The Economics of German Unification after Twenty-Five Years: Lessons for Korea

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Abstract

This paper reviews the performance of the East German economy in the turbulent quarter-century following reunification and draws some conclusions for the reunification of North and South Korea. In this period, the gap in output per capita between East and West Germany declined at a speed not far from empirical estimates of the neoclassical growth model, yet systematic total factor productivity differentials persist despite identical institutional frameworks and significant investment in the eastern regions. At the same time, regional disparities in income, well-being, and health are little different from those found within West Germany, and net migration has ceased. On this human metric, German unification has been an unqualified success. For Korea, an effort of this dimension will be costly. A back-of-the-envelope calculation suggests that Korean unification will cost roughly twice as much as its German counterpart.

1   Introduction

On November 9, 1989, the East German government opened the Berlin Wall and allowed its citizens to travel freely across a border which had been closed for 28 years. In doing so, the government of the German Democratic Republic (GDR) set the stage for its own demise and the replacement of communism with a capitalist economic system. On July 1, 1990, the GDR adopted a regime of free trade in goods and services, free flow of labor capital and ideas, as well as the economic and social framework that had existed in the Federal Republic of Germany since the end of World War II. Political union was sealed on October 3 of the same year.

The state of the East German economy in 1990 was nothing short of catastrophic. Amplified by cumulative migration of millions of its citizens to the West, disparities in economic development between the two Germanies were enormous. After forty years of separation from the Federal Republic, Eastern German per capita income stood at about one-third of Western levels. What has happened in the meantime? Are those developments consistent with received economic theory and evidence? Can German unification inform policy regarding feasible paths of a future unified Korea?

This paper reviews the evolution of the East German economy in the turbulent and remarkable quarter-century following reunification, and does so with an eye to the potential unification of North and South Korea, which by all accounts is a much larger project. Despite an initial surge in productivity, unprecedented structural change, deep trade integration, and record levels of capital inflows and outmigration, East-West differences in output per capita have declined over the entire period at a speed not far from that predicted by the benchmark neoclassical growth model with a large share of national income accruing to capital. Yet convergence was far from uniform, with most coming in the first ten years; despite commonly shared rule of law, identical institutional frameworks and massive investment activity in the eastern regions, a significant East-West productivity gap continues to persist. At the same time, Eastern levels of consumption per capita, well-being, unemployment rates and health are little different from those across West Germany. On this human metric, German unification has been an unqualified, albeit expensive success. Judging from that experience, Korean unification is likely to be a very expensive proposition.

2   Initial conditions and progress

We begin by reviewing the initial situation as well as the overall evolution of the East German economy since the fall of the wall. Formal political reunification took place in October 1990, but reliable national income and product account data for Eastern Germany are unavailable before 1991. While once considered by the US Central Intelligence Agency to be the Eastern Bloc's economic powerhouse, East Germany's GDP was revealed at unification to be significantly below that of the West.[1] This case was made convincingly by Akerlof et al. (1991), who obtained the top-secret "Valuta-prices" used by the GDR trade ministry to estimate the value of exports priced in Ostmark necessary to generate one West German mark at a fictional exchange rate parity (which was ultimately adopted in July 1990). Akerlof and his colleagues estimated that 80% of industrial output was uncompetitive when valued at world prices, and within a year, the economic backwardness of the GDR was plain to see - physical production had collapsed by more than 50% and joblessness in the new states had risen from zero to well over 20%, if short-time working is included (Akerlof et al. 1991). The gale forces of competition and consumer sovereignty devastated East Germany's industrial landscape, while offering opportunities in services sectors ranging from retail and wholesale trade, logistics, and business services to restaurants, entertainment and other personal services.

Figure 1 displays per capita GDPs for all 16 *Bundesländer* (federal states) in 1991.[2] Most striking is the distinctive disparity between the GDPs of the Western *Länder* and those of the five new ones from the East: Brandenburg, Saxony, Mecklenburg-Western Pomerania, Saxony-Anhalt and Thuringia. Unified Berlin most vividly illustrates the burden of unification - while large cities normally boast productivity twice the national average, Berlin's was around 90%. Overall, the gap between the Eastern states and the least productive in the West – Schleswig-Holstein – amounts to a factor of about three – roughly comparable to the GDP gap between Mexico and the United States. We focus initially on GDP rather than income because fiscal policy can always break the link between the two. From the beginning, the new states received enormous support in the form of governmental transfers, estimated cumulatively to be more than € 2 trillion. These transfers took many forms: direct subsidies to local and state governments, investment financing, but most importantly, the propping up of social funds in the years imme-

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[1] Absurd as it may seem, the CIA Factbook of 1987 estimated GNP per capita at $10,400 per capita in 1985 compared with $10,300 per capita for West Germany!

[2] We use data from the Federal Statistical Office collected in cooperation with the federal states. See the Appendix for the exact sources.
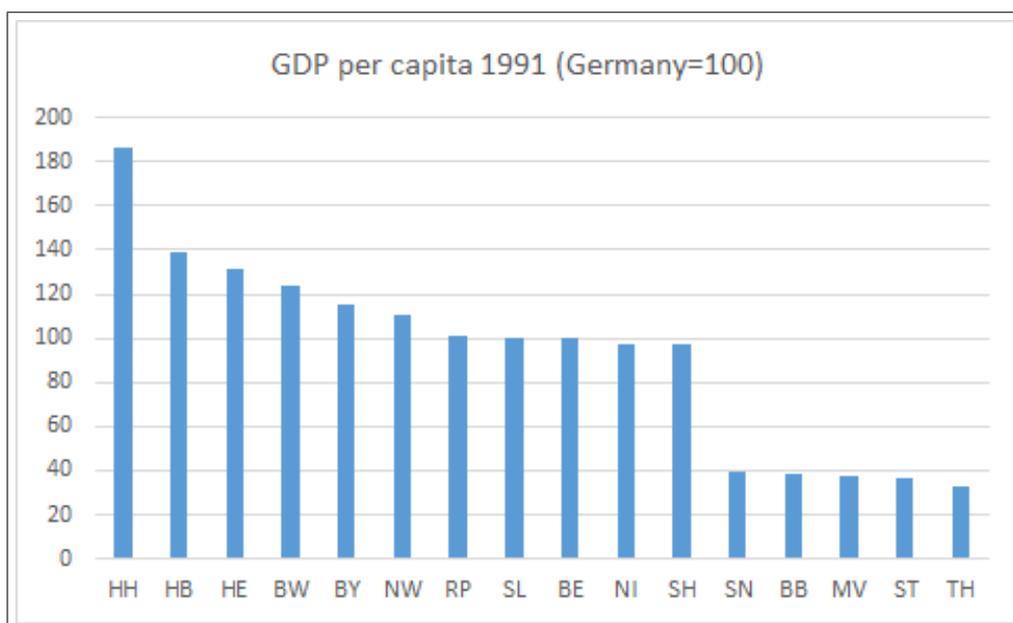
Figure 1: Per capita GDP. German states, 1991

diately following unification, including retirement benefits, health insurance, disability payments, unemployment benefits, and short-time work. Because East Germans were unable to finance their share of social union, West Germans picked up the tab via a "solidarity surcharge" on income taxes and, more importantly, increases in social contribution rates paid by all German workers.[3]

In the course of the past 25 years of economic transformation - best described as a mix of structural change, technological upgrading, inward capital mobility and outward migration - the gap in income between East and West shrank significantly, as shown in Figure 2. In particular, while per capita GDP of the new *Bundesländer* is still well below those that of Bavaria and Baden-Württemberg, it no longer lags significantly behind that of the poorer states in the West (Schleswig-Holstein and Lower Saxony). A North-South divide is gradually emerging as the lasting feature of East Germany' economic geography, just as in the Western part of the country.

