The Persistent Pay Gap between Easterners and Westerners in Germany: A Quarter-century after Reunification

Dickey, H., & Widmaier, A. M. (2021). The Persistent Pay Gap between Easterners and Westerners in Germany: A Quarter-century after Reunification. Papers in Regional Science. https://doi.org/10.1111/pirs.12594

Published in:
Papers in Regional Science

Document Version:
Publisher's PDF, also known as Version of record

Queen's University Belfast - Research Portal:
Link to publication record in Queen's University Belfast Research Portal

Publisher rights
Copyright 2021 the authors. This is an open access article published under a Creative Commons Attribution License (https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution and reproduction in any medium, provided the author and source are cited.

General rights
Copyright for the publications made accessible via the Queen's University Belfast Research Portal is retained by the author(s) and / or other copyright owners and it is a condition of accessing these publications that users recognise and abide by the legal requirements associated with these rights.

Take down policy
The Research Portal is Queen's institutional repository that provides access to Queen's research output. Every effort has been made to ensure that content in the Research Portal does not infringe any person's rights, or applicable UK laws. If you discover content in the Research Portal that you believe breaches copyright or violates any law, please contact openaccess@qub.ac.uk.
The persistent pay gap between Easterners and Westerners in Germany: A quarter-century after reunification

Heather Dickey1 | Alessa M. Widmaier2

1Queen’s University Belfast, UK
2University of Aberdeen Business School, UK

Correspondence
Heather Dickey, Queen’s University Belfast, Riddel Hall, 185 Stranmillis Road, Belfast, BT9 5EE, UK.
Email: h.dickey@qub.ac.uk

Abstract
A quarter of a century after Germany’s reunification, Eastern Germans still earn substantially less than Western Germans. This paper revisits the German wage differential and isolates the effect of differing returns to human capital endowments, the possibility of a location effect, and human capital depreciation on the regional wage gap. While the endowment effect, location effect, and human capital depreciation jointly account for the wage differential between Easterners and Westerners living in the West, the same does not hold true for individuals settled in the East, where part of the wage gap remains unexplained.

KEYWORDS
decomposition, German reunification, quantile regressions, wage differentials

JEL CLASSIFICATION
J15; J31; R23

1 INTRODUCTION

With the reunification of East and West Germany in 1990, the challenging process of economic, political, and institutional integration of two seemingly incompatible systems began. Previously occupied by the communist regime of the Soviet Union, the former territory of the German Democratic Republic (GDR or ‘East’) underwent rapid assimilation to Western capitalism and liberalism in the years that followed. Numerous aspects of the transition...
process occurred immediately, such as freedom of movement and the privatization of the Eastern economy that were implemented directly after the fall of the Berlin Wall in 1989, with monetary union following in July 1990. Other longer-term redistributive measures, which are still active today, were put into place to allow the East to catch up with the level of capital and technology available in the West.

However, other aspects of convergence lagged behind the general move ‘West-ward’. A prime example of differences that did not disappear so seamlessly is the wage gap between Easterners and Westerners, which still persists almost 30 years after reunification. While Easterners’ relative earnings increased dramatically in 1990, from one-quarter to one-half of Westerners’ wages, the adjustment rate slowed down during the 1990s. By 2016, the relative wage was approximately three-quarters.

Classical economic theory would predict that convergence between wages in East and West Germany would occur over time. In classical economic equilibrium models, labour and capital respond to inter-regional disparities in economic opportunities, through undertaking regional migration, and thus act to reduce these disparities. The adoption of Western labour market (especially wage-setting) institutions should also be expected to reduce wage differentials between the two regions over time. However, despite the large number of East-to-West migrants and collectively bargained wages set to reach parity with West German levels in 1994, the persistence of a relatively large wage differential between East and West Germany points to the reality that transition processes in labour markets may be much slower than assumed by economic theory.

This paper aims to isolate and quantify potential sources of the German regional wage differential. Most of the existing research on the East-West wage gap addresses the well-documented geographical difference in wages, and possible explanations for this are explored in the empirical literature. However, comparatively little attention has been paid to the substantial earnings gap between Easterners and Westerners, independent of their location after reunification. We seek to contribute to the existing empirical literature in the following ways. First, the paper investigates three potential determinants of the Easterner-Westerner wage differential: differences in human capital endowments; location effects; and human capital depreciation. To the authors’ knowledge, no other empirical study has decomposed the Easterner-Westerner wage gap into its three most probable sources.

Second, most of the existing literature (e.g., Burda & Schmidt, 1997; Franz & Steiner, 2000; Orlowski & Riphahn, 2009; Smolny & Kirbach, 2011) focuses on either regional wage differentials (i.e., East compared to West) or the wage gaps by origin (i.e., Easterners compared to Westerners). For a more in-depth exploration of the regional wage gap, this paper utilizes the Blinder–Oaxaca decomposition for the Eastern and Western German labour markets separately. The empirical analysis estimates four distinct wage equations: for Easterners settled in the East and in the West, and for Westerners settled in the East and in the West. Comparing wage equations by origin provides information about the importance of productive endowment differentials. Comparing by region can provide further insights into the effect of location. In addition, conducting this analysis for cross-sectional data over time can shed light on the potential influence of human capital depreciation.

Third, most existing studies analyse the East-West German wage gap at the average level. However, it may be the case that the wage gap between Easterners and Westerners varies significantly along the wage distribution. If the relationship between the regressors and the dependent variable evolves across the conditional wage distribution, this will be ignored by the standard OLS methodology (Dickey, 2007). We use the quantile regression methodology to identify the regional wage differentials at the 10th, 25th, 50th, 75th, and 90th percentiles and attribute these gaps to the potential sources stated above.

Finally, the most recent studies (Blüen, Möller, thi Hong Van, & Drunow, 2016; Kluge & Weber, 2018; Smolny & Kirbach, 2011) addressing the Easterner-Westerner wage differential were conducted using data up to 2008 and 2010 respectively, and most of the empirical literature employed data from the 1990s or early 2000s. This paper uses data from the SOEP for 2016. In light of the persistently large wage differential between East and West Germans a quarter of a century after reunification, it is timely to re-examine the sources of this particular regional wage differential and attempt to identify why regional convergence in wages has not fully taken place as predicted by standard economic theory. Identifying the causes of this persistent wage gap may also shed light on appropriate
policy responses to mitigate this gap; in particular, whether “people-based” or “place-based” policies would be more effective in addressing the wage disadvantage experienced by East Germans relative to their Western counterparts.

The paper is organized as follows. Section 2 briefly outlines the theoretical and empirical literature that addresses the Easterner–Westerner wage differential in Germany. Section 3 discusses the data and methodology used, and the results of the empirical analysis are discussed in section 4. Section 5 provides a discussion of potential policy implications, and lastly, section 6 concludes.

2 | THEORETICAL PREDICTIONS AND EMPIRICAL EVIDENCE

How much an individual earns for their labour is influenced by both the quantity and quality of various productive characteristics, most notably education, labour market experience, and training. The “quantity” of human capital an individual is endowed with is directly related to their exposure time (expressed in years) to each of these components of human capital, whereas the “quality” of an additional endowment unit is assessed in its ability to increase productivity (Hanushek, Ruhose, & Woessmann, 2015).

This section will describe three mechanisms that may induce, at least part of, the wage gap between Easterners and Westerners. The endowment effect is associated with the quantity of human capital endowments, while the location effect and human capital depreciation are more directly related to the quality of productive characteristics.1

2.1 | The endowment effect

The endowment effect describes the wage premium that an individual with larger amounts of human capital receives compared to an individual with less favourable endowments. If individuals are assumed to be rational, human capital accumulation can be regarded as an investment decision, where individuals weigh up the costs and benefits associated with attaining a particular amount of human capital. For example, the costs of attaining a university degree will include the direct costs of attending university, as well as the opportunity cost of the foregone earnings while not working and the foregone return to work experience. The future benefits of this investment in higher education is the wage premium (over high school graduates) accrued over the working life of the individual. This investment decision applies not only to formal education but to other forms of human capital as well, for example, on-the-job training. In essence, individuals will only make the effort to acquire human capital if it will increase their future earnings by more than the cost of acquiring the human capital, where the minimum necessary wage premium will vary across individuals.

In a similar way, profit-maximizing employers weigh up the costs and the benefits of hiring workers. The cost per employee is equal to the real wage rate, while the benefit per employee is the value of output they produce. Standard economic theory suggests that with perfect competition, each employee will earn their marginal product of labour (MPL):

$$w = MPL.$$ (1)

Hence employers are not willing to pay higher real wages to some employees unless they are more productive than others.

Two hypotheses are in line with the rational decision-making assumption of economic agents. The human capital model (e.g., Schultz, 1961) suggests that the acquisition of education and training itself makes individuals more

---

1The role played by other factors (such as systematically diverging industry and employment preferences or discrimination) in contributing to the wage gap will not be addressed in this paper.
productive because it involves the transmission of knowledge and skills relevant to the labour market. Conversely, the signalling hypothesis (Spence, 1973) argues that those individuals who choose to undertake a degree are, on average, more productive than those who do not, but that college does not in itself increase productivity. If the cost of undergoing further education is higher for less productive individuals (because they have to invest more effort to achieve the same outcome as more productive individuals), then having a college degree can inform employers about the otherwise unobserved productivity of potential employees. While these models differ fundamentally on how human capital affects productivity, they both lead to the outcome that individuals with higher amounts of human capital are, on average, more productive and therefore it is natural to expect them to occupy a more advanced position in the labour market. The “justified” (Blinder, 1974) pay differential resulting from systematic differences in human capital between groups is commonly referred to as the endowment effect. In our analysis of the wage gap between Easterners and Westerners in Germany, part of this persistent gap may be explained by Easterners having less favourable human capital endowments compared to Westerners.

