} with their lags (because we also view prices as being flexible):

$$y_{it} = \theta^l l_{it} + \theta^m m_{it} + \theta^k k_{it} + p_{it} + h_{it}(.) + \xi_{it} + \varepsilon_{it}. \quad \text{(A.5)}$$

When deriving $TFPQ_{it}$ we do not extract p_{it} right away from the residuum as we are interested in the difference on the East-West firm productivity gap between specifications controlling and not controlling for output prices. Hence, we derive $TFPQ_{it}$ by:

$$TFPQ_{it} = q_{it} - (\theta^l l_{it} + \theta^m m_{it} + \theta^k k_{it}). \quad \text{(A.6)}$$

In addition to the revenue- and quantity-based productivity measures, we also calculate a profitability measure, denoted by $TFPP_{it}$. Its estimation closely follows the routine used for the revenue-based specification with the only differences that i) we use wage bills instead of FTE as labor input and ii) deflate nominal values for revenues, capital stocks, intermediate expenditures, and wage bills by the country-wide consumer price index (to increase comparability over time). Denoting the log of firm's wage bill by w_{it} and letting a tilde indicate that variables are deflated by the CPI, we derive $TFPP_{it}$ as:

$$TFPP_{it} = \tilde{r}_{it} - \left(\theta^w \tilde{w}_{it} + \theta^m \tilde{m}_{it} + \theta^k \tilde{k}_{it}\right). \quad \text{(A.7)}$$

Below, Table A.1 shows key results of the main text for our derived total factor productivity measures. The results are based on our single-product firm sample. As can be seen, all our key results are qualitatively identical to our baseline labor productivity and competitiveness specifications of the main text. Again, West German firms are characterized by a higher revenue-productivity. Without controlling for prices, East

German firms are physically more productive. This physical productivity advantage vanishes after controlling for output prices, turning to a physical productivity advantage of West German firms conditional on output prices. Notably, East German firms are more profitable than West German firms, confirming our findings on differences in wage profitability (competitiveness) between both regions from the main text.

TABLE A.1

REVENUE TFP, PHYSICAL TFP, AND TOTAL FACTOR PROFITABILITY (TWO-STEP APPROACH), EAST VS. WEST GERMANY

	$TFPR_{it}$	$TFPR_{it}$	$TFPQ_{it}$	$TFPQ_{it}$	$TFPP_{it}$	$TFPP_{it}$
	(1)	(2)	(3)	(4)	(5)	(6)
$East_{it}$	-0.0686***	-0.0657***	0.198***	-0.0570***	0.0274***	0.0282***
	(0.0046)	(0.0046)	(0.00378)	(0.0162)	(0.0041)	(0.0041)
$log(\frac{K_{it}}{L_{it}})$	-0.0307***	-0.0304***	-0.0401***	-0.0696***		
	(0.0013)	(0.0022)	(0.0174)	(0.0097)		
$log(\frac{M_{it}}{L_{it}})$	0.0109***	0.0128***	0.535***	0.361***		
	(0.0033)	(0.0033)	(0.0269)	(0.0018)		
$log(P_{it})$		0.0108***		-0.972***		0.0043***
		(0.0018)		(0.0066)		(0.0014)
$log(\frac{K_{it}}{w_{it}L_{it}})$					-0.0385***	-0.0382***
					(0.0018)	(0.0018)
$log(\frac{M_{it}}{w_{it}L_{it}})$					0.0450***	0.0461***
					(0.0032)	(0.0032)
Main product FE	YES	YES	YES	YES	YES	YES
Single-product sample	YES	YES	YES	YES	YES	YES
Observations	41,104	41,104	40,955	40,955	41,104	41,104
Number of firms	9,204	9,204	9,178	9,178	9,204	9,204
R-squared	0.975	0.975	0.970	0.992	0.976	0.976

Notes: Table A.1 reports OLS-regression results for projecting revenue- (columns 1 and 2) and quantity-based (columns 3 and 4) total factor productivity measures as well as total factor profitability measure (columns 5 and 6) on a dummy indicating whether firms are located in East or West Germany. The measures are derived as described in the online Appendix A section on the two-step approach. We always include year dummies and never include sector dummies. Standard errors are clustered at the firm level. Significance: *10 percent, **5 percent, ***1 percent.