Is this convergence process in line with the predictions of neoclassical growth theory? Or did the West-East transfers as well as the seamless inte-

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[3]Social insurance in Germany is financed in typical Bismarkian fashion by worker and employee contributions, i.e. the wage bill. In the period from 1990 to 1997, the overall social security burden (social contributions to all social funds paid by workers and firms as a fraction of the wage bill) rose from just under 30% to 36.3%.
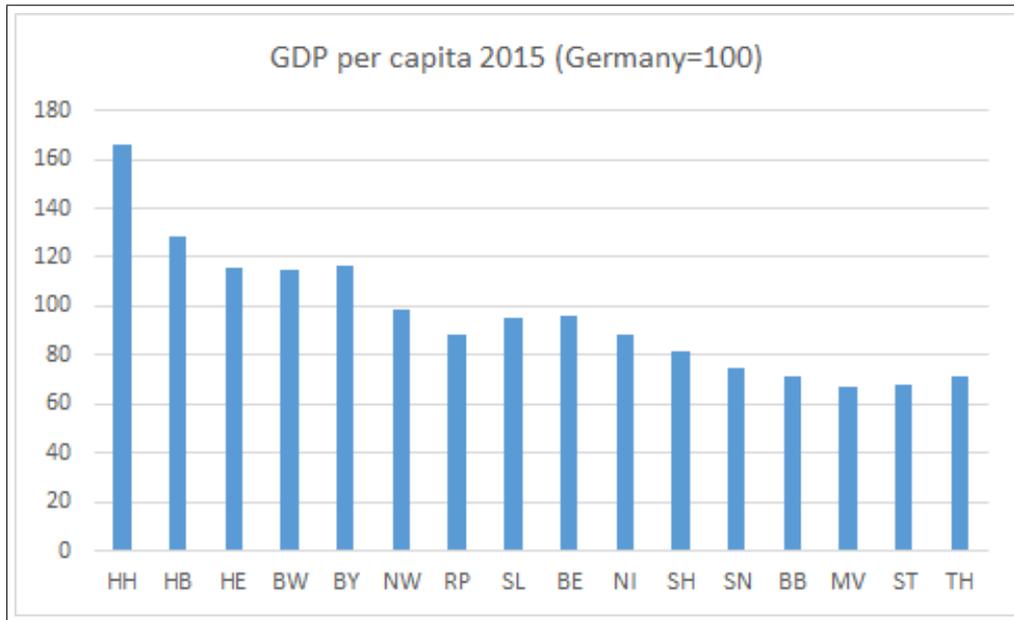
Figure 2: Per capita GDP, German states, 2015

gration of capitalist institutions generate an especially strong speed of economic convergence? In the next section, we examine German data using central predictions of neoclassical growth theory.

3 East Germany through the lens of Solow (1956) and Swan (1956)

Many mechanisms drive economic integration - trade in goods and services, capital mobility, labor mobility, transfer of technology and the adoption of economic institutions. In the German unification episode, the most conspicuous force was a massive surge in private and public investment activity in the East. In the years 1991-2013 more than €2 trillion was spent on gross capital formation, a number which roughly matches the estimated volume of transfers from the West. About a third of this was in equipment, about two-thirds in structures, and tax subsidies played a large role in steering investment patterns (Sinn 1991, 2002). Despite excessive investment in residential housing at the expense of plant and equipment, average investment rates overall in the new states averaged 29%, significantly higher than 20% in

the West.[4] Within a few years of unification, per capita consumption jumped to about 2/3 of West German levels even as restructuring was ubiquitous and output stagnated, so new investment was funded by current account deficits.

While we will later invoke central insights of Ramsey (1928) when considering the integration of Eastern Germany, it is most natural to think in terms of the Solow-Swan growth model with its emphasis on physical capital accumulation and its centerpiece, the neoclassical aggregate production function.[5] The Solow-Swan model provides a useful framework for looking at proximate sources of economic growth and the theory features several falsifiable implications. We concentrate on the role of investment and migration in growth as well as the issue of economic convergence, that is, if per-capita income will equalize across regions over time. In particular, we ask (i) if there exists a positive relationship between output growth and the investment rate and (ii) if the growth rate of output per capita is negatively related to the initial levels.[6]

3.1 Investment rates and economic growth

One of the key predictions of the Solow-Swan model is that economic development is closely associated with the accumulation of physical capital (which, given the model's closed-economy setup, corresponds to savings). We start by discussing the impact of different investment patterns across the German *Länder* and ask if high investment manifested itself in higher rates of economic growth. We measure for each state the investment rate as the average of the 1991-2015 investment to GDP ratios and economic growth rates (as in per capita GDP). Figure 3 shows a clear positive relationship between the individual investment rates as well as growth rates: those *Länder* that exhibited the fastest growth over the last 25 years were typically those that have had a relatively high rate of capital accumulation. This fits well what is suggested by the Solow-Swan model. In fact, the states that grew the fastest were located in the East and capital formation is evidently one central reason for their faster rate of development over the last twenty-five years.

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[4]Source: Statistisches Bundesamt, VGR der Länder Reihe 1 Band 3.

[5]Solow (1956) and Swan (1956).

[6]Labor mobility is another important source of economic growth. Following Barro and Sala-i-Martin (2004), we examine below the role of migration in the convergence process.
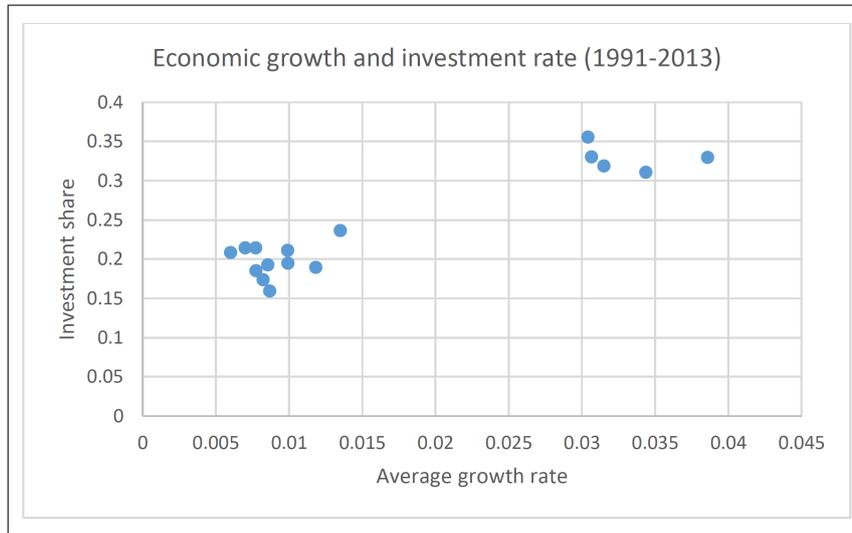
Figure 3: Growth and Investment in the German states

3.2 Convergence

Of great significance in the public policy debate was the speed and timing of convergence, i.e. how many years would it require for standards of living of both parts of Germany to become indistinguishable in an economic sense. Chancellor Kohl's now famous promise of *blühende Landschaften* (blossoming landscapes) in the new states was a key slogan in political campaigns of the early 1990s. In fact, income convergence in Germany was subject of the academic debate from the very beginning. Barro (1991) suggested that it would take a significant amount of time until a roughly equal standard of living is reached. He stated that the East will "[...] eventually catch up to the West, but in a couple of generations rather than a couple of years or a couple of decades." [Barro, 1991].