2.2 | The location effect

The location effect describes the pay differential between geographically separated groups that is the direct result of differences in regional economic conditions. Here, the main focus lies on differences in returns to productive endowments that are induced by regional differences in factor availability and technological progress. If the quality of human capital stock is assessed in its ability to increase productivity, investment in these productive characteristics may not be of the same value in different locations.

Both the human capital and signalling models propose that individuals with more favourable endowments are more productive (whether the relationship is causal or not). Rewriting the profit maximizing condition in differential form gives:

\[ dw = dMPL, \]  

(2)

which implies that a change in productivity directly translates into a change in the real wage rate. This observation can help to explain why returns to human capital variables may vary, not only between individuals, but also across geographical regions. Different returns to education, for example, mean that \( dw \) differs across regions for a given increase in years of education, implying that an educational investment enhances productivity to varying extents. Hence, the answer to differential returns will lie within the determinants of labour productivity.

Assuming a regional economy is described by a Cobb-Douglas production function \( (Y = AL^\alpha K^\beta) \), the marginal product of labour is given by:

\[ MPL = \frac{\partial Y}{\partial L} = A\alpha L^{\alpha-1}K^\beta = A\alpha L^{-\beta}K^\beta = A\alpha \left( \frac{K}{L} \right)^\beta, \]  

(3)

where constant returns to scale are assumed. The effectiveness of labour, \( A \), captures knowledge and skills that assist in transforming factors of production into units of output. \( A \) is assumed to increase when an individual acquires more human capital, inducing the marginal product of labour to change in the following way:

\[ \frac{\partial MPL}{\partial A} = \alpha \left( \frac{K}{L} \right)^\beta. \]  

(4)

Since \( K, L, \) and \( \beta \) are strictly positive numbers, \( \left( \frac{K}{L} \right)^\beta \) must be increasing in the capital-per-labour-unit ratio \( \frac{K}{L} \). Thus, the greater the relative capital abundance that prevails in an economy, the more will MPL increase when the
effectiveness of labour improves \((\text{given } \alpha > 0)\). The amount by which human capital investment increases an individual’s productivity directly depends on the relative factor availability in the economy. Consequently, a region with larger availability of physical capital per unit of labour will exhibit higher returns to human capital investments.

Technological progress enhances returns to human capital investments in a similar fashion. In a dynamic economy, the effectiveness of labour increases at a fast pace, allowing human capital investment to intensify labour productivity proportionally more than in an economy with slower technological advancements. Deriving this phenomenon using models of technological diffusion, Nelson and Phelps (1966, p. 75) conclude that “the rate of return to education is greater the more technologically progressive is the economy.”

Other regional economic conditions may also affect wage levels, either directly or indirectly (i.e., through alteration of returns to human capital stocks). These factors include, but are not limited to, the cost of living, unemployment levels, population density, the presence of collective bargaining and negotiated wages, industry concentration, and the share of firms belonging to high-paying sectors (Sapsford & Tzannatos, 1993).

In the context of the East–West wage gap in Germany, it is possible that homogeneous human capital characteristics are rewarded differently in the two regions due to location effects. This would particularly be the case if the East exhibits less favourable economic conditions and most individuals in the East and West remained in their respective region of origin. However, arbitrage in the form of regional factor migration and redistributive efforts is expected to equalize economic conditions in the two German regions in the long run. Thus, classical economic theory would argue that the Eastemer–Westemer wage gap that is due to location effects should approach zero in the future as differences in regional economic conditions diminish.

### 2.3 Human capital depreciation

In 1990 the political and economic system previously only prevalent in the West was applied to the whole of reunified Germany. “East German workers ‘arrived’ in a completely new environment, albeit neither voluntarily nor as the result of a physical move” (Burda & Schmidt, 1997, p. 4). The situation in Germany in the early 1990s was therefore comparable to a “mass-migration” of Eastern workers into the capitalist system. Here, the assimilation and migration literature can be drawn upon to help explain a further source of the East–West German wage gap.

The assimilation hypothesis, originating in the seminal work of Chiswick (1978), seeks to explain the well-documented wage differentials observed between foreign-born and native-born individuals. This theory centres on the argument that human capital acquired in a foreign country may be less productivity-enhancing than natively-acquired endowments. This may be a result of the knowledge and skills obtained through education, training and experience being, to some extent, country-specific. Relevant to this study is the possibility that education and experience obtained in a centrally-planned economy may not be as advantageous in a capitalist system as education and experience acquired in a free market economy. In addition to human capital being country-specific, and therefore not perfectly transferable from home to host country, migrants may also face another source of disadvantage post-migration. Migrants’ productivity relative to natives may be lower due to their lack of familiarity with customs, regulations, working practices, and job opportunities in the host country, and this may directly translate into a relative wage penalty for migrants.

Productivity differences between native and immigrant workers may also have consequences for firms’ hiring decisions. Employers may incur higher costs when hiring recent migrants if they find it difficult to verify the quantity and quality of migrants’ human capital or to check references from non-native employers and schools. Firms may also perceive an increased risk associated with employing a recent immigrant due to their unfamiliarity with host country labour market conditions and institutions, making it more difficult to predict migrants’ productivity, approach to potential problems, and work ethics. For recent migrants we can represent the total cost per employee incurred by the employer:
where $w_I$ denotes the wage rate for immigrants, $s$ is the dollar-value of search costs, and $r$ denotes the dollar-value of risk involved in employing a recent immigrant (adapted from Becker, 1971). In comparison, the total cost per native worker, $c_N$, will simply equal the wage rate, $w_N$. If immigrants had the same wage rate as equally productive natives, employers would exclusively hire natives since this would reduce their costs. If immigrants wanted to be hired, they would have to comply with the competitive behaviour of firms and accept a wage discount of the amount $(s + r)$.

Thus, human capital acquired abroad by immigrants does not enhance wages by the same margin as natively-sourced endowments for two reasons: (i) it enhances productivity to a lesser extent; and (ii) foreign human capital invokes additional search costs and risks for employers. However, the assimilation hypothesis also predicts a process of catch-up where the initial wage disadvantage due to “temporary adjustment problems” (Lang, 2000) will disappear over time as migrants gain work experience, training, and education in the host country. As immigrants assimilate, it is predicted that their earnings will rise faster than those of native workers. The “knowledge gap” will narrow at a diminishing rate since the largest adjustments are made just after arrival. Consequently, the differences in returns explained by human capital depreciation will asymptotically approach zero in the long run (Laing, 2011).

The application of the assimilation hypothesis to Germany would suggest that human capital acquired in the GDR would be of less value in the market economy of reunified Germany than human capital acquired in the West. Numerous empirical studies post-reunification support this by documenting the fall in returns to human capital experienced by Eastern Germans. For example, much of East Germans’ individual human capital was rendered unproductive after reunification (Burda & Schmidt, 1997). Bird, Schwarze, and Wagner (1994) find that firm experience did not translate to the same amount of human capital under socialism as under capitalism, and the value of labour market experience accumulated in the former socialist economy of the GDR has depreciated in the transition process to a market economy, partially explained by new production processes and profound changes in the organization of work (Franz & Steiner, 2000).

We investigate to what extent the depreciation of Easteners’ human capital endowments can account for the wage gap between Easteners and their Western counterparts. Note, however, that the wage gap between these two groups should approach zero in the long run as Easteners assimilate to the requirements of the free market system and catch-up to Westerners in terms of wages.

### 2.4 Empirical evidence

Given the uniqueness of the German case, the East–West (or Easterner-Westerner) wage differential has attracted a considerable amount of research, with much of this literature dating to the early years after reunification. This section briefly summarizes the main studies that investigate the earnings gap between East and West Germany.

Early investigations into the effect of reunification on wages in the two countries tended to focus on what happened to wages and the returns to human capital endowments in the East during its transition process towards a capitalist economy. Bird et al. (1994) investigated the changes that took place in the structure of wages in the former GDR during its transition. Prior to reunification East Germany exhibited a much flatter wage structure compared to the West German labour market, although the free-labour market assumptions were not directly applicable to West Germany either since the West German labour market was heavily influenced by wage-setting regulations and national-level union-industry negotiations. The introduction of free-market bidding in the previously socialized labour market was expected to affect both the value of human capital attributes such as education and experience, and also the supply of and demand for these aspects of human capital. Bird et al. (1994) find that education retained
its value after the transition to a capitalist economy, but the return to experience fell to half its earlier value. Older workers in East Germany, whose human capital largely consisted of work experience but little schooling, therefore suffered the largest decline in wages under the new system.

Krueger and Pischke (1995) focused on both wage determination and inequality in East and West Germany. East German wages grew rapidly between 1989 and 1991, by 38.3%, along with an increase in earnings dispersion that occurred mostly at the upper tail of the distribution (earnings grew by over 50% between 1990 and 1991 for the top 10% of earners). Similar to Bird et al. (1994), Krueger and Pischke’s results indicate that, while education was of equal quality and value in the GDR and the West, the returns to experience were much lower in East Germany, suggesting very low returns to seniority in that country. Krueger and Pischke (1995) conclude that workers’ skills were not the main problem in East Germany; instead outdated technology, insufficient capital, and inefficient management contributed more to low wages and low productivity in the East.