One-step approach

An apparent alternative to the two-step approach described above is to directly include a dummy variable indicating whether firms are located in East Germany into the estimation of the production functions from which we derive $TFPR_{it}$, $TFPQ_{it}$, and $TFPP_{it}$ (see the two-step approach above for a description of the methodology). From the coefficient on this dummy, we can directly infer on the East-West productivity gap. In this online Appendix section, we apply this one-step procedure.

To implement it, we make two adjustments to the production function estimation routine above: First, we do not estimate the production function separately by industries as this would complicate the calculation of the overall East-West productivity differences. Second, as the dummy for the East German location is nested in the categorial variable for the German states (i.e. Bundesland) that we included in the production function estimation above, we now omit this categorial state variable from the regressions. Else, we exactly apply the same specifications for the various production functions (i.e. for $TFPR_{it}$, $TFPQ_{it}$, and $TFPP_{it}$) as in case of the two-step procedure.

Table A.2 replicates our main results using the one-step approach we just described. Again, we focus on our single-product firm sample. Note that the one-step approach causes a dramatic reduction in the observation count. This results from i) the production function estimation demanding lagged values and ii) the one-step approach being only applicable to firms entering the production function.[27] For convenience, Table A.2 only reports the relevant coefficients on the dummy indicating whether firms are located in East Germany and the output price and omits coefficients on all other terms entering the

[27] In case of the two-step approach, we can use the estimated parameters of the production function also for firms outside of the production function estimation sample.

production function estimation. All regressions do, however, include the full set of production function variables specified above for the revenue-based ($TFPR_{it}$), quantity-based ($TFPQ_{it}$), and profitability-based ($TFPP_{it}$) specification.

TABLE A.2

REVENUE TFP, PHYSICAL TFP, AND TOTAL FACTOR PROFITABILITY (ONE-STEP APPROACH), EAST VS. WEST GERMANY

	Revenue-based PF ($TFPR_{it}$) (1)	Revenue-based PF ($TFPR_{it}$) (2)	Quantity-based PF ($TFPQ_{it}$) (3)	Quantity-based PF ($TFPQ_{it}$) (4)	Profitability-based PF ($TFPP_{it}$) (5)	Profitability-based PF ($TFPP_{it}$) (6)
$East_{it}$	-0.0832***	-0.0801***	0.166***	-0.0773***	0.0061	0.0063
	(0.0045)	(0.0045)	(0.0397)	(0.0141)	(0.0040)	(0.0040)
$log(P_{it})$		0.0123***		-0.975***		0.0041***
		(0.0017)		(0.0057)		(0.0014)
Main product FE	YES	YES	YES	YES	YES	YES
Single-product sample	YES	YES	YES	YES	YES	YES
Observations	29,978	29,784	29,978	29,784	29,978	29,784
Number of firms	7,810	7,733	7,810	7,733	7,810	7,733
R-squared	0.992	0.992	0.939	0.989	0.994	0.994

Notes: Table A.2 reports coefficients on a dummy indicating whether firms are located in East or West Germany and firms' output price from a production function estimation routine. Results in columns 1-2 are based on a revenue-based production function. Results in columns 3-4 are based on a quantity-based production function. Results in columns 5-6 are based on a profitability-based production function. For details on the production function specifications see online Appendix A section on the two-step approach above. All specifications include the full set of production function variables. Standard errors are clustered at the firm level. Significance: *10 percent, **5 percent, ***1 percent.