Barro's claim followed directly from empirical evidence: a negative relationship between the growth rate of per capita output and the initial output per capita (measured as the distance from the steady state). The relationship was established empirically by Baumol (1986), Barro and Sala-i-Martin (1992) and others when looking across countries as well as regions, and Barro and Sala-i-Martin (1995) derive a quantitative prediction for a log-linearized Solow-Swan economy close to its steady state growth path. In cross-country analyses, variation in savings rates, population growth, technical progress and other parameters will lead countries to converge to different steady states of economic development. In principle, this conditional convergence should
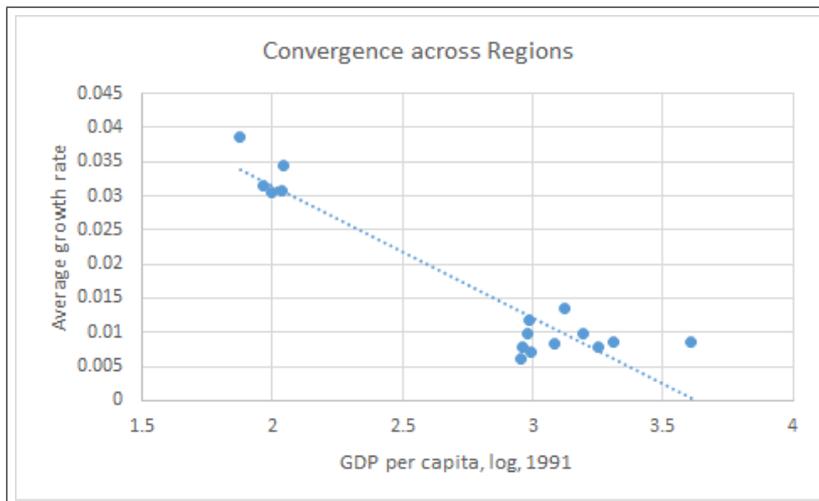
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Figure 4: Convergence

be less important in Germany, where agents and firms share the same government, institutions and preferences. We thus begin by assuming that all German regions converge to the same steady state and test for absolute convergence. Even though the neoclassical growth model often predicts local convergence rates of 4% or more, Barro and Sala-i-Martin's (1991, 2004) consistently find convergence speeds in the vicinity of 2% per annum for U.S. states, European regions, and Japanese prefectures.[7] Given enormous financial transfers involved as well as the relatively seamless adoption of functioning institutions, was the speed of convergence of the new German states significantly different from that predicted by the empirical work of Barro and Sala-i-Martin?

To investigate this question, we run the following univariate regression using data for the sixteen *Bundesländer* indexed by i :

$$g_{y_{i,2015}/y_{i,1991}} = c - \left[(1 - e^{\beta T})/T\right] \ln y_{i,1991} + u_i.$$

In this regression, $g_{y_{i,2015}/y_{i,1991}}$ is the average annual rate of growth of each of the *Bundesländer*, $y_{i,1991}$ denotes the 1991 real per capita GDP of *Bun-*

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[7]Barro and Sala-i-Martin (2004) show that in the Solow/Swan model near its steady state y^*, $d \ln y/dt = -\lambda \ln(y/y^*)$, where $\lambda = (1 - \alpha)(a + \delta + n)$; α is the capital elasticity of production, a is the rate of technical progress, δ is the rate of capital depreciation, and n is the rate of population growth. To obtain an empirical value of λ in the range of 0.02, a much higher capital share is necessary. They argue this may be the case if a large component of wages actually reflects a return to an accumulable factor, i.e. human capital.

desland i, adjusted by population, the parameter β stands for the speed of the convergence process. Lastly, c is a constant and we set $T = 24$, reflecting time frame of available data. The estimated β coefficient of 0.016 ($\overline{R}^2 = 0.88$) is confirmed by Figure 4's plot of the average growth rates and the initial values of per capita GDP. The implied half-life to close the initial gap is $t = \ln 2/\beta = 0.69/0.016 \approx 40$ years. The estimate is comparable to those reported by Barro and Sala-i-Martin (1991, 2004) for US states. In fact, in the longest sample (1880-2000), they report an estimate for β of 0.016, suggesting that the overall convergence speed of the German *Bundesländer* since 1991 is slightly below the 2% rule, although thoroughly consistent with Barro's prediction in 1991.

To shed further light on this question, we re-run the same convergence regression on the two subperiods 1991-2001 and 2002-2015. The results are now strikingly different, however: The coefficient β for the first decade after unification is estimated at 0.0454, indicating convergence significantly in excess of the 2% rule. In the second subsample, the estimated convergence coefficient is only 0.0093 or less than 1%. Rather than conventional unconditional convergence, we see a more plausible account of the past twenty-five years as a very rapid convergence to a common, lower conditional steady state productivity level followed by little or no improvement in the aftermath. To support this claim below, we adduce evidence on persistently lower total factor productivity in eastern German states. Applied to the Korean context, this implies low-hanging fruit in the initial stages of a reunification in terms of rapid productivity gains, followed by a long hangover of disappointing progress. The difficult part will be to identify the conditional steady state of North Korea with any degree of accuracy, given that it depends on a host of largely unknown factors.

3.3 The contribution of migration

The original papers by Solow (1956) and Swan (1956) studied closed economies. In that context, deferred consumption rather than capital mobility is the primary mechanism driving convergence. It is even more striking that despite massive capital mobility, convergence did not occur at any faster rate than the 2% rule. Yet capital mobility is not the only alternative mechanism of convergence. While free trade between East and West in a common currency (the Deutsche Mark) ensured a convergence of output prices, the opening of the wall was followed by mass migration of more than one million persons. Such population movements, involving mostly persons of working age, are likely to have had an effect on the evolution of GDP per capita, wages, and unemployment. Burda and Hunt (2001) and Hunt (2006) study this ques-

tion and find that wage differentials between east and west *Länder* played a central role in shaping migration patterns. They also find that the wage pull was asymmetric and strongest for young people, just as theory predicts.

After the fall of the Wall, formerly communist companies and factories in the East were suddenly thrust into competition with significantly more efficient western enterprises. Many eastern regions never recovered from the shock and even over 25 years after reunification, unemployment in the former East Germany hovers at above 7-8% compared with 5-6% or less in the West German states. However, as economic development took on asymmetric patterns, people decided to move: the population of the East (excluding Berlin) declined from 14.6 million in 1991 to 12.7 million, while the West German population increased by about 5 million.

In the following, we take up this question, following the lead of Barro and Sala-i-Martin (2004) and examine empirical determinants of migration among the *Länder*. Labor movements is proxied by net migration into *Bundesland* i at time t, $m_{i,t}$, reflect difference in present and future income, proxied by the former, per capita income, $y_{i,t}$; and *Bundesland* population density, d_i, which proxies for effects related to urbanization, externalities etc. and its square. A simple OLS regression yields:

$$m_{i,t} = \underset{(-4.04)}{-0.818} + \underset{(3.93)}{0.085} \ln y_{i,t} - 0.057 d_i + \underset{(0.99)}{0.011} d_i^2 \qquad \overline{R}^2 = 0.55$$

This result is robust to exclusion of city-states Berlin, Hamburg and Bremen:

$$m_{it} = \underset{(-3.48)}{-0.819} + \underset{(3.17)}{0.087} \ln y_{i,t} - \underset{(-0.26)}{0.126} d_i + \underset{(0.99)}{0.105} d_i^2 \qquad \overline{R}^2 = 0.45$$

Consistent with Burda and Hunt (2001) and Hunt (2006), we find that migration is strongly influenced by GDP differentials. The value for intra-German mobility is higher than what Barro and Sala-i-Martin (2004) find for the US and Japan (over longer period, they also adjust for geography - heating days - but that seems to be irrelevant for a small country like Germany where the weather much less across the country).