Burda and Schmidt (1997) employed an Oaxaca-style decomposition to investigate the East–West wage differential, which amounted to approximately 25% in 1996. Their analysis points to comparable endowments of education and training in both countries (if not more favourable in the East), but returns to age were depressed under socialism and continued to be so after reunification. Their decomposition analysis found that differing rates of return to endowments, and not measurable endowments themselves, were the cause of the observed wage differentials. In fact, if East Germans had received the same returns to their endowments as West Germans in 1990, their relative hourly earnings would have been almost 4% higher. They conclude by stating that the East–West variation of estimated returns is more appropriately interpreted as a measure of human capital depreciation, and not wage discrimination.

Franz and Steiner (2000) revisited the East–West wage gap a decade after the two countries of Germany reunified. They describe the changes that took place in the distribution of hourly wages between 1990 and 1997 and analyse the economic factors determining these changes. Regarding wage developments, the first two years saw excessive increases in nominal wages, followed by a sharp decline in the growth rate of nominal wages between 1993 and 1995, and stabilization of wage growth in the following years.

To account for structural factors that affect wages, Franz and Steiner (2000) control for firm size, industry and region in their analysis. They find that firm size differentials were relatively small under socialism (possibly explained by little job mobility in the former GDR), but increased substantially after reunification. Similarly, the effect of firm tenure (as a proxy for firm specific human capital) was also small, but tenure profiles became steeper after reunification. Franz and Steiner (2000) conclude that, since observable human capital endowments did not change dramatically in East Germany after reunification, the observed rise in wage inequality in the East was related to an increase in the returns to innate abilities that became more important in the more flexible East German labour market.

More recently, Orlowski and Riphahn (2009) investigate whether the systematic differences in the returns to experience and tenure in the two regional labour markets have disappeared over time. They confirm the findings of earlier studies that the East exhibited flatter experience-wage profiles, which continued to exist into the mid-2000s. Their results suggest that the returns to tenure are small but similar in the East and West, whereas experience profiles still lag behind substantially in the East almost twenty years after reunification. This is particularly the case for medium and high-skilled workers who enjoy significantly higher returns to experience in the West. Orlowski and Riphahn (2009) conclude that the observed differences in returns to experience between Easterners and Westerners is unlikely to be caused by differences in the price of homogeneous experience, but instead is more likely to be a result of the type of experience earned in the East German labour market differing in character or quality compared to the experience earned in the West German labour market. Overall, the differences between the East and West wage structures are due to systematic regional differences (such as differences in firm characteristics and regional public policy) and not a result of individual differences between Easterners and Westerners.
Smolny and Kirbach (2011) investigate whether the source of the persisting wage differences is related to the location or the people, and ask what East Germans would have earned if their working place would have been in West Germany instead of East Germany. They find that the factors that were important for income determination in West Germany are relevant in East Germany as well. Their estimates reveal that the returns to experience and education converged in the two Germanys over the period 1990–2008. If human capital depreciation was responsible for the significantly lower returns in the East after reunification, then the differences in returns between the East and West would be expected to narrow over time as Easterners adapted to the requirements of the competitive market system. Smolny and Kirbach’s (2011) results, along with Burda and Schmidt (1997), therefore provide some evidence that human capital depreciation was an important component in explaining the East–West wage gap.

However, Smolny and Kirbach (2011) also find evidence of a persistent wage gap once the two regions exhibited similar returns to productive endowments in 2008, and they interpret the remaining wage differential as the consequence of a negative location effect in the East. Despite significant redistribution at the federal level, the East may not have fully caught up with the West with respect to technological progress and capital accumulation. Their finding that Eastern migrants moving to the West experienced a wage gain of nearly 30% supports the hypothesis that differences in locational conditions, and not differences in human capital endowments, are primarily responsible. The authors further suggest that the remaining gap between Eastern migrants and Westerners might be the consequence of a negative selection effect in migration (i.e., Eastern migrants have less favourable endowments than Eastern stayers). Hypothetical wage gains for Easterners with average characteristics moving to the West could amount to 40%, resulting in even higher earnings than those received by Westerners.

Lastly, two very recent studies have revisited the persistent wage gap between East and West Germany. First, Blien et al. (2016) argue that the substantial differences between labour market outcomes in Eastern and Western Germany must be understood in relation to the initial conditions of unification and transformation in eastern Germany. Their focus is primarily on the substantial institutional changes that followed unification; in particular, how the transformation of the East German economy and its industrial and ownership structure led to the divergence of innovation and productivity performances in the East and West, which then propagated to the labour market, influencing unemployment and wages in both regions. Their findings indicate that the regions of East Germany have problems developing an endogenous growth process because they lag behind in the frequency of innovations, and because many firms in the East lack autonomy and capacities in research and development due to their owners being located in the West. The authors conclude by suggesting that technology policies could be one solution to stimulate innovation behaviour and improve productivity development in the East as part of integrated regional policies to promote regional capacities.

Second, Kluge and Weber (2018) use a large linked employer-employee dataset to decompose the German East–West wage gap into composition and wage-structure effects. Their analysis covers the period 1996–2010, and focuses on differences in worker, establishment, and regional characteristics (female employment share, union coverage, industrial structure, establishment size, labour productivity, urban agglomeration, and local price levels). Adopting recentred influence function (RIF) regressions, to estimate region-year-specific wage equations, and the Blinder-Oaxaca decomposition approach, they estimate that around 40% of the observed wage gap at the median level can be explained by differences in worker, establishment, and regional characteristics. Of particular importance among these structural factors are local price levels and differences in establishment size. The authors conclude by observing that these structural differences between the East and the West have been stable over time, with little evidence that they will diminish over time; thus, there is little expectation that Eastern wages will converge considerably toward West German levels in the years to come (Kluge & Weber, 2018).

In summary, much of the existing empirical literature supports the argument that the endowment effect, if it exists at all, is only a minor factor in explaining the East–West (or Easterner–Westerner) wage gap. The remaining wage gap between the two regions has been interpreted as either human capital depreciation or as a location effect.
DATA AND METHODOLOGY

3.1 Data

The microdata for the empirical analysis comes from the German Socioeconomic Panel Study (GSOEP), which is a longitudinal survey of private households and persons started in the Federal Republic of Germany in 1984 and extended to the GDR in June 1990. For the purposes of this study, the GSOEP collects information regarding personal and human capital characteristics, and labour market outcomes. The most recent wave is 2016, constituting 29,178 individuals from 17,822 households.

We focus on employed individuals with German citizenship aged 27 to 65 years of age, who have been living in present-day German territory both before and after reunification. Excluding individuals with no information on gross monthly earnings, weekly working hours, or human capital variables reduces our sample to 9,133 observations in 2016. Table 1 provides information on the number of observations in our sample over the longer time period of 2002–2014. Years prior to 2002 are not considered due to the small number of West–East migrants in those years.

The dependent variable in the econometric analysis is the log of hourly earnings, where hourly earnings are calculated from gross monthly earnings divided by 4.3 (weeks per month), and further divided by average working hours per week (see Burda & Schmidt, 1997).

3.2 Methodology

When separating wage differentials into its components, the empirical literature commonly relies on two approaches. The first approach utilizes one function for all individuals and regresses earnings \( Y \) on relevant productive characteristics (vector \( X \)) and a dummy variable (\( E \)) equal to one if the individual is an Easterner:

\[ Y_i = \alpha + (X_i)\beta + \gamma(E_i) + \epsilon_i. \] (6)

If \( \gamma < 0 \), its magnitude denotes the fixed disadvantage associated with being an Easterner, ceteris paribus. While \( \gamma \) represents a horizontal shift in the wage function, the regression does not allow for differences in the slope coefficients of the other explanatory variables (vector \( \beta \)), which leaves dissimilarities in the returns to education, experience, or other productive characteristics unaccounted for.

\[ \text{2Since the role played by human capital depreciation is only relevant for those Easterners who were born in the former communist system, the sample is restricted to those individuals born before reunification occurred.} \]
The second approach (referred to as the Blinder–Oaxaca decomposition) avoids any potential bias arising from this rigid specification by estimating separate regression functions for Easterners (E) and Westerners (W), thereby making the regional dummy variable redundant:

\[ Y_{ij} = \alpha_j + X_{ij}^\beta + \epsilon_{ij} \]

where the subscripts denote the individual’s origin within Germany. The specification of the two functions must be strictly comparable. Any existing pay gap in the predicted average wage,

\[ \frac{Y_E - Y_W}{C_0/C_1} \]

can then be decomposed into two distinct sources: (i) dissimilarities in endowments \(X_E - X_W\), where the X's are measured at the average; and (ii) unequal returns to productive endowments \(\beta_E - \beta_W\), including a fixed pay differential \(\alpha_E - \alpha_W\).

