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Michael C. Burda and Battista Severgnini

TFP Growth in Old and New Europe

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TFP Growth in Old and New Europe

Michael C. Burda
Humboldt-Universität zu Berlin, CEPR, CESifo and IZA

Battista Severgnini
Humboldt-Universität zu Berlin and CEBR

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Abstract: Using two alternative methods for calculating estimates of total factor productivity (TFP) growth proposed in Burda and Severgnini (2008), we present estimates productivity growth in a sample of 29 European economies and compare these with classical Solow residual estimates. In most economies of Western Europe, we find a deceleration of TFP growth in the second half of the sample. However, the economies of "New Europe" exhibit a higher level of TFP growth overall and have slowed less than those of "Old Europe". In the new market economies of Central and Eastern Europe, we find high levels as well as an acceleration of TFP growth in the second half of the sample. Regression evidence from Western Europe suggests that product market regulation may adversely affect TFP growth and may thus adversely affect convergence.

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JEL: D24, O47

1. Introduction: Eastern Europe and the New Europe

The integration of Europe after the collapse of the iron curtain two decades ago has proceeded relatively rapidly, despite pessimistic expectations delivered by standard growth theory (Barro and Sala-i-Martin 1990, 1995). Yet this convergence of GDP per capita has often not been rapid enough for some critics and has often stoked the fires of nostalgia for the good old days of central planning. Assessing the progress of the Great European Integration episode will be a long-term project, and is not really done justice by a single indicator such as GDP per capita, even if economists are convinced that it is the correct one. Evidently, European integration involves many dimensions, some of which are only vaguely related to economic indicators.

In this paper, we assess the progress made in the short period since 1990 in the new market economies of Europe along the dimension of technological progress and technical efficiency – the rate of growth of total factor productivity (TFP). Since TFP growth is the source of all sustainable growth in standards of living, it seems imperative to get good measurements of TFP growth and try to understand what drives them. This paper construct three different measures of productivity growth in a set of EU economies – the standard Solow residual plus two which we have proposed elsewhere (Burda and Severgnini 2008) as a solution to a severe measurement problem arising in transition economies. In doing so, we will assess the determinants of TFP growth in the established economies, especially as relates to old, new and Eastern European countries.

This task appears all the more important, now that it is clear that EU membership increasingly represents a Janus-faced economic challenge for the newcomers. On the one hand, trade integration has proceeded briskly among EU members since the completion of the internal market in the late 1980s and has accelerated since the accession of the "new EU-12" (Slovakia, Slovenia, Czech Republic, Estonia, Lithuania, Latvia, Poland, Cyprus, Malta, Hungary, Romania and Bulgaria). To see the impact of this trade integration consider that in 1995 German exports represented 22% of GDP; by 2007 they had risen to over 45% of GDP.

The other face of Janus is the heavy hand of the EU's common external tariff and product and labor market regulations. In particular, the *acquis communautaires* have added to the regulatory burden of enterprises and possibly made convergence of the poorer nations more difficult. While the return to Europe contains many promises of economic order and stability, it also contains the prospect of adopting regulations which may, in the medium term, end up preventing rapid convergence to the high standards of living already enjoyed by Old Europe.

2. Central and Eastern Europe's integration shock and subsequent recovery

The fall of the iron curtain two decades ago was difficult to think about using standard models and paradigms. Siebert (1992) called it an "integration shock." Economists find it convenient to speak of dimensions of integration. Following Eichengreen (1990), one can define economic integration as simply the achievement of the efficient level of production and allocation of production factors made possible by the union of two or more regions, it is impossible to identify a number of mechanisms:

1) **Simple convergence**, driven by internal capital accumulation, to common levels of GDP per capita given by common underlying fundamentals, as predicted by standard growth theory (e.g. Solow's (1956) model);

2) **Migration** of labor from labor-rich and capital-poor regions to labor-poor, capital rich ones;

3) **Capital mobility**, meaning the transfer of physical capital from abroad or from rich regions to poor ones;

4) **Factor proportions (Heckscher-Ohlin) trade**, assuming that factor allocations of the regions lie in the zone of non-specialization;

5) **Acquisition of technological expertise and experience** by backward regions from wealthier regions;

6) **Efficiency gains** of already available capital equipment, education, labor force and technological know-how **through better institutions, rule of law, credible property rights, etc.**

All of these mechanisms have been important in generating the impressive increases in living standards observed in the new market economies of Europe since 1990. While it is difficult to sort out these different sources of growth, we will focus in this paper on the last two: improvements in multifactor productivity or efficiency, given redeployment of capital and labor induced either by factor mobility or redeployment of resources in the course of structural change. As Hall and Jones (1999) emphasize, the last two are decisive determinants of backwardness. In a telling comparison, they estimated that while per capita productivity in the US at the end of the last century was roughly 35 times that of Niger, giving the