3.4 The initial jump in productivity: What was it?

Although the overall convergence rate appears in line with the Barro/Sala-i-Martin's 2% rule, convergence in the new German states is largely driven by a quantum jump in growth in the first five years following reunification. This high rate of growth was associated with an investment boom, especially in housing, and may have distorted the economy as it entered the first decades

of the 21st century. But it was also driven by significant restructuring and unemployment at the time (Burda and Funke 1995).

As we have seen, the speed of convergence decreased dramatically after a roaring 1990s period. The migration process no doubt played a significant part in this decline, as a significant component of productivity convergence occurs via the denominator, i.e. movement of people. That convergence has ground to a halt since 2000 suggests that conditional convergence may be the more appropriate perspective for studying the integration of the two regions of Germany: Despite common rule of law, near-identical institutional frameworks and enormous investment activity in the eastern regions, significant regional productivity differentials persist that appear due to underlying differences in production conditions. In the next session we explore these differences in more detail.

4 East Germany through the lens of Solow (1957)

Solow (1957) demonstrated the decisive importance of technological change, or generalized economic efficiency, for economic development. We thus continue our study of East Germany from the perspective of neoclassical growth theory by examining productivity levels across Germany. In particular, we ask: how different is total factor productivity across the *Länder* and are those differences correlated with output per capita?

In particular, we will consider the "development accounting" decomposition following Hall and Jones (1999) and Caselli (2005), and assume that each *Bundesland* has access to a Cobb-Douglas aggregate production function of the form

$$Y_{i,t} = K_{i,t}^{\alpha}(A_{i,t}L_{i,t})^{1-\alpha} \qquad 0 < \alpha < 1$$

where $Y_{i,t}$ denotes output, $K_{i,t}$ stands for the aggregate physical capital stock, and $L_{i,t}$ is labor input.[8] We allow the *Bundesländer* to have different states of technology. This is captured in the variable $A_{i,t}$ which stands for labor-augmenting total factor productivity. As we do not adjust for human capital, $A_{i,t}$ embodies a liberal interpretation of technology which includes education and training as well as infrastructure, rule of law, and social capital. We set the capital elasticity $\alpha = 0.36$. We use this aggregate production function to

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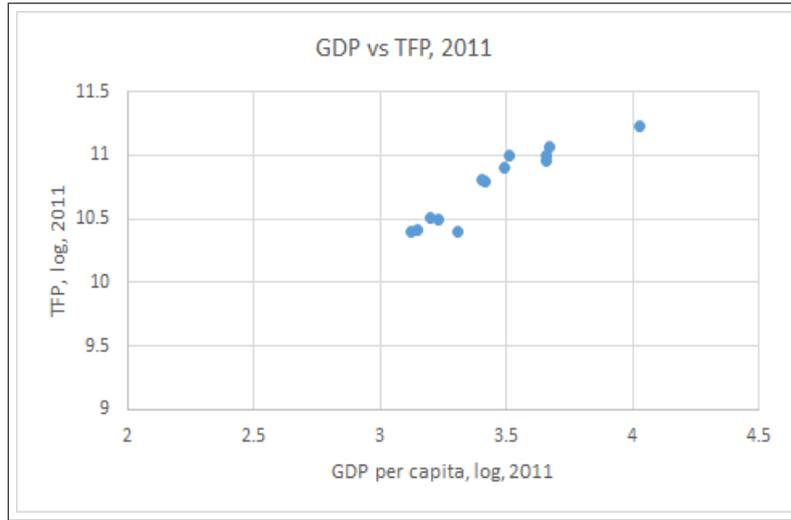[8]For a similar analysis see Severgnini (2010) and Burda and Severgnini (forthcoming).

Figure 5: Total factor productivity (TFP) and GDP levels

back out each region's level of total factor productivity in time t:

$$A_{i,t} = \frac{Y_{i,t}^{\frac{1}{1-\alpha}}}{K_{i,t}^{\frac{\alpha}{1-\alpha}} L_{i,t}}.$$

For this exercise, we require data on regional aggregate outputs as well as factor inputs in some particular year. The capital stocks were constructed by Burda and Severgnini (2015) extending data of the Federal Statistical Office and labor input is measured as total hours worked.[9] Figure 5 plots levels of total factor productivity as well as outputs per employee in 2011. The clear pattern is that the less productive states have significantly lower levels of total factor productivity. Figure 6 graphs total factor productivities for 2000 as well as 2011 and shows that productivity differentials across the *Bundesländer* are persistent over time.

To investigate the importance of productivity differentials in explaining East-West labor productivity differences, we construct the following counterfactual: what would be the output of an East German state if it could produce using the best possible TFP? Concretely, given the data series of capital and labor input employed in each state, we compute GDP $Y_{i,t}^p$ implied if each *Land* were to have access to the level TFP of Baden-Württemberg (the

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[9]Currently available data on total hours worked covers the years from 2000 to 2011 which is the reason for our timing choice. Furthermore, we combine Berlin and Brandenburg, taking into account the large number of commuters between the two states.
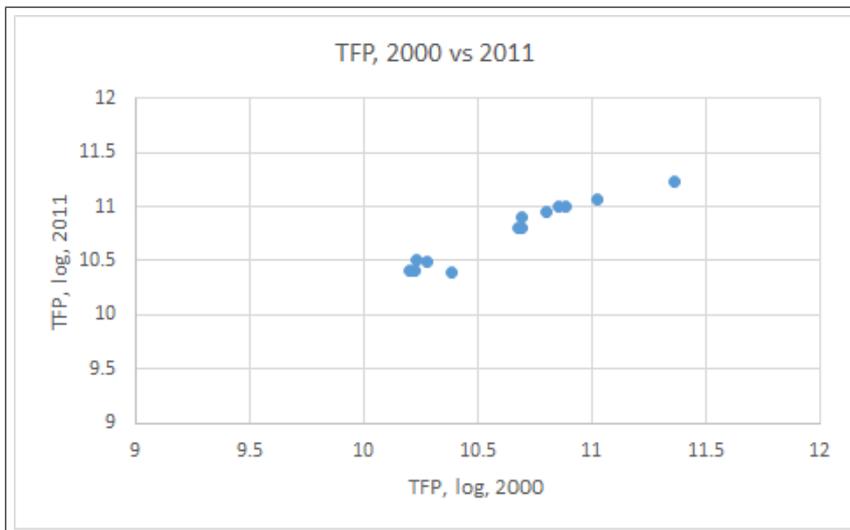
Figure 6: Persistence of TFP

non-city *Land* with the highest value) denoted by $A_{BW,t}$, as

$$Y_{i,t}^p = K_{i,t}^\alpha (A_{BW,t} L_{i,t})^{1-\alpha}.$$

Figure 7 compares actual and counterfactual per capita GDPs for several states. The gap between the two represents the contribution of different TFP levels. Consider Saxony, which despite thriving new industrial developments in the Dresden region (including Volkswagen, Bombardier etc.) remains one of the least productive states; its GDP per capita in 2011 was roughly 65 % that of Baden-Württemberg in 2015. If Saxony had access to Baden-Württemberg's level of total factor productivity while using current capital and labor inputs, its predicted 2011 GDP per capita is close to 90% of Baden-Württemberg's value. Similar results apply for the other eastern *Bundesländer*. In fact, Figure 7 suggests that the pattern is remarkably uniform across the states. This straightforward exercise demonstrates the decisive role that total factor productivity plays in explaining productivity differentials across Germany.