Let \(\bar{Y}(X_A, \beta_B)\) denote the predicted average earnings for an individual with average characteristics of group A and returns to endowments of group B. Then, we have the following expression:

\[ \Delta_{E,W} = \bar{Y}_E - \bar{Y}_W = (\bar{Y}(X_E, \beta_E) - \bar{Y}(X_E, \beta_W)) + (\bar{Y}(X_E, \beta_W) - \bar{Y}(X_W, \beta_W)). \]

The first difference on the right-hand side denotes the earnings premium (or discount, if negative) an average Easterner experiences when compared to a Westerner with the same characteristics. This differential is solely due to unequal returns for the two groups (including diverging constant terms). The second difference accounts for the possibility that productive endowments may be unequally distributed among the two groups (Burda & Schmidt, 1997). In that case, the resulting average wages would diverge even if Easterners and Westerners received the same returns (endowment effect).

In much of the empirical literature that utilizes the Blinder-Oaxaca decomposition method, the return-induced wage differential is usually referred to as discrimination. This may be accurate in the case of, for example, the gender pay gap since women and men live in the same neighbourhoods, attend the same schools, experience the same economic conditions, etc., and therefore would be expected to be remunerated equally for their endowments in a non-discriminatory environment. However, the reunification of two very distinct economies in Germany resulted in a situation where differential returns to productive characteristics between Easterners and Westerners could have sources other than discrimination. In our analysis we examine two of these potential sources, namely the location effect and human capital depreciation.

### 3.2.1 The location effect

First, given the significant political and economic divide between GDR and the West, it is likely that regional productive characteristics, such as technological progress and capital stock, are still unequally distributed across reunified Germany. Consequently, individuals living in the East may be productively different compared to individuals in the West with the same endowments. Given that most Easterners and Westerners remained in their region of origin, part of the wage differential between Easterners and Westerners may be explained by differences in locational conditions. The location effect is assumed to affect all individuals living in the same region equally. Consequently, it can be accounted for by calculating the Easterner-Westerner wage differential only for individuals living in the East:

\[ \Delta_{E,W} = \bar{Y}_E - \bar{Y}_W = (\bar{Y}(X_E^E, \beta_E^E) - \bar{Y}(X_E^W, \beta_W^E)) + (\bar{Y}(X_E^E, \beta_W^E) - \bar{Y}(X_W^E, \beta_W^E)). \]

and separately only for individuals settled in the West:
Here individuals’ settlement region after reunification is denoted by the superscripts \( E \) (for East) and \( W \) (for West) and individuals’ region of origin is denoted by the subscripts \( E \) (for Easterners) and \( W \) (for Westerners). In the equation for the East, the first difference denotes the wage gap induced by diverging returns for Easterners living in the East compared to Westerners living in the East. This is the part of the return differential that is still unaccounted for after the location effect has been considered. The second difference accounts for the endowment effect in the East. The equation for Western Germany is interpreted in a similar fashion for Easterners and Westerners living in the West.

If less advanced capital and/or technology influence the productivity of labour in the East, then the difference in returns between Easterners and Westerners should be lower when both regions are considered separately than when considered jointly. Therefore, a location effect exists if the return differentials in both the East and the West are smaller than the return differential at the national level. Mathematically:

\[
\Delta_{E,W}^W = \bar{Y}_{E}^W - \bar{Y}_{W}^W = \left( \bar{Y} \left( X_E^W, \beta_E^W \right) - \bar{Y} \left( X_W^W, \beta_W^W \right) \right) + \left( \bar{Y} \left( X_E^W, \beta_W^W \right) - \bar{Y} \left( X_E^W, \beta_W^W \right) \right).
\]  

(10)

3.2.2 | Human capital depreciation

Second, various studies in the empirical literature find evidence that human capital depreciation at the time of reunification decreased Easterners’ returns to productive endowments.

However, factor mobility and redistributive efforts should lead to this initial disadvantage diminishing over time. Typically, in the migration literature, the assimilation hypothesis is tested empirically by including a variable for ‘years since migration’ (Lang, 2000). In the German case, however, this variable is not required since human capital depreciation, if it occurred, coincided for all Easterners. Instead, the return differential is analysed over time. A decrease during the period 2002–2016 can be interpreted as the ability of Easterners to assimilate to the post-unification system. One reason to expect a decline in the return differential over time is the age pattern. The depreciation of human capital was particularly large for elder workers (those who suffered the largest decline in wages under the new system). Over time, these older workers have retired and been replaced by younger workers who were educated under the new system. Evidence to support age-dependent productivity effects is provided by Brunow and Hirte (2009).³

Here, again, the analysis needs to be conducted in the East and the West separately, because the location effect is also expected to decrease over time, making it impossible to isolate the effect of human capital depreciation when only observing the national return differential. To quantify the share of the return differential that is caused by human capital depreciation, we must observe its trend over time and anticipate its behaviour in the future. If the return differentials’ trend line approaches zero in the long run, then the current difference in returns may be entirely accounted for by human capital depreciation. In this case, the remaining differential would disappear in the future as

³This observation was kindly pointed out by an anonymous referee.
Easterners assimilate to the capitalist system. The better the trend line fits the data and the nearer in the future it closes in on zero, the more precise is the prediction that human capital depreciation accounts for the remaining wage gap.

One of the main limitations of the original Blinder-Oaxaca decomposition is that it decomposes the difference in mean levels of wages between two groups, but it cannot decompose these changes at different quantiles of the wage distribution. In this paper, in order to provide a detailed picture of the wage differential between Eastern and Western Germans, the analysis is conducted using the quantile regression method, and wage differentials are identified at the 10th, 25th, 50th, 75th, and 90th percentiles. The most commonly used quantile regression framework is the conditional quantile regression (CQR) that estimates the impact of an explanatory variable on a quantile of the dependent variable conditional on specific values of other covariates. However, despite the widespread use of the CQR framework, it has received criticism from the fact that it may generate results that are often not generalizable or interpretable in a policy or population context (Borah & Basu, 2013). In response to this limitation of the original CQR framework, other procedures have sought to generalize the Blinder–Oaxaca decomposition to describe changes along the whole distribution.

For example, Machado and Mata (2005) propose a method to decompose the changes in the wage distribution over a period of time into changes in individual workers' characteristics and changes in the remuneration of these attributes. They extend the traditional Oaxaca decomposition of effects on mean wages to the entire wage distribution. They first estimate the wage distribution conditional on the covariates of interest using CQR, and then marginalize the conditional distribution using different scenarios for the distribution of workers' attributes in order to yield a decomposition of the factors that explain changes in the marginal distribution of wages.

The Melly (2006) decomposition is very similar to the Machado and Mata (2005) decomposition. The first step is to estimate the distribution of wages conditional on the covariates using CQR, and then second the conditional distribution is integrated over the covariates to obtain the unconditional distribution. The procedure therefore uses the information contained in the regressors to more precisely estimate the unconditional distribution of wages. Similar to Machado and Mata (2005), it allows for the estimation of counterfactual unconditional distributions, and decomposes the difference between the unconditional quantile of wages between two groups into a part explained by different characteristics distribution and a part explained by the different returns to characteristics (Borah & Basu, 2013). In contrast to Machado and Mata (2005), the Melly (2006) procedure has the advantage of faster implementation as it does not rely on simulations.

A more recent approach is the use of an unconditional quantile regression (UQR) model based on the concept of the RIF proposed by Firpo, Firtin, and Lenieux (2018). This is a two-stage method where distributional changes are divided into a wage structure effect and a composition effect using a reweighting function, and then these two components are further divided into the contribution of each individual covariate using the RIF technique. The proposed advantages of this procedure are its ease of implementation, its more interpretable results for policy purposes, and its ability to divide the contribution of each covariate to the composition effect (Firpo, Firtin, & Lenieux, 2018). However, unlike the interpretation of a conditional effect, the unconditional effect produced in a UQR framework must be interpreted in the context of a target population to which the estimates pertain. Therefore, defining the target population is an important step towards interpreting results from UQR (Borah & Basu, 2013).

In this paper, the Melly (2006) procedure is used for the quantile regression estimation. This allows for the extension of the Blinder-Oaxaca decomposition of effects on mean wages to the entire wage distribution. Thus, the difference between the unconditional quantile of wages between East and West Germany is decomposed into a part explained by differences in wage determining characteristics and a part explained by the differences in returns to these characteristics. Since these two components are not further divided into the contribution of each individual covariate at the individual quantiles, the UQR model is not adopted in this study.

Finally, in order to isolate the potential sources of the regional wage gap, wage equations are estimated both by origin (Easterners compared to Westerners) and by region (East compared to West). Lastly, by using data from the
most recent wave of the SOEP, we can test whether the findings of earlier studies still apply and whether there is evidence to support the theoretical (Classical) predictions of wage convergence.

4 | RESULTS

To assess the magnitude of the raw wage differential between Easterners and Westerners in 2016, a simple wage equation is estimated with log hourly earnings as the dependent variable and a regional dummy variable as the only independent variable. The coefficient of $-0.271$ (statistically significant at the 1% level) indicates that, on average, Easterners earn 27.1% less than their Western counterparts. This compares to a wage gap of more than a half in 1991 and a third in the mid-1990s (Franz & Steiner, 2000). Figure 1 demonstrates the differences in the wage distributions of the two groups. Both the central tendency and the variability of hourly wages are significantly lower for Easterners. From Figure 1, we would expect the wage gap to be narrower at lower percentiles and larger at the top end of the distributions.

While the average wage gap and the differences in the two distributions point to a large and significant wage differential between Easterners and Westerners, they do not indicate to what extent the wage gap is “justified.” To explore how much of the wage gap can be explained, the next section isolates the share that is due to differences in human capital endowments; the second section considers the possibility of a location effect; and in the last section, the development of the wage gap over time since 2002 is examined to test for the presence of human capital depreciation.