As can be seen, the results are again closely in line with our baseline approach of the main text. Again, West German firms possess higher revenue-productivity levels. Without condition on output prices, East German firms are more productive in terms of physical units. After condition on output prices, wee see that West German firms can produce more quantities of a product of a given price-level. In terms of profitability, we find again minor differences favoring East Germany, which in Table A.2 are, however, only close to being statistically significant at the 10 percent level. Nevertheless, this confirms the general notion that East German firms are characterized by (at output prices evaluated) competitiveness levels similar to West German firms.

Appendix B: Controlling firms' share of product market sales in total revenue

TABLE B.1

REVENUE AND PHYSICAL PRODUCTIVITY,
EAST VS. WEST GERMANY, CONTROLLING FOR FIRMS' SHARE OF PRODUCT MARKET SALES IN TOTAL REVENUE

	$log\left(\frac{Rev_{it}}{L_{it}}\right)$	$log\left(\frac{Rev_{it}}{L_{it}}\right)$	$log\left(\frac{Q_{it}}{L_{it}}\right)$	$log\left(\frac{Q_{it}}{L_{it}}\right)$	$log\left(\frac{Rev_{it}}{w_{it}L_{it}}\right)$	$log\left(\frac{Rev_{it}}{w_{it}L_{it}}\right)$
	(1)	(2)	(3)	(4)	(5)	(6)
$East_{it}$	-0.0796***	-0.0767***	0.184***	-0.0755***	0.0071*	0.0077**
	(0.0042)	(0.0042)	(0.0358)	(0.0042)	(0.0038)	(0.0376)
$log(\frac{K_{it}}{L_{it}})$	0.0441***	0.0445***	0.0774***	0.0468***		
	(0.0018)	(0.0018)	(0.0146)	(0.0182)		
$log(\frac{M_{it}}{L_{it}})$	0.716***	0.718***	0.881***	0.711***		
	(0.0032)	(0.0032)	(0.0211)	(0.0032)		
$log(P_{it})$		0.0108***		-0.987***		0.0035***
		(0.0015)		(0.0016)		(0.0013)
$log(\frac{ProdValue_{it}}{TotRev_{it}})$	-0.0044	-0.0048	0.951***	0.995***	-0.0033	-0.0034
	(0.0037)	(0.0037)	(0.0242)	(0.0037)	(0.0033)	(0.0033)
$log(\frac{K_{it}}{w_{it}L_{it}})$					0.0293***	0.0295***
					(0.0016)	(0.0016)
$log(\frac{M_{it}}{w_{it}L_{it}})$					0.669***	0.0670***
					(0.0032)	(0.0033)
Main product FE	NO	NO	YES	YES	YES	YES
Single-product sample	NO	YES	YES	YES	YES	YES
Observations	41,138	41,138	40,138	41,138	41,138	41,138
Number of firms	9,212	9,212	9,212	9,212	9,212	9,212
R-squared	0.958	0.958	0.936	0.999	0.950	0.986

Notes: Table B.1 reports OLS-regression results for projecting revenue- (columns 1 and 2) and quantity-based (columns 3 and 4) productivity measures as well as a wage profitability measure (columns 5 and 6) on a dummy indicating whether firms are located in East or West Germany. All regressions control for firms' share of product market sales in total revenue. Column 1 uses the entire sample of firms. Columns 2-6 use a single-product firm sample. We always include year dummies and never include sector dummies. Standard errors are clustered at the firm level. Significance: *10 percent, **5 percent, ***1 percent.

As the data source for our product quantity and price data differs from the data source for revenues, capital, labor, and intermediates, and as the revenue information is based on total realized revenue rather than on product values at the factory gate, this section presents a robustness check where we include a control variable for firms' product values at the factory gate over total realized revenue in our main regressions (denoted by $log(\frac{ProdValue_{it}}{TotRev_{it}})$). As noted in the main text, product market values at the factory gate and total realized firm revenue are highly correlated. Table B.1 shows the results of this

robustness check. As expected, our results in Table B.1 are extremely similar to our baseline estimates of the main text.