Using several direct and indirect measurements, Burda and Severgnini (2015) document a slowdown in TFP growth after 1995, with subsequent relative labor productivity improvements until 2000 deriving from increases in capital intensity. Using regression analysis following Griffith et al (2004), they infer an influence of firm size but not the density of headquarters, agglomeration, urbanization or population density on TFP growth or levels. They do find a significant influence of the concentration of managers and
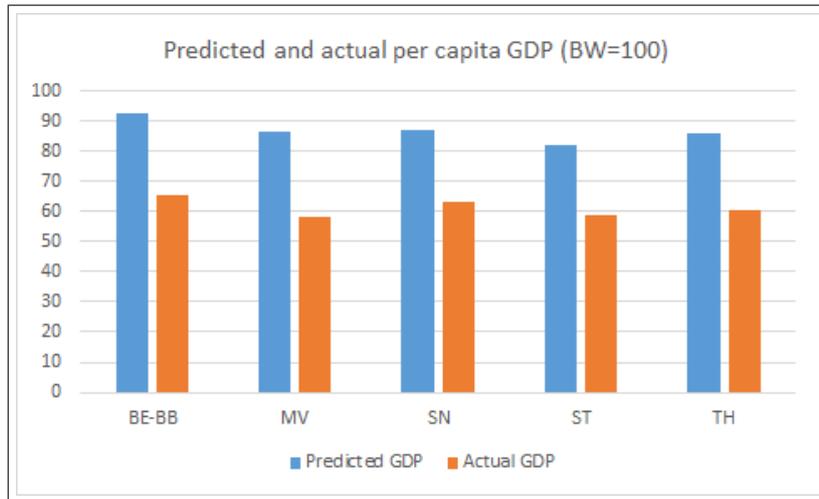
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Figure 7: Counterfactual Output

technical personnel as well as a negative influence of the investment rate. The latter finding supports the view that investment is a substitute for, rather than a complement to multifactor productivity, at least in the current context. This is consistent with the finding that in industrial sectors, East German workers currently work with more capital per worker and their firms exhibit lower capital productivity than Western counterparts.

While differences in TFP are the central source of persistent output gaps, low employment rates also play a role in explaining the gap in GDP per person. Employment ratios in the new states are still much lower than those in the West. Baden-Württemberg's employment ratio stands at 55 % compared with an average rate in the eastern states of 46 % and 48 % in Saxony. Certainly, low labor force utilization has an impact on per capita GDP. To assess its significance, we construct the following counterfactual: Assume that workers in each *Bundesland* have the current, state-specific, average labor productivity, however, let us also assume that the employment ratio in each eastern state is counterfactually equal to that of Baden-Württemberg's. Figure 8 shows that by increasing employment – holding productivity levels of workers constant– GDP per capita of the eastern states would increase more or less uniformly by about 20%. It is likely that continued implementation of labor market reforms initiated in 2003-5 will increase labor force utilization, leading to further convergence.

It should be stressed however, that significant regional differences in GDP exist and persist within countries; in fact, they are the rule rather than the exception. In the United States, GDP per civilian employee in 2010 ranged
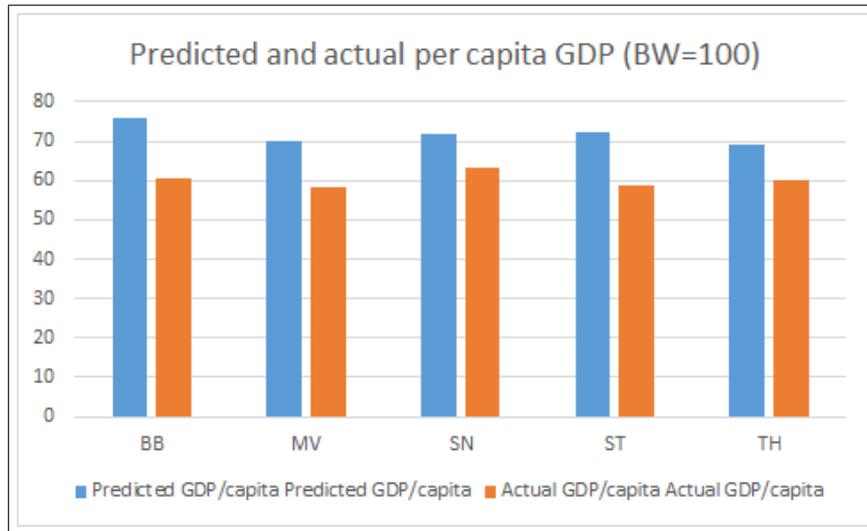
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Figure 8: Counterfactual employment ratios

from \$135,000 in the state of New York state Connecticut, and \$125,000 in Massachusetts, to \$90,000 in New Hampshire and \$82,000 in Maine, in a year when the national figure was \$106,926 (and Washington DC boasted a GDP per employee of \$337,000). The land area of reunified Germany is roughly equal to the New England states plus the state of New York.

5   East Germany through the lens of Ramsey (1928)

Economics gives us the liberty to think about adjustment paths which respect only the resource constraints of the economy but not those of a potentially imperfect market system. What would have been the social planner's solution to the German unification problem? The prescription of Frank Ramsey's (1928) seminal paper would be to smooth consumption over time relative to output.[10] In a closed economy, this prescription would impose early hardship on households, when initial output per capita is far below the steady state level, given their need to accumulate capital rapidly. For Eastern Germany, an open economy with access to loans and transfers from a rich uncle to the West, the problem was fundamentally different. At the same time, freedom

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[10]See Blanchard and Fischer (1989) for a formulation of the wide-reaching implications of Ramsey's (1928) paper.

of movement within Germany would require attention to potential external costs of large population movements in response to wage differentials. From early on, it was clear that Eastern German residents expected a rapid rise of consumption to levels comparable with the West (Collier and Siebert, 1991).

A Ramsey-constrained optimum is not trivial to formulate, especially if one subscribes to the view that tastes of East and West Germans had diverged over the Communist era. Nonetheless it is instructive to consider a rarefied version of such a Ramsey problem prescribing optimal paths of consumption, investment, output and labor deployment for identical representative consumers in the presence of externalities. The key lessons of such an exercise can be summarized verbally as follows.[11] The central planner will generally frontload investment and restructuring, if it is possible to "import" or reallocate resources across regions. In the presence of high congestion costs or the uptake of public goods, she would also raise consumption in the East to a path which is close to, but generally lower than Western levels, followed by a very slow convergence, thereby decoupling East consumption from production. Recognizing labor mobility and associated negative externalities, it is also generally optimal to reduce migration incentives implied by the decentralized market solution. Hours for those in work should be higher than those that would obtain in a pure market solution, and would fall over time relative to the West as consumption rises. The constrained efficient solution would imply an initial burst of migration which boosts marginal product of labor in the East followed by a slow rise of productivity in the aftermath. In the past twenty-five years, how does the historical record compare with that benchmark?

5.1 Convergence of consumption and unemployment

As the previous section showed, significant regional productivity differentials and productivity gaps persist, despite common rule of law and institutions, as well as enormous transfers and investment activity. Yet at the same time, East-West disparities in consumption, well-being and unemployment rates fell more rapidly than those in GDP per capita or wages. Table 1 shows a convergence of consumption patterns that has occurred over the last twenty years, in particular the percentage of households owning durable goods such

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[11]Burda and Wyplosz (1992) and Sinn (2000) are examples of social planner's problems that take into account various external effects of the transformation.

as cars, television sets, personal computers, and dishwashers.