4.1 | The endowment effect

To investigate the hypothesis that Easterners may have less favourable human capital characteristics, a Blinder–Oaxaca decomposition is conducted for log hourly earnings at five quantiles. The regression equation

![Figure 1: Wage distributions by region of origin](image-url)
includes: years of education and vocational training; a dummy variable for tertiary education; a dummy variable for part-time employment; years of work experience and experience squared; the percentage share of total experience that was acquired in full-time mode; and tenure (years of working with the current employer).

Since the aim of this section is to decompose the part of the wage gap that is due to differences in productive characteristics and differences in the returns to these productive characteristics, the regression model includes a range of variables that capture the human capital characteristics of individuals, and deliberately excludes other explanatory variables that may affect individual wages (e.g., establishment characteristics and regional characteristics). The choice of productive characteristics is informed by the theoretical and empirical literature on human capital, and includes variables to capture the effect of both formal schooling and on-the-job training (the two main types of human capital). Human capital attained through formal schooling is captured through the variables measuring years of education and level of formal education achieved. Experience in the labour market is captured through years of experience and experience squared, and job- or firm-specific experience is controlled for by tenure. Type of employment (full time compared to part time) is also expected to affect individual wages, and the fact that labour market experience will vary by type of employment is also controlled for in the wage equations. Personal variables, such as gender and age, are not included because they are generally considered to be productivity-unrelated and are approximately equally distributed for both Easterners and Westerners. Table 2 presents the results of the wage decomposition at each of the five quantiles.4

For each quantile, three results are presented: the “raw difference” gives the wage gap at that quantile; “characteristics” shows the magnitude of the wage gap that is due to differences in productive endowments; and “coefficients” provides the amount of the wage gap that can be explained by different returns to human capital characteristics.

With a gap of 23.4%, wages diverge the least at the 10th percentile. The differential increases to 28% at the median, and then slightly decreases to 27.3% at the 90th percentile. As expected from Figure 1, the wage gap is indeed narrower at lower quantiles. Further along the wage distribution, the gap remains relatively stable between 27% and 28%. The wage differential at the median is approximately one percentage point higher than at the average.

Differences in human capital characteristics explain only a small share of the total wage gap at all quantiles. At the 10th and the 25th percentiles, differences in endowments between Easterners and Westerners are not statistically significant at the 5% level. At the median, less favourable productive characteristics account for only 2.7 percentage points of the wage differential, with the relevant figures for the 75th and the 90th percentiles being 3.4 and 2.8 percentage points, respectively. The share of the raw wage gap that is induced by differences in productive endowments is not higher than 12% at any quantile under consideration. Therefore, while less favourable characteristics do lower Easterners’ earnings compared to Westerners, the endowment effect does not account for more than one-eighth of the total wage gap.

In contrast, differences in returns to productive endowments are statistically significant at the 1% level for all quantiles. If Easterners at the median received the same remuneration for their human capital characteristics as Westerners, their hourly earnings would increase by 25.3%. Ranging between 88% (at the 75th percentile) and 97% (at the 10th percentile) of the wage gap, return differentials constitute by far the most significant determinant of Easterners’ wage disadvantage. The finding that differences in returns to endowments, not in endowments themselves, are responsible for the Easterner–Westerner earnings gap is in line with earlier empirical studies (e.g., Burda & Schmidt, 1997; Krueger & Pischke, 1995; Orlowski & Riphahn, 2009).

To further investigate which variables cause the differences in characteristics and/or coefficients, Table 3 presents the results of the Blinder-Oaxaca wage decomposition at the average.

---

4In practice, the sample sizes of two groups being compared in any Blinder–Oaxaca decomposition are rarely the same. In this study the number of observations for the Eastern sample is smaller than for the Western sample. While sample weights could be applied, the estimates in this paper are unweighted for simplicity. When sample weights are used to estimate mean outcomes, the interpretation of the contribution from group differences in observed characteristics remains unchanged (Fairlie, 2005).
The raw wage difference at the average amounts to 27.1%, as previously stated. Approximately 3.4 percentage points of this earnings differential are accounted for by differences in endowments. Apart from the part-time dummy, all endowments exhibit statistically significant differences between Easterners and Westerners. Specifically, were Easterners endowed with the same characteristics as Westerners, they would experience a wage gain of 4.3% for education and tenure, but a wage loss of 0.8% for experience. Similar to the quantile analysis, the endowment effect only constitutes a small part of the total wage differential at the average.

The remaining wage discount for Easterners originates from differences in returns. The largest part of the differences in returns is the divergent remuneration to experience. If Easterners received the same returns to their experience as Westerners do, their wages would increase by 20.8%. Differences in returns to experience account for more than three-quarters of the total wage gap. These results confirm the most recent findings from the mid-2000s (Orlowski & Riphahn, 2009), demonstrating that differences in returns to experience continue to be highly relevant nearly a decade later.

While Table 3 reports the wage decomposition at the average, it seems likely that differences in returns to experience may also constitute the largest share of the return differential at all quantiles. First, the total amount of the return-induced wage gap is similar at the average and at all quantiles, and second the difference in returns to experience at the average is not only highly statistically significant but also very large in magnitude. Consequently, the next

| Quantile 0.10 | Raw difference | −0.234*** |
| Characteristics | −0.007 |
| Coefficients | −0.227*** |
| Quantile 0.25 | Raw difference | −0.271*** |
| Characteristics | −0.015* |
| Coefficients | −0.256*** |
| Quantile 0.50 | Raw difference | −0.280*** |
| Characteristics | −0.027*** |
| Coefficients | −0.253*** |
| Quantile 0.75 | Raw difference | −0.280*** |
| Characteristics | −0.034*** |
| Coefficients | −0.246*** |
| Quantile 0.90 | Raw difference | −0.273*** |
| Characteristics | −0.028*** |
| Coefficients | −0.245*** |
| No. of observations | 9,133 |
| No. of Westerners | 6,515 |
| No. of Easterners | 2,618 |

Note: Asterisks indicate level of statistical significance:
***< 0.01;
**p < 0.05;
*p < 0.1.
two subsections examine two reasons why Easterners’ have flatter experience-earnings profiles compared to Westerners: less favourable economic conditions may reduce returns to experience in the East (location effect), or the experience acquired in the former GDR is less valuable in the post-reunification capitalist system (human capital depreciation).

4.2 | The location effect

The previous section has established that, by far, the largest share of the wage differential is due to divergent returns to human capital characteristics and not due to differences in endowments themselves. While Smolny and Kirbach (2011) suggest that regional differences in capital accumulation or technological progress may cause a fixed East–West wage gap, this section contributes to the existing literature by investigating the yet unexplored hypothesis that the location effect may also affect the returns to human capital characteristics in the East.

Figure 2 displays the wage distributions in the East and the West in 2016. The resemblance between Figures 1 and 2 strongly suggest that all or most of the Easterner-Westerner wage gap can be attributed to the location effect. Indeed, given that most individuals in the sample lived in the same region in both 1989 and 2016, it seems likely that regional economic conditions did play a major role in lowering Easterners’ remuneration. However, it is not entirely accurate to quantify the location effect using a wage decomposition by region since some individuals have moved away from their region of origin, so that individuals referred to as “Easterners” are not the same group as individuals living in the East in 2016 (labour mobility would be expected to occur after reunification as individuals respond to differences in regional wages and employment by engaging in regional migration as predicted by classical migration theory). Indeed, post-unification saw a large number of East–West migrants who benefited from enormous wage gains (Smolny & Kirbach, 2011).

| Component        | Regression estimates |
|------------------|----------------------|
| Raw difference   | 0.271***             |
| Characteristics  |                      |
| Education        | 0.021***             |
| Part-time        | −0.002               |
| Experience       | −0.008**             |
| Tenure           | 0.022***             |
| Total            | −0.034***            |
| Coefficients     |                      |
| Education        | −0.017               |
| Part-time        | 0.010                |
| Experience       | 0.208***             |
| Tenure           | −0.037**             |
| Constant         | 0.059                |
| Total            | 0.237***             |
| No. of observations | 9,133         |
| No. of Westerners | 6,515               |
| No. of Easterners | 2,618               |

Note: Asterisks indicate level of statistical significance:
*** < 0.01;
** p < 0.05;
*p < 0.1.

TABLE 3 Blinder–Oaxaca decomposition by origin (mean estimation)
To quantify the extent to which Easterners’ and Westerners’ wages are influenced by the location effect, the earnings equation must be decomposed by origin and settlement region simultaneously. Comparing the wages of Easterners living in the West with those of Westerners living in the West (and subsequently a separate analysis with the same setup for the East) removes any location effect from the equation since only individuals from the same settlement region are considered. In this manner, the following examination finds the remaining wage gap between Easterners and Westerners after persistent differences in economic conditions across the two regions have been accounted for. To the best of the authors’ knowledge, this procedure has not been applied to both the West and the East before.

Table 4 (column (1)) presents the Blinder–Oaxaca decomposition for individuals living in the West. Easterners settled in the West earn less than Westerners in the same region at all quantiles (except the 10th percentile). The earnings differential in the West is increasing in quantiles, rising from 8.3% at the 25th percentile to 14.4% at the 90th percentile.