Appendix C: Graphs for alternative samples

REVENUE-BASED LABOR PRODUCTIVITY, USING OUR SINGLE-PRODUCT FIRM SAMPLE AND TEN-DIGIT PRODUCT AVERAGES FOR DEMEANING. EAST VS WEST GERMANY

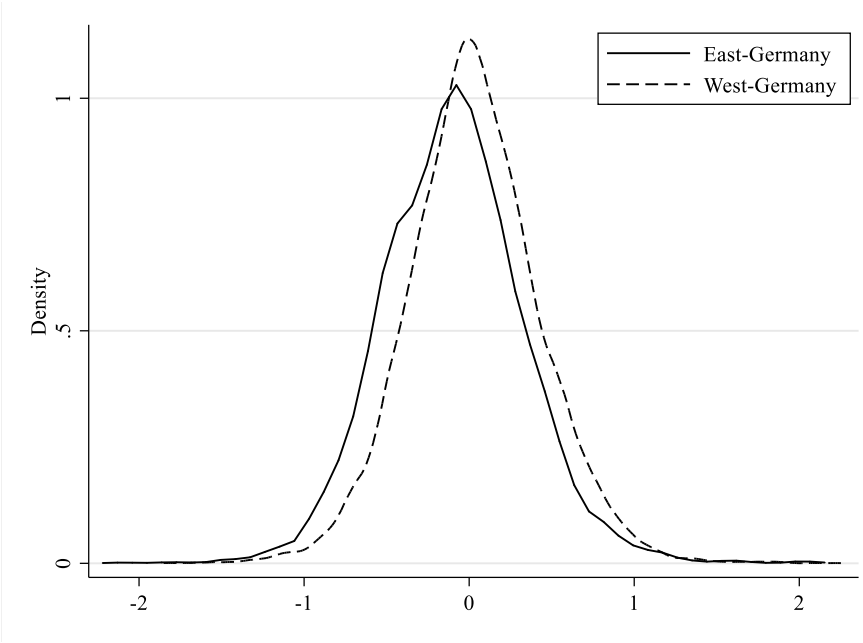

FIGURE C.1 – Distribution of firm-level revenue over FTE separately for East and West German firms. The solid (dashed) line refers to East German (West German) firms. Germany's manufacturing sector. Single-product sample firms. Top and bottom two percent are trimmed.

PRODUCT PRICE DIFFERENCES ACROSS ALL PRODUCTS IN THE DATA: EAST VS. WEST GERMANY.

FIGURE C.2 –Product price differences (in logs) between East and West German firms manufacturing the same ten-digit product. The horizontal axis displays all products manufactured in both regions, ordered according to price differences. Positive values indicate higher prices in West Germany. Germany's manufacturing sector. Full data.