Durable Good	1993 East/West	1998 East/West	2008 East/West	2016 East/West
Automobile	66/74	71/76	73/78	70/79
Landline telephone	49/97	94/97	86/91	100/92
Cell phone	-/-	11/11	86/86	95/95
Personal Computer	16/22	34/40	72/76	87/89
Internet access	-/-	5/9	58/66	88/90
Television	96/95	98/95	95/94	98/98
Cable access	-/-	64/51	55/46	55/43
Satellite dish	-/-	30/29	34/40	39/50
Video recorder	36/49	61/63	-/-	-/-
Refrigerator	-/97	99/99	99/99	100/100
Microwave oven	15/41	41/53	70/70	74/73
Dishwasher	3/38	26/49	55/64	64/71
Washing Machine	91/88	94/91	-/-	98/96
Dryer	2/24	14/33	22/42	24/46

Source: German Federal Statistical Office (2016)

Table 1: Household ownership of durable consumption goods.

Most of the rise occurred in the 1990s, in the first ten years following unification.[12] This is confirmed at the macroeconomic level in Table 2, even though labor productivity growth slowed significantly in the early 2000s, which we have shown to be related to a slowdown in East German TFP growth beginning in 1995. Thus, higher Eastern German wages were paid for in the form of higher unemployment, and while wages rose sharply, they did not rise beyond labor productivity, while high consumption levels were

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[12]Note that the quality of goods is not reflected in the numbers of Table 8; especially during the early 1990s, inferior durable goods produced in the GDR were replaced by more expensive counterparts produced in the West.

financed by transfers from the West.

Year	Private consumption	Nominal wages per hour	Nominal wages per worker	Labor producitvity per hour	Labor productivity per worker	GDP per capita	Unemployment rate	Participation rate
1991	64	n.a.	57	n.a.	45	44	165	116
1993	75	n.a.	74	n.a.	67	59	193	107
1995	82	n.a.	78	n.a.	72	67	163	109
1997	83	n.a.	79	n.a.	74	68	177	109
1999	84	n.a.	79	n.a.	75	68	195	108
2001	85	73	80	72	76	67	235	106
2003	86	74	80	73	78	69	216	106
2005	85	75	81	73	78	69	187	103
2007	85	74	80	73	78	70	201	104
2009	87	75	81	74	80	72	186	105
2011	85	76	82	74	79	71	188	104
2013	85	76	82	75	80	71	173	103
2015	85*	79	81	78	n.a.	72	161	n.a.

Source: German Federal Statistical Office, Bundesagentur für Arbeit *=2014

Table 2: Macroeconomic indicators.

Labor markets have converged in a similar fashion. In 2005 unemployment in East Germany peaked at 20.6 % (versus 11 % in the West). Since then the rate has not only come down dramatically but the regional gap has declined as well: as of October 2016, the unemployment rate in East Germany stands at 7.7 % which is not much higher than the West's 5.3 %. In fact, Figure 9 shows that unemployment rates in Thuringia, Saxony and Brandenburg now have lower rates of unemployment than North Rhein-Westphalia, Berlin, and Bremen. As in the case of GDP, seemingly a North-South divide has developed, with Bavaria and Baden-Württemberg now appearing very distinct from the rest of Germany. It is noteworthy that West German labor force participation has risen significantly since unification, reflecting the growing adoption of East German child care practices in the West.

Wages rose sharply in the early 1990s, driving up unit labor costs and rendering many economic activities unprofitable. In the aftermath of restructuring and new investment, unit labor costs fell as productivity rose and wage growth slowed (Figure 10). Slow wage growth was associated with the collapse of collective bargaining in the East, despite higher initial union membership and coverage rates initially there. In 2013, 60% of workers in the West worked under labor contracts negotiated by unions, while the corresponding figure in the East was 47% (Bispinck and Schulten 2014)
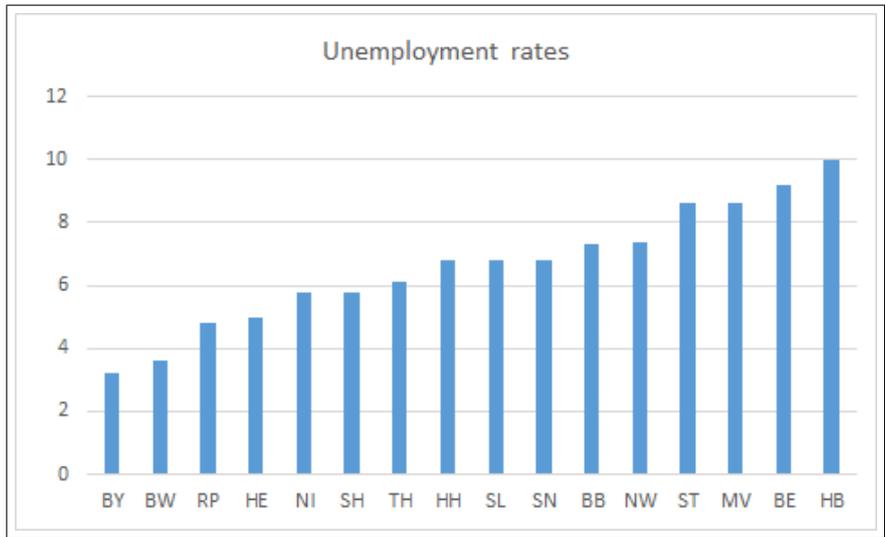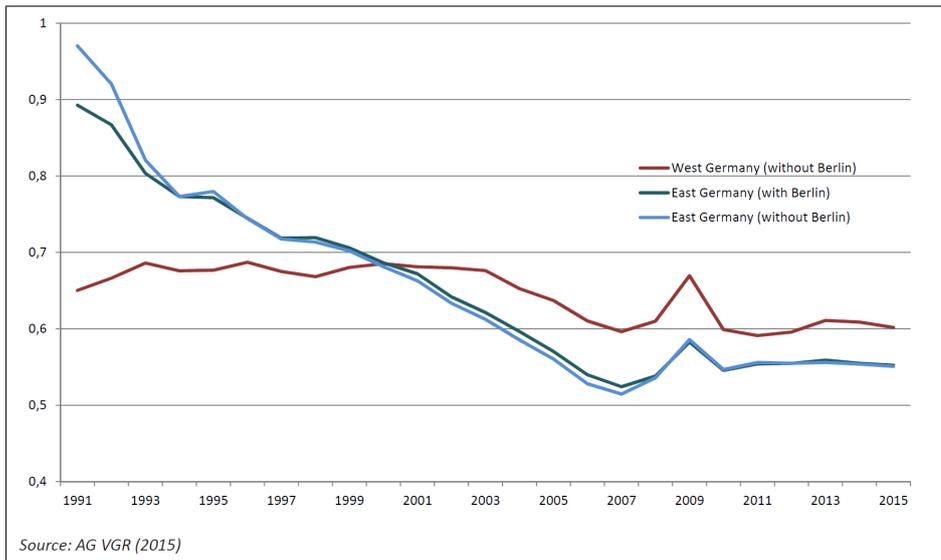
Figure 9: Unemployment rates, October 2016

Figure 10: Real Unit Labor Costs in Manufacturing
(employee costs as a fraction of value added), 1991-2015
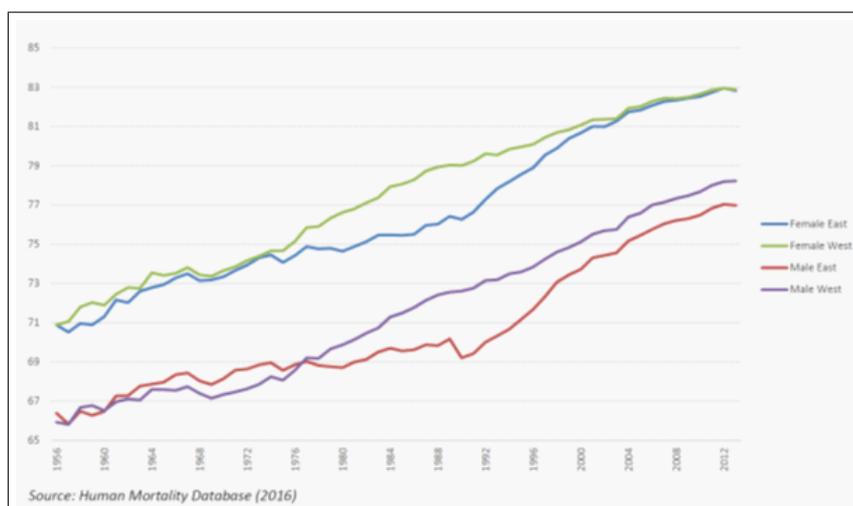
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Source: Human Mortality Database (2016)

Figure 10: Life expectancy at birth (in years), 1956-2014.