Among all individuals living in the West, Easterners have slightly less favourable human capital characteristics (the endowment effect), lowering their median wages by approximately 6% as compared to Westerners (1.9% at the 10th percentile and 8.0% at the 90th percentile).

Most interesting are the return differentials since they constitute the unexplained part of the wage gap after endowment and location effects have been fully accounted for. If Easterners in the West received the same remuneration for their productive endowments as Westerners in the West, their wages would increase by a minimum of 2.4% (at the 10th percentile) and by a maximum of 6.4% (at the 90th percentile).

Note that the differences in returns are substantially lower when only individuals settled in the West are considered. At the national level the return differential amounts to roughly 25 percentage points (Table 2). Comparing Easterners to Westerners within the same region reveals that Easterners in the West are rewarded less for their human capital characteristics than Westerners in the West, inducing a wage gap of approximately 5% that cannot be explained by either differential endowments or location effects.
The results for the Blinder-Oaxaca decomposition for individuals living in the East are also presented in Table 4 (column (2)). Similar to the results for the West, the raw wage difference between Easterners and Westerners in the East is increasing in quantiles, starting at 16.3% at the 10th percentile and rising to 45.6% at the 90th percentile. At the median, Easterners in the East earn 40.9% less than Westerners in the same region, a much larger difference than the median wage gap of 10.7% in the West. Differences in endowments do explain part of this earnings differential in the East. Eastern stayers have less favourable human capital characteristics than West-East migrants at the three highest quantiles (accounting for a wage gap of around 16%).

The remaining wage differential between Easterners and Westerners living in the East is due to differences in returns to human capital endowments. If Eastern stayers were remunerated for their characteristics as West-East migrants are, their wages would increase by 20% at the 25th percentile, by 24.8% at the median, rising to 29.5% at the 90th percentile. These differences in returns represent the remaining wage gap between Easterners and Westerners in the East after differences in regional economic conditions have been accounted for. These values are substantially larger than the corresponding figures for the differences between Easterners and Westerners in the West.

| Component                  | Regression Estimates |        |        |
|----------------------------|----------------------|--------|--------|
|                            | West                 | East   |        |
| Quantile 0.10              |                      |        |        |
| Raw difference             | −0.043               | −0.163*** |
| Characteristics            | −0.019***            | −0.046 |
| Coefficients               | −0.024***            | −0.117 |
| Quantile 0.25              |                      |        |        |
| Raw difference             | −0.083***            | −0.293*** |
| Characteristics            | −0.039***            | −0.093 |
| Coefficients               | −0.045***            | −0.200*** |
| Quantile 0.50              |                      |        |        |
| Raw difference             | −0.107***            | −0.409*** |
| Characteristics            | −0.060***            | −0.161*** |
| Coefficients               | −0.048***            | −0.248*** |
| Quantile 0.75              |                      |        |        |
| Raw difference             | −0.130***            | −0.439*** |
| Characteristics            | −0.076***            | −0.168*** |
| Coefficients               | −0.054***            | −0.271*** |
| Quantile 0.90              |                      |        |        |
| Raw difference             | −0.144***            | −0.456*** |
| Characteristics            | −0.080***            | −0.160** |
| Coefficients               | −0.064***            | −0.295*** |
| No. of observations        | 6,952                | 2,181  |
| No. of Westerners          | 6,392                | 123    |
| No. of Easterners          | 560                  | 2,058  |

Note: Asterisks indicate level of statistical significance: ***< 0.01; **p < 0.05; *p < 0.1.
To further investigate whether a location effect does indeed exist, Figure 3 compares the differences in returns between Easterners and Westerners at the national level, in the West, and in the East.\(^5\)

A location effect exists if the return differentials in both the West and the East are lower than the return differential at the national level (see discussion in subsection 3.2.1). This is the case for the median and below. At the two highest quantiles, the return differential in the East is higher than at national level. Thus, the location effect played a role in the lower half of the wage distribution, but not in the upper half.

Even after accounting for any potential location effect, a wage gap remains and is statistically significant at all quantiles in both the East and the West. This is in line with Orlowski and Riphahn’s (2009) conclusions. Going beyond the existing evidence, we find that lower returns for Easterners translate into a moderate wage discount in the West, but a substantial earnings reduction in the East. Consequently, factors other than endowment or location effects are not only relevant for explaining the Easterner-Westerner wage gap but they are much more influential in the East.

The following section investigates whether human capital depreciation has diminished the returns to Easterners’ endowments, and whether this effect is stronger in the East than in the West.

### 4.3 Human capital depreciation

The depreciation of Easterners’ human capital may explain the difference in returns to human capital endowments if, for example, the experience acquired by Easterners in the GDR was less relevant for employment in the new capitalist system than experience acquired by Westerners in the West. Over time, however, we would expect the experience acquired by both groups to become more similar after reunification and the differences in returns to experience to diminish, especially as older workers in the East successively move of the workforce. The role played by human capital depreciation can be identified by focusing on the trend in the returns to human capital endowments over the period 2002–2016 in both regions. Unlike existing studies, this analysis is conducted separately for

---

\(^5\)The value marked by a cross is statistically insignificant at the 5% level so the adjacent dotted line should only be considered as a rough estimate.
the West and the East to ensure that the effects of human capital depreciation are isolated from the location effect, which may also be diminishing over time.6

Table 5 shows the differences in returns between Easterners and Westerners living in the West for the period 2002–2016 by quantile. These differences in returns are also presented graphically in Figure 4. Both clearly reveal a tendency for the return differential to increase in quantiles. Easterners in the West at top percentiles experience a much larger wage disadvantage compared to those Easterners in the West located further down the wage distribution at the lower percentiles. A possible explanation may be that well-paid Easterners are better skilled than their low-earning counterparts and thus suffered more from human capital depreciation at the time of reunification.

Furthermore, the differences in returns between the two groups in the West are decreasing over time at all quantiles. At the median, the return-induced wage gap declined from 15.8% in 2002 to 4.8% in 2016 (a decrease of almost 70%). Similar movements can be observed at the other quantiles. These developments correspond to the adjustment of Easterners’ endowments to Western productivity standards, thereby counteracting the initial human capital depreciation.

While the wage gap due to differences in returns to human capital is larger at higher quantiles, so is its rate of decay. The return differential fell by 72% at the 90th percentile compared to 64% at the 25th percentile over the 14-year period, indicating that high earners may be more effective in adjusting their human capital to the demands of the post-unification system. As a consequence, the return differentials at different quantiles converged over time (Figure 4).

The fact that higher quantiles consistently exhibit larger return differentials which also decrease faster over time provides some evidence for the convergence hypothesis (or asymptotic decay). The wage gap induced by divergent returns to endowments had decreased to approximately 5% in 2016, and it is likely that this figure will further decrease in the future. If the observed trends continue and the return differential curves approach zero as Figure 4 suggests, then human capital depreciation accounts for the remaining, unexplained part of the wage gap. The return differential of 5% is then just the difference in productivity of Easterners’ and Westerners’ human capital that has not yet fully disappeared but will do so in the long run.

6Human capital depreciation is expected to be relevant (and detrimental) only to those Easterners who were educated and skilled in the former communist system, whereas those who were educated under the democratic system would not experience any adverse wage effect due to human capital depreciation. Education ‘distance’ from the former communist system could be tested for by splitting the sample into age cohorts and conducting the decomposition by age as well. Unfortunately, the small sample sizes for the East prohibits us from carrying this out in our paper.

| Year | Quantile | 0.10 | 0.25 | 0.50 | 0.75 | 0.90 |
|------|----------|------|------|------|------|------|
| 2002 | –0.068***| –0.125***| –0.158***| –0.175***| –0.229***|
| 2004 | –0.141***| –0.167***| –0.151***| –0.164***| –0.201***|
| 2006 | –0.142***| –0.149***| –0.143***| –0.162***| –0.208***|
| 2008 | –0.087***| –0.112***| –0.134***| –0.158***| –0.200***|
| 2010 | –0.089***| –0.111***| –0.107***| –0.122***| –0.158***|
| 2012 | –0.009* | –0.055***| –0.073***| –0.076***| –0.092***|
| 2014 | –0.006* | –0.052***| –0.063***| –0.076***| –0.115***|
| 2016 | –0.024***| –0.045***| –0.048***| –0.054***| –0.064***|

Note: Asterisks indicate level of statistical significance:

***< 0.01;
**p < 0.05;
*p < 0.1.
Table 6 presents the return differentials in the East for the same period by quantile, and Figure 5 graphs these differences in returns to human capital. Similar to the results for the West, the return differential tends to be greater at higher quantiles since human capital depreciation affected higher-paid Easterners more strongly. As before, there exists a downward trend for the return differential over time. At the median, the return-induced wage gap decreased from 53.5% in 2002 to 24.8% in 2016 (a decline of approximately 54%). Similar movements can also be observed at the other quantiles. The decline in the differences in returns shown in Figure 5 is interpreted as the assimilation response to initial human capital depreciation. Unlike in the West, however, return differentials at different quantiles do not converge, and they fluctuate more strongly over time. This makes it more difficult to predict the future.