PRODUCT PRICE DIFFERENCES ACROSS ALL PRODUCTS IN THE DATA: EAST VS. WEST GERMANY, BY INDUSTRY

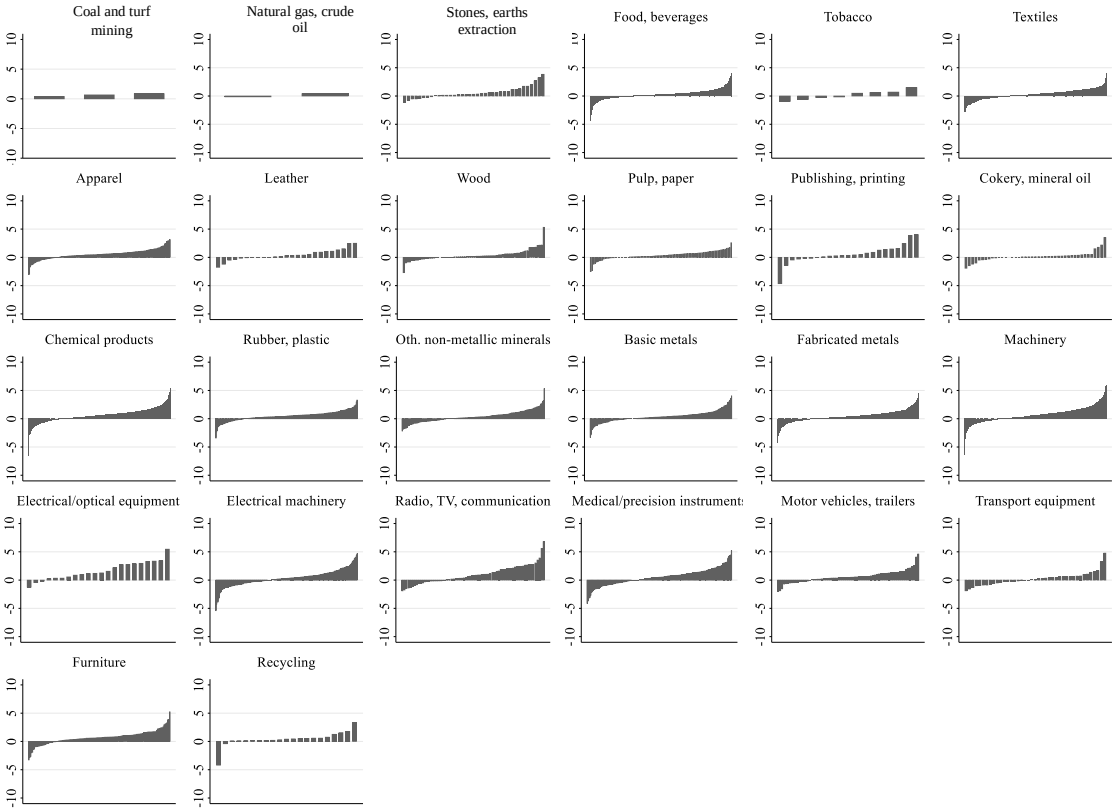

FIGURE C.3 – Product price differences (in logs) between East and West German firms manufacturing the same ten-digit product, separately by two-digit industries. The horizontal axis displays all products manufactured in both regions ordered according to price differences. Positive values indicate higher prices in West Germany. Germany's manufacturing sector. Full data.

Appendix D: Value-added productivity differences

In the main text, we noted that our regional productivity gap coefficient from our revenue labor productivity specification can be upscaled by the inverse of 1 minus the intermediate input output elasticity to yield the corresponding value-added based regional productivity gap coefficient. In this section, we show that this is indeed the case. To do so, Table D.1 first reports output elasticities from our revenue-based production function specification pooled across all sector (which we also applied in the one-step approach in online Appendix A).[28] For convenience, we omitted variables of the productivity control function. As can be seen, the intermediate input output elasticity equals 0.69.

Table D.2 subsequently compares our main text revenue labor productivity specifications with a value-added-based specification (denoted by $log\left(\frac{VA_{it}}{L_{it}}\right)$) showing that we can multiply the revenue-based coefficients with $\frac{1}{1-0.69} \approx 3.226$ to (roughly) receive the value-added based coefficients. Note that as intermediates are accounted for on the left-hand side in the value-added specifications, we omit the intermediate over labor input ratio for the value-added-based specifications from the right-hand side.

[28] For details on the estimation of the production function, please see online Appendix A.