5.2 Health, happiness and mobility

It is sometimes argued that productivity, GDP per capita and consumption per capita are flawed measures of economic performance that do not accurately reflect human welfare. While the critics offer few reliable alternatives, it is useful to corroborate national income and product account data with other measures of well-being. We consider three.

The first involves health. Figure 11 shows that life expectancy at birth in both regions increased steadily at comparable rates until the early 1970s, after which East Germany fell sharply behind. After reunification, this gap was closed for women by 2004; a man in Eastern Germany has seen a relative improvement in life expectancy of three years since 1990, even while continuing to lag behind the West by one year.

A second key indicator often stressed is happiness or life satisfaction. Surveys by the Pew Foundation indicate that life satisfaction among East Germans since 1991 has been markedly greater than that of Russians, Poles and Ukrainians, and that they have reached levels hardly distinguishable from their West German counterparts. More exact attention to mean differences in responses on a finer scale continue to show a small but significant East-West gap, but one that is declining steadily over time (Petruynk and Pfeiffer, 2015).

A final indicator of convergence in living standards after a quarter-century of unification comes from household mobility. Within three years of the fall of the wall, more than one million people migrated to the West, most of
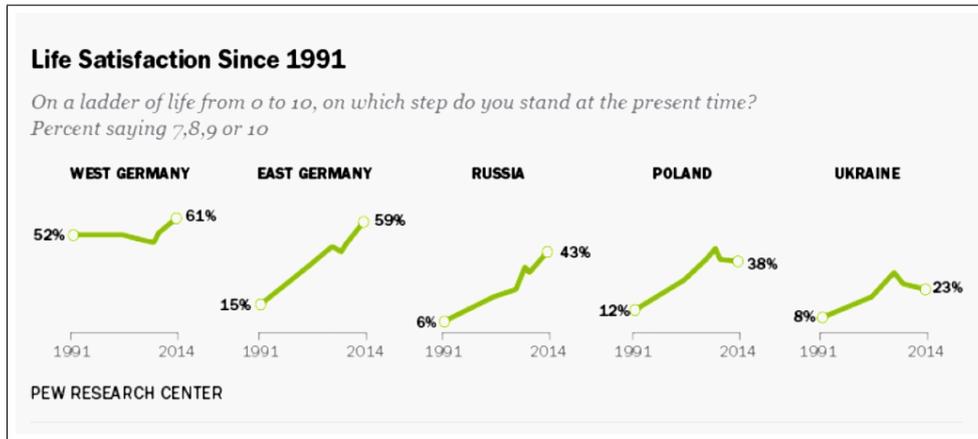
20

Figure 11: Life Satisfaction, Pew Survey

these of working age. This migration wage was driven in part by fear that the migration option might soon be rescinded. Consistent with this view, gross outmigration decreased dramatically after 1991, while return migration steadily rose, as shown in Figure 12. Since then, Hunt (2006) has shown that *fewer* East Germans migrated than would have been predicted by wage and unemployment differentials' effects on West-West German migration flows before 1990. Dire predictions of East Germany becoming a national park (e.g., Uhlig 2008) proved to be premature. After a loss of about two million inhabitants, net migration from eastern German as a whole has been zero since 2014.

6   The costs? Lessons for Korean Unification

What are the key lessons of the German unification episode for a similar union of South and North Korea? First, Germany was able to orchestrate a Ramsey-style increase in East German consumption to two-thirds of Western levels in five years, even as output in the East plummeted and unemployment soared. Raising wages slowed emigration of those in work; given that unemployed are less likely to migrate (Hunt, 2006), joblessness resulting from this high wage strategy was the short-term price of stablizing the population of the eastern states. The applicability of this model to Korea may be limited, however. While sharing the same language and cultural history, North and South Korea's separation is a quarter-century longer than Germany's was in 1990. Besides being more populous and capital-poor than the GDR was, North Korea is isolated from developments in technology as well as knowledge
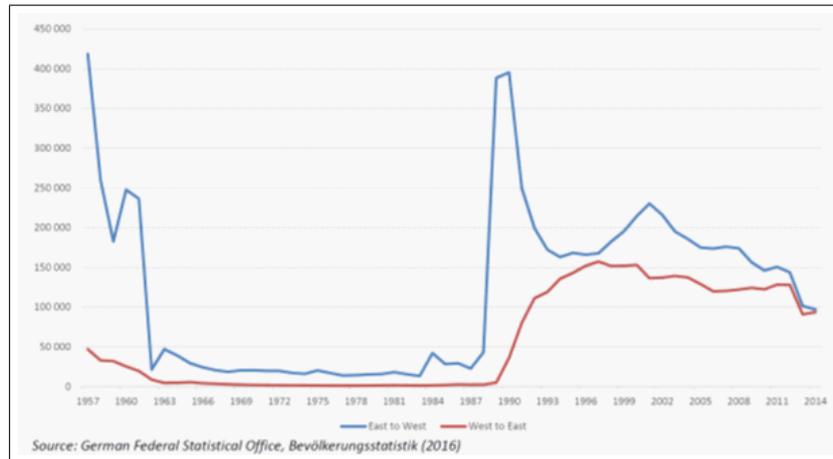
21

Figure 12: East-West German migration, 1957-2014.

of Western society and institutions, and are possibly less aware of opportunities in the South. This may reduce migration pressure at the outset, which forced Chancellor Helmut Kohl to adopt the 1:1 Ostmark-D-Mark exchange rate in Germany at the outset. Yet it seems likely that pressure for a common currency and comparable wage levels in Korea will grow, especially if labor mobility is allowed.

The Ramsey program left its mark on the West German economy. Figure 13 plots the excess of output (GDP) over absorption for eastern and western Germany (with and without Berlin) since 1991. Taken together and individually, all the new states in the East are still net transfer recipients after 25

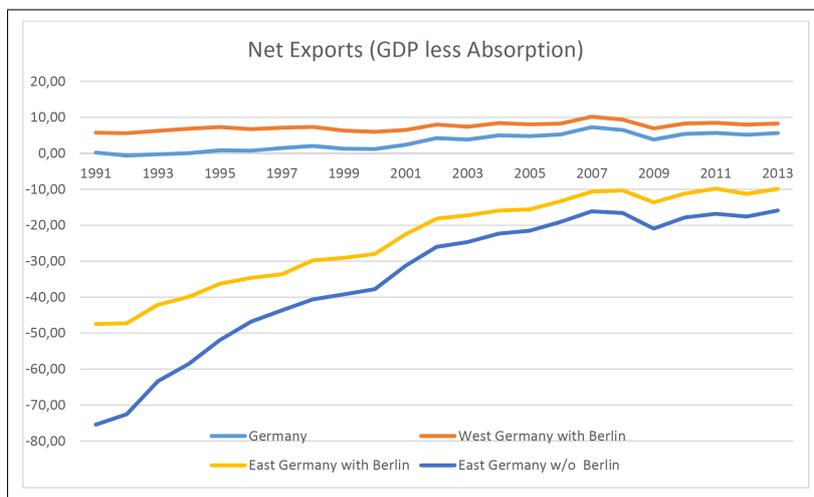years, on average receiving about 15% of own GDP annually.[13]