**FIGURE 4** Differences in returns in the West 2002–2016

Table 6 presents the return differentials in the East for the same period by quantile, and Figure 5 graphs these differences in returns to human capital. Similar to the results for the West, the return differential tends to be greater at higher quantiles since human capital depreciation affected higher-paid Easterners more strongly. As before, there exists a downward trend for the return differential over time. At the median, the return-induced wage gap decreased from 53.5% in 2002 to 24.8% in 2016 (a decline of approximately 54%). Similar movements can also be observed at the other quantiles. The decline in the differences in returns shown in Figure 5 is interpreted as the assimilation response to initial human capital depreciation. Unlike in the West, however, return differentials at different quantiles do not converge, and they fluctuate more strongly over time. This makes it more difficult to predict the future.

**TABLE 6** Differences in returns in the East between 2002 and 2016

| Year | Quantile | 0.10 | 0.25 | 0.50 | 0.75 | 0.90 |
|------|----------|------|------|------|------|------|
| 2002 | –0.459***| –0.479***| –0.535***| –0.585***| –0.612***|
| 2004 | –0.344***| –0.418***| –0.484***| –0.517***| –0.515***|
| 2006 | –0.377***| –0.446***| –0.465***| –0.445***| –0.422***|
| 2008 | –0.021 | –0.326** | –0.451***| –0.502***| –0.550***|
| 2010 | 0.061 | –0.196** | –0.345***| –0.333***| –0.298***|
| 2012 | –0.139** | –0.229***| –0.283***| –0.328***| –0.383***|
| 2014 | –0.000 | –0.128 | –0.246***| –0.322***| –0.401***|
| 2016 | –0.117 | –0.200***| –0.248***| –0.271***| –0.295***|

Note: Asterisks indicate level of statistical significance:
***p < 0.01;
**p < 0.05;
*p < 0.1.
development of the return differential, and the assumption of asymptotic decay may not be as valid in the East as in the West.

This is further evidenced by graphing the return differentials at the median in the East and the West over time. Figure 6 clearly displays the difference in the level of the return differentials in the regions, and the greater decline in absolute terms for the East compared to the West. The prediction that the return differential between Easterners

**FIGURE 5** Differences in returns in the East 2002–2016

**FIGURE 6** Differences in returns at the median 2002–2016
and Westerners will follow its trend-line and eventually approach zero is more uncertain for the East. Even if the return differential in the East did follow its trend-line, it would take 18 years for the East to achieve the level that the West had in 2016.

Two potential explanations for this slower convergence in the differences in returns in the East are: (i) it could be that assimilation of Easterners came into effect later in the East so that the return differentials in the two regions started to decrease at different times. However, there is no obvious reason why this should have been the case; (ii) it is possible that the return differential between Easterners and Westerners was higher in the East to begin with. If Easterners’ human capital depreciated by the same amount in both regions at the time of reunification, then the implication is that the larger wage gap in the East is not fully explained by differences in endowments, location effect, and human capital depreciation.

5 | DISCUSSION

The persistence of a wage gap between Easterners and Westerners, particularly in the East, should provide interesting scope for future research. The two regions are homogeneous in many ways (e.g., similar legal systems, languages, climates, and education systems), and technologies and physical capital can be easily transferred across the two regions (Uhlig, 2008). In addition, fiscal transfers from the West to the East have been substantial. So why, after 26 years, do Eastern Germans still get paid less than their Western counterparts? While this paper does not pursue an explanation of the remaining wage gap unaccounted for by the main three factors discussed, it will be important from a policy perspective for future research to identify the source of the remaining wage gap between Easterners and Westerners in the East. If it is due to an underlying but yet unidentified regional factor, then it may be more appropriate to focus on “place-based” approaches, which emphasize the importance of designing appropriate institutional systems whereby regional policy aims to foster participation between central and local government, and between public, private and civil society sectors. This approach would further strengthen economic restructuring and redistributive efforts that have proven insufficient so far in reducing the regional wage gap. However, if the cause of the remaining wage differential is related to differences in preferences or soft skills between Easterners and Westerners, then more “people-based” policies maybe more appropriate, where policies are designed without explicit consideration to space (McCann, 2013), but instead favour inter-regional factor mobility as the best way to promote economic development and bring about convergence in regional factor prices.

Drawing upon the empirical literature and evidence to date, it is interesting to speculate on what might lie behind the remaining wage gap, and from this draw some tentative policy suggestions. One striking feature of the German reunification experience has been the East–West ratio of labour productivities. While the early 1990s saw significant increases in productivity in the East, by 2010 the East–West labour productivity ratio was still only 0.78 (Fuchs-Schündeln & Izem, 2012). Further, the rise in labour productivity that did take place in the East was due to the reduction in employment, and not real productivity gains (Franz & Steiner, 2000). While there is not, as yet, a definitive answer in the literature as to why labour productivity remains low in the East, several hypotheses have been investigated.

Fuchs-Schündeln and Izem (2012) find that, while worker characteristics do not differ significantly between the East and West, job characteristics in the East are less favourable than those in the West. This points to regional differences in factors such as agglomeration effects, firm size, managerial and organizational capabilities, and factor endowments as the driving forces of the low labour productivity in the East. They conclude that the less favourable job characteristics in the East are not likely to be the result of factors that are easily influenced by individual firms, but instead are more likely to be the result of poorer public infrastructure or agglomeration effects (production networks that cannot be easily transplanted from the West to the East). Thus, despite substantial financial subsidies encouraging firms to invest in the East, these programmes have somehow failed to produce the same quality of jobs in the East as in the West.
Another hypothesis for why labour productivity in the East remains lower than in the West is the significantly lower rate of innovation among East German firms. Blien et al. (2016) argue that the approach to privatization in the early years after reunification had consequences for innovation behaviour and productivity. Specifically, the privatization process resulted in a “dependent economy” where a surprising amount of the production in the East was controlled from headquarters in the West, and this production largely revolved around production and assembly. In contrast, the locations of research and development departments of large firms were disproportionately in the West, as were many of the well-paid qualified jobs. Consequently, there was little capacity for research and development, innovation and re-investment within many East German companies.

However, the role of differences in labour productivity between the two regions in propagating the persistent wage gap is not clear cut. Differences in firm-level productivity do not necessarily explain a large part of the observed wage gap. Kluge and Weber (2018) find that only 3% of the observed East–West wage gap can be attributed to East–West differences in establishment-level labour productivity. Instead of firm-level productivity driving wages, studies such as Card et al. (2018) show that rent sharing between workers and management seems to play a more prominent role.

Kluge and Weber (2018) also find that the impact of industrial structure and urban agglomeration patterns only account for small portions of the wage gap. In contrast, 11% of the wage gap at the median can be attributed to differences in establishment size, with the contribution of the gender composition of employees also being of considerable magnitude. The authors conclude that these observed structural differences between the East and the West are fairly stable over time, which suggests that East German wages will not converge considerably toward West German levels in the years to come.

From a policy perspective, the empirical literature largely concludes that the East–West wage differential cannot be attributed to the characteristics of workers. Instead, the general consensus is that locational conditions and characteristics of firms lie behind the wage differential. This would perhaps imply that place-based policy (with an emphasis on geography) may be more appropriate is seeking to reduce the wage gap than people-based policy. However, regional development is a conditional strategy, in that specific locational conditions may be necessary but not sufficient conditions for improving regional economic performance.

Regional policy traditionally has been used as an institutional mechanism to improve regional welfare positions or to mitigate spatial disparities. In past decades the emphasis of most regional development policies was placed on hard infrastructure to improve the competitive position of a region. More recently, awareness had grown that, in an open, globalizing and networked system of regions, the quality of the knowledge and innovative systems is of crucial importance (Nijkamp, 2017). This shift from regional infrastructure initiatives to investments that stimulate creative and knowledge-based development is demonstrated in recent European regional development policy that emphasizes knowledge, innovation and social capital as effective ingredients for smart regional specialization. Knowledge is increasingly seen as the engine of regional growth, and recent years have witnessed an increased interest in the region as a focal point of innovation policy. Thus, the use of the regional knowledge capacity is seen as a crucial factor for the success of regional development (Nijkamp, 2016).

This shift in regional development focus is illustrated in the recent concepts of territorial capital (Camagni, 2009) and resourceful regions (Nijkamp, 2016). The idea behind territorial capital is simply that the various types of capital in a region form the conditions that shape regional growth, where these elements include technology, social capital, resources, and human capital. A resourceful region is a functionally and spatially demarcated geographical area which combines its assets (skills, physical resources, technology, social capital, institutional support systems, geographical connectivity) in order to maximize its capabilities to achieve accelerated economic progress and a more sustainable socio-economic performance (Nijkamp, 2016).

Central to both these concepts is the idea that every region has a portfolio of growth opportunities, ranging from physical geographical conditions to human-social abilities. Since all region-specific assets are important for enhancing a region’s performance, the intelligent combination of these resources is the key challenge of regional development policy. Regions are therefore viewed, in this light, as critical actors who have to enhance their
competitiveness strategies. Nijkamp (2016) argues that this calls for new instruments for regional growth policies, where policy is orientated towards territorial competitiveness and quality, for example, tailor-made regional innovation policy based around region-specific and sector-specific innovation systems (Camagni & Capello, 2017). Thus, regional development strategies in the future should be critically dependent on the self-organizing capabilities of regions, where a “one size fits all” policy is replaced by emphasis on each region's specificities, competitive advantages, and assets (including natural resources, social-institutional settings, social capital, human capital, etc.).