TABLE D.1

OUTPUT ELASTICITIES
FROM THE PRODUCTION FUNCTION ESTIMATION (ONE-STEP APPROACH)

	Dep. var: Deflated revenue	Dep. var: Deflated revenue
	(1)	(1)
Labor output elasticity (coeff. on labor)	0.0256***	0.0253***
	(0.0077)	(0.0077)
Capital output elasticity (coeff. on capital)	0.0642***	0.0636***
	(0.0075)	(0.0075)
Intermediate input output elasticity (coeff. on intermediate inputs)	0.691***	0.691***
	(0.0060)	(0.0061)
$log(P_{it})$		0.0123***
		(0.0017)
Year-FE	YES	YES
Product-FE	YES	YES
Observations	29,978	29,784
Number of firms	7,810	7,733
R-squared	0.992	0.992

Notes: Table D.1 reports results from estimating a Cobb-Douglas production function across all sectors following the one-step approach described in online Appendix A. The estimation includes a regional dummy indicating whether firms are located in East or West Germany. Variables of the productivity control function are omitted. Standard errors are clustered at the firm level. Single-product firm sample. Significance: *10 percent, **5 percent, ***1 percent.

TABLE D.2

REVENUE-BASED AND VALUE-ADDED BASED PRODUCTIVITY,
EAST VS. WEST GERMANY

	$log\left(\frac{Rev_{it}}{L_{it}}\right)$	$log\left(\frac{Rev_{it}}{L_{it}}\right)$	$log\left(\frac{VA_{it}}{L_{it}}\right)$	$log\left(\frac{VA_{it}}{L_{it}}\right)$
	(1)	(2)	(3)	(4)
$East_{it}$	-0.0796***	-0.0768***	-0.263***	-0.262***
	(0.0042)	(0.0042)	(0.0115)	(0.0116)
$log(\frac{K_{it}}{L_{it}})$	0.0441***	0.0444***	0.178***	0.179***
	(0.0018)	(0.0018)	(0.0018)	(0.0048)
$log(\frac{M_{it}}{L_{it}})$	0.717***	0.719***		
	(0.0031)	(0.0031)		
$log(P_{it})$		0.0108***		0.0077**
		(0.0015)		(0.0038)
Main product FE	YES	YES	YES	YES
Single-product sample	YES	YES	YES	YES
Observations	41,138	41,138	41,138	41,138
Number of firms	9,212	9,212	9,212	9,212
R-squared	0.958	0.958	0.556	0.556

Notes: Table D.2 reports OLS-regression results for projecting revenue- (columns 1 and 2) and value-added-based (columns 3 and 4) productivity measures on a dummy indicating whether firms are located in East or West Germany. We always include year dummies and never include sector dummies. Standard errors are clustered at the firm level. Single-product firm sample. Significance: *10 percent, **5 percent, ***1 percent.

Appendix E: Regional price differences in the raw data

In the main text, we report enormous regional price differences between Eastern and Western single-product firms manufacturing products within the same ten-digit product category. In extreme cases, regional product prices differ by a factor of more than 250. One concern could be that these product price differences result from misreports of firms or plants. Yet, as mentioned in the main text, our price data is already cleaned from outliers. In addition, on request, the statistical offices informed us that they carefully check the product data (as all their datasets) and calculate themselves product price averages from which they assess the credibility of the data. In case of doubts, the statistical offices even go back to the reporting unit and ask for a statement on why product prices are as high (low) as reported. If they do not hear back or do not receive a convincing answer, they even delete the respective price information. Note also that we only compare products with each other that are measured by the same quantity unit (e.g. kilogram). The statistical offices, in fact, exactly specify how quantity units should be measured for each individual product and carefully check if the specified measurement unit is applied. We therefore can be sure that our reported price differences are not subject to any such data issues.

Another concern could be that we make mistakes in our reclassification of products causing these enormous price differences (product classifications changed in 2002 and 2008, see section 3.1). To present evidence against this argument, we use the raw product data to report regional product price differences for the period between 2002 and 2008 in Table E.1. In this period, the product classification stayed constant. While we focus on single-product firms in the main text, Table E.1 uses all available product observations to

also show that our extreme price differences are not a result of a sample selection issue (see also online Appendix C).