Figure 13: East-West imbalances (GDP less absorption, as
% of GDP) *Source*: Statistisches Bundesamt, authors'
calculations

Second, the forces of economic integration which shape the steady-state
outcome are strong, but also unpredictable. The reorganization of production
in the first five years as well as the adoption of West German institutions led
to sharp TFP increases, which represent low-hanging fruit also available to
North Korea. The rapid increases in eastern German TFP disappeared after
about five years, exposing productivity differences between East and West
are reflected in wage differentials even in 2016. Barring a massive program
of transfers, mass migration pressures may increase in the medium run. Nat-
urally the greatest migration flows result from social unrest, civil war, and
outright military conflict, which were conspicuously absent in the German
case. Similarly, the political unification enhanced East German access to
western and international capital, rendering FDI much easier. Because the
Republic of Korea (ROK) will not be able to finance unification alone, it will
important to provide a similar level of assurance to international investors.

Third and most important, a Ramsey-style program for North Korea will
be expensive. Raising private consumption of 16 million East Germans to
two-thirds of western levels in 1991 and to 85% by 2015, spending more than
two trillion Euros on domestic capital formation as well as installing a modern

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[13]The poorest western German state, Schleswig-Holstein, received transfers amounting
to about 10% of own GDP in 2013.

system of governance could not be funded from present and expected future Eastern German output. Rather it was financed by a significant run-up of all-German government debt, an increase in distortionary social security taxes, and a draw-down of net foreign assets. North Korea is larger, with a population roughly half of the South's, and much poorer, with a GDP in 2014 of $1,800 per capita versus $35,700 (CIA Factbook, 2016).

Estimating the cost of Korean reunification is an inherently speculative exercise and depends heavily on a range of assumptions. Yet such "back-of-the-envelope" exercises can set useful boundaries on resource transfers from the wealthy to the poorer partner during a unification episode, expressed in present discounted value terms and as a fraction of GDP. Applied to the German case, and defining the costs of unification as the sum of the excesses of regional absorption over GDP, we calculate a net cumulated resource transfer to Eastern Germany excluding Berlin over the years 1990-2016 of €1.88 trillion.[14] Discounting by a real interest rate of 2% and the realized growth rate of 2.5% over the period, this burden of €1.2 trillion represents 95.4% of West Germany's GDP of 1.3t EUR in 1990.

A simple back-of-the-envelope calculation shows that a "Mercedes-Benz" version of unification will be costly for Korea. To fix ideas, let us assume a steady-state objective of providing North Korea's 25 million inhabitants with two-thirds of the South's 2015 per capita levels of private and public consumption. This alone comes with a price tag for the first year of $296.7 billion (21.2% of ROK GDP of $1.4 trillion).[15] North Korea will contribute significantly to resources towards reunification in the medium to long term, but with an initial GDP per capita of 1/20th of the ROK in 2015, it will need to raise its physical capital stock rapidly to accomplish this aim. Rather than formulating and solving the Ramsey policy explicitly, we consider a scenario of funding a North Korean investment path (in % of GDP) that mirrors the one implemented in East Germany in the twenty-five years following unification. We assume an employable and fully employed labor force of 12.5 million in North Korea and further assume that its TFP follows the pattern observed in eastern Germany, rising to two-thirds of the South's

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[14]Net imports of the new German states including Berlin from 1991 to 2013 sum to €1.622 trillions (€1.677t excluding Berlin); assuming a transfer of €40b for each year in the period 2014-16 plus a conservative estimate of €100b in the year 1990 yields €1.8t. This is not far from current estimates.

[15]In 2015, ROK private consumption was $681.8 billion; public consumption was $209.6 billion (World Bank). With 50 million inhabitants, this implies private and public consumption per capita of $13,600 and $4,200 respectively. Providing two-thirds of this per capita consumption to 25 million North Koreans implies (2/3)(13600+4200)x25 million = $296,7b. in the first year.

level in 5 years at a rate of 5% per annum, but remaining at that relative level for the rest of the period. South Korea's own TFP level in 2013 is estimated using values of capital and employment (in persons) taken from the IMF's Investment and Capital Stock Dataset (IMF, 2015) and World Economic Outlook, respectively, and then extrapolated to 2015 assuming exogenous technical progress of 1% annually.[16] Finally, we assume that the South Korean economy grows at a trend rate of 3.5% per annum throughout. Under these conditions, total transfers from South Korea to North Korea over a quarter-century post-unification sum to $3.8 trillion, or 278.6% of 2015 ROK GDP. Discounting by 2% and assuming ROK growth of 3.5% per annum throughout, this comes to 165.3% of ROK 2015 GDP.[17] Under these rather optimistic conditions, unification in Korea will cost about twice as much as it did in Germany.[18]

7 Conclusions

This paper has reviewed the evolution of the East German economy in the turbulent quarter-century following reunification and drawn some tentative conclusions for Korea. In the wake of unprecedented trade integration, structural change, capital inflows, and outmigration, output per capita differentials between East and West declined over the entire period at a speed not far from that predicted by empirical experience and the neoclassical growth model with a sufficiently high capital share. Yet progress since 2002 has been minimal, suggestive of conditional convergence to a lower steady GDP per capita. Evidence points to persistently lower total factor productivity in the East as the proximate cause. Despite common rule of law, near-identical institutional frameworks and intensive investment in the eastern regions, significant East-West productivity differentials persist and the TFP gap appears unlikely to disappear for generations to come. Yet at the same time, regional disparities in income, well-being, unemployment rates and health are now hardly different from those within West Germany. On this human metric, German unification has been an unqualified success.

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[16] A Cobb-Douglas constant returns production with a capital elasticity of 0.4 was assumed. In doing so we arrive at an initial 2016 value of TFP for North Korea of 78.3% of the ROK's value, or roughly the value Lee (2016) estimates for ROK in 1980.

[17] For a comparable estimates see McKibbin, et. al (2017). Their study is based on a much more detailed general equilibrium analysis and considers the impact of accelerated South Korean growth, fueled by FDI as well as North-South migration.

[18] If the North Korean consumption (private and public) is fixed instead at 50% of Southern levels and all other assumptions remain constant, the net transfer declines to $891.6b, or 55.2% of 2015 ROK GDP in present discounted terms.

The German success story may have limited applicability for Korea. The systematic gap in total factor productivity in the East after 25 years raises natural concerns that the ROK economy may not be scalable. It remains a striking fact that, even after a quarter-century, Eastern Germany has not recovered the economic prowess it possessed before World War II and continues to receive transfers on the order of 15% of GDP. In comparison, current divergence of its North and South is far greater than the initial gap between eastern and western Germany. Unless consumption in the North is stabilized at a lower level, it will be more challenging for the South to finance the Korean reunification process. Our back-of-the-envelope calculation suggest that Korean unification would cost roughly twice that of the German episode.

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8 Appendix

Data sources Original source of data: http://www.vgrdl.de/VGRdL/

Federal states' codes ISO 3166-2 codes of Bundesländer: BW - Baden-Württemberg, BY- Bayern, BE - Berlin, BB - Brandenburg, HB - Bremen, HH - Hamburg, HE - Hessen, MV - Mecklenburg-Vorpommern, NI - Niedersachsen, NW - Nordrhein-Westfalen, RP - Rheinland-Pfalz, SL - Saarland, SN - Sachsen, ST - Sachsen-Anhalt, SH - Schleswig-Holstein, TH - Thüringen.