In the context of the persistent East–West wage gap, this study has found that differences in the quantity of productive characteristics (endowments) do not seem to be important in driving the wage gap between Easterners and Westerners; however, it may be that differences in the type or subject matter of educational training across the two regions is more important. For example, if improvements in innovation behaviour are crucial for productivity development in the East, then promoting educational or vocational qualifications in local educational institutions that increase skills and capabilities in innovation, technology, and research and development could be one way of closing the productivity gap between the East and the West. This education policy could be combined with technology policies, as part of an integrated regional policy to promote regional capacity in the East through linking different areas of public responsibility. Increased investment in entrepreneurship, innovation, creativeness, and regional knowledge capability in the East could then redress the current regional imbalance in the location of research and development departments, and facilitate redistribution of some of these technological and knowledge-based activities to company locations in the East. This redistribution to the East, combined with more targeted education in productivity-enhancing areas, such as innovation and technology, could address the issues highlighted in this study. For instance, investments in innovation education and behaviour could improve the labour market opportunities of low-wage workers in the East who are currently disadvantaged by poorer regional economic conditions (the location effect). In addition, the expansion of technological and knowledge-based activities in the East would improve the quality of jobs in the region, and subsequently the quality of labour market experience gained by Eastern workers (e.g., through a shift away from production and assembly towards productivity enhancing jobs in these emerging sectors). Through the upskilling of low wage Easterners and improving the quality of both jobs and human capital, this integrated regional policy would further help to redress the losses suffered by Easterners from the depreciation of their human capital, and would promote faster convergence in the returns to human capital between Easterners and Westerners.

This investment and redistribution could also mitigate other sources of the wage gap; for example, if it led to an increase in establishment size through enabling small enterprises to grow and expand their innovative and productive capacity, and mitigated the outmigration of young well-educated Easterners who expect better working careers in the West.

It may therefore be the case that an innovative regional strategy in the East that combines both place-based policies (emphasizing physical infrastructure, socio-economic institutions, connectivity, production networks) and people-based policies (emphasizing innovation, creativeness, entrepreneurship, knowledge orientation) is the most appropriate solution for redressing the technological backwardness of Eastern regions and closing the wage gap between the two regions.

6 CONCLUSIONS

Just over a quarter of a century after the reunification of Germany, there still persists a substantial wage gap between Eastern and Western Germans. This is despite rapid economic integration, large-scale investment, redistributive efforts from the Federal Government (Smolny & Kirbach, 2011), and post-unification labour mobility. In contrast to the predictions of economic theory, empirical studies over the last decade still find systematic regional differences in the wage structure (e.g., Orlowski & Riphahn, 2009).

This paper revisits the German wage gap 26 years after reunification and decomposes the wage differential into its three most likely determinants. First, adopting the Blinder–Oaxaca method, the Easterner-Westerner earnings
gap is decomposed into differences in productive endowments and differences in the returns to these characteristics. We find that only a small part of the wage gap can be explained by differences in endowments, whereas differences in the returns to productive characteristics play a much more significant part in the Easterner-Westerner wage gap. How transition to a market economy affects the wage structure depends on how schooling and experience gained under the socialist economic system are assessed in the new market economy (Bird et al., 1994). In line with earlier studies, we find that labour market experience did not translate to the same amount of human capital under socialism as under capitalism, suggesting that the average “quality” of experience is heterogeneous between East and West Germany.

Second, the possibility of a location effect was investigated by conducting separate decompositions by settlement region. While the differences in returns between Easterners and Westerners settled in the West are small at all quantiles and lower than at the national level, in the East the return differential is only lower than the national level at the median and below, indicating that only low wage Easterners are disadvantaged by the less favourable regional economic conditions in the East. Third, to explore whether the remaining differences in the returns to human capital between Easterners and Westerners is due to the depreciation of Easterners’ human capital, we test for the presence of asymptotic decay. Our results suggest that the depreciation of Easterners’ human capital at the time of reunification has not yet fully been remedied, and still adversely affects Eastern Germans 26 years later, particularly in the East.

In summary, while the three determinants jointly do seem to account for the wage differential between Easterners and Westerners in the West, this is not the case in the East. This, as yet, unexplained part of the Easterner-Westerner wage gap in the East could be the focus for future research. Whatever the source of the remaining wage gap between East and West Germans, the persistence of this wage gap a quarter of a century after reunification does point to the reality that transition processes in labour markets may be slower than expected, and that regional wage convergence is not a foregone conclusion.

ORCID
Heather Dickey 🐻 https://orcid.org/0000-0003-1623-5990

REFERENCES
Becker, G. S. (1971). The economics of discrimination (2nd ed.). Chicago, IL: University of Chicago Press.
Bird, E. J., Schwarze, J., & Wagner, G. G. (1994). Wage effects of the move toward free markets in East Germany. ILR Review, 47, 390–340. https://doi.org/10.1177/001979399404700302
Blien, U., Möller, J., thi Hong Van, P., & Drunow, S. (2016). Long-lasting labour market consequences of German unification. Journal of Economics and Statistics, 236(2), 181–216.
Blinder, A. (1974). Toward an economic theory of income distribution. Cambridge, MA: MIT Press.
Borah, B., & Basu, A. (2013). Highlighting differences between conditional and unconditional quantile regression approaches through an application to access medication adherence. Health Economics, 22, 1052–1070. https://doi.org/10.1002/hec.2927
Brunow, S., & Hirtle, G. (2009). The age pattern of human capital and regional productivity: A spatial econometric study on German regions. Papers in Regional Science, 88(4), 799–823. https://doi.org/10.1111/j.1435-5957.2009.00228.x
Burda, M. C., & Schmidt, C. M. (1997). Getting behind the East-West wage differential: theory and evidence. SFB 373 Discussion Paper 1997, 77.
Camagni, R. (2009). Territorial capital and regional development. In R. Capello & P. Hijkamp (Eds.), Handbook of regional growth and development theories (pp. 118–132). Cheltenham: Edward Elgar.
Camagni, R., & Capello, R. (2017). Regional innovation patterns and the EU regional policy reform: smart innovation policies. In R. Capello (Ed.), Seminal studies in regional and urban economics (pp. 313–343). Cham: Springer.
Card, D., Cardoso, A. R., Heining, J., & Kline, P. (2018). Firms and labor market inequality: Evidence and some theory. Journal of Labor Economics, 36(51), S13–S70. https://doi.org/10.1086/694153
Chiswick, B. R. (1978). The effect of Americanization on the earnings of foreign-born men. The Journal of Political Economy, 86, 897–921. https://doi.org/10.1086/260717
Dickey, H. (2007). Regional earnings inequality in Great Britain: Evidence from quantile regressions. Journal of Regional Science, 47, 775–806. https://doi.org/10.1111/j.1467-9787.2007.00528.x
Fairlie, R. W. (2005). An extension of the Blinder-Oaxaca decomposition technique to logit and probit models. *Journal of Economic and Social Measurement, 30*(4), 305–316.

Firpo, S., Firten, N., & Lenieux, T. (2018). Decomposing wage distributions using recentered influence function regressions. *Econometrics, 6*(2), 28. https://doi.org/10.3390/ecometrics6020028

Franz, W., & Steiner, V. (2000). Wages in the East German transition process: Facts and explanations. *German Economic Review, 1*, 241–269. https://doi.org/10.1111/1468-0475.00013

Fuchs-Schündeln, N., & Izem, R. (2012). Explaining the low labor productivity in East Germany – A spatial analysis. *Journal of Comparative Economics, 40*(1), 1–21. https://doi.org/10.1016/j.jce.2011.09.001

Hanushek, E. A., Ruhose, J., & Woessmann, L. (2015). Human capital quality and aggregate income differences: development accounting for U.S. States. IZA Discussion Paper 9130.

Kluge, J., & Weber, M. (2018). Decomposing the German East-West wage gap. *The Economics of Transition, 26*, 91–125. https://doi.org/10.1016/j.ecot.12137

Krueger, A. B., & Pischke, J. (1995). A comparative analysis of East and West German labor markets: Before and after unification. In *Differences and changes in wage structures* (pp. 405–446). Chicago, IL: University of Chicago Press.

Laing, D. (2011). Labor mobility II: Immigration and outsourcing. In *Labour economics: Introduction to classic and the new labor economics* (pp. 717–754). New York: W.W. Norton & Company.

Lang, G. (2000). Native-immigrant wage differentials in Germany: Assimilation, discrimination, or human capital? In: Volkswirtschaftliche Diskussionsreihe, Institut fuer Volkswirtschaftslehre der Universitaet Augsburg 197.

Machado, J., & Mata, J. (2005). Counterfactual decomposition of changes in wage distributions using quantile regression. *Journal of Applied Econometrics, 20*, 445–465. https://doi.org/10.1002/jae.788

McCann, P. (2013). *Modern urban and regional economics* (2nd ed.). Oxford: Oxford University Press.

Nelson, R. R., & Phelps, E. S. (1966). Investment in humans, technological diffusion, and economic growth. *The American Economic Review, 56*, 69–75.

Uhlig, H. (2008). The slow decline of East Germany. *Journal of Comparative Economics, 36*(4), 517–541. https://doi.org/10.1016/j.jce.2008.07.006

**How to cite this article:** Dickey H, Widmaier AM. The persistent pay gap between Easterners and Westerners in Germany: A quarter-century after reunification. *Pap Reg Sci*. 2021;1–27. https://doi.org/10.1111/pirs.12594

DICKEY AND WIDMAIER 27