TABLE E.1

TOP PRODUCT PRICE DIFFERENCES BETWEEN EAST AND WEST GERMAN FIRMS, ALL PRODUCTS AND FIRMS, 2002-2008

Panel A: Highest West German relative price advantage

Product code	Product	Log price difference
321051550	Transistors with a dissipation power of less than 1 Watt	9.11
312027800(2)	Devices for closing, disrupting, securing, or connecting electrical circuits with an electric voltage of no more than 1000 Volt, not elsewhere specified (and manufactured as contracted work)	8.32
366374000	Instruments, apparatus, devices, and models for demonstrations (e.g. for exhibitions and classes)	7.13
294211109	Laser, light, and other photon beams (non-numerically controlled)	7.08
241331530	Aluminum sulfate, 17-18% AL203	7.01

Panel B: Highest East German relative price advantage

Product code	Product	Log price difference
293214500	Fertilizer spreader, not elsewhere specified	-7.87
334022500	Telescopes and other astronomical instruments and their mounts	-6.98
297214003	Non-electrical flow heaters and boilers with gas heating	-5.45
261511100	Cullet and other waste and shards of glass	-5.30
334036700	Equipment for photographic and similar laboratories including negatoscopes	-5.22

Notes: Table E.1 shows the products with the highest average log price difference between West- and East German firms in the raw data for the period from 2002 to 2008. Panel A (B) displays the products with the highest West German (East German) relative price advantage. Positive values signal higher prices in West German firms. Germany's manufacturing sector.

As Table E.1 shows, the reported product price differences between Eastern and Western firms become even more extreme (in both directions) when using the raw data for 2002 to 2008. The largest regional product price difference in the raw data for this period are found for "Transistors with a dissipation power of less than 1 Watt", where we report a regional log price differences of 9.11, implying a price difference factor of $\exp(9.11) \approx 9{,}045$. Given these extreme price differences in the raw data, we view our results of the main text as a conservative benchmark for regional price differences between Eastern and Western firms.

Appendix F: Firms that do not purchase any commodities for resale

Table F.1 replicates our main regression for a sample of single-product firms that do not purchase any commodities for resale. As can be seen, our results are nearly unchanged when using this sample of firms. This excludes the possibility that our estimated productivity differences result from Western firms purchasing final products at below market prices from Eastern firms for resale purposes.

TABLE F.1

REVENUE AND PHYSICAL PRODUCTIVITY, EAST VS. WEST GERMANY, FIRMS THAT DO NOT PURCHASE ANY COMMODITIES FOR RESALE

	$log\left(\frac{Rev_{it}}{L_{it}}\right)$	$log\left(\frac{Q_{it}}{L_{it}}\right)$	$log\left(\frac{Rev_{it}}{L_{it}}\right)$	$log\left(\frac{Q_{it}}{L_{it}}\right)$
	(1)	(2)	(3)	(4)
$East_{it}$	-0.0835***	0.194***	-0.0808***	-0.0716***
	(0.0054)	(0.0463)	(0.0054)	(0.0154)
$log\left(\frac{K_{it}}{L_{it}}\right)$	0.0443***	0.0640***	0.0445***	0.0484***
	(0.0023)	(0.0196)	(0.0023)	(0.0068)
$log\left(\frac{M_{it}}{L_{it}}\right)$	0.704***	0.734***	0.706***	0.609***
	(0.0041)	(0.0318)	(0.0041)	(0.0163)
$log(P_{it})$			0.0098***	-0.978***
			(0.0019)	(0.0059)
Main product FE	YES	YES	YES	YES
Single-product sample	YES	YES	YES	YES
Observations	24,244	24,244	24,244	24,244
Number of firms	6,303	6,303	6,303	6,303
R-squared	0.957	0.925	0.957	0.987

Notes: Table F.1 reports OLS-regression results for projecting revenue- and quantity-based productivity measures on a dummy indicating whether firms are located in East or West Germany, for firms that do not purchase any commodities for resale. We always include year dummies and never include sector dummies. Single-product firms. Standard errors are clustered at the firm level. Significance: *10 percent, **5 percent, ***1 percent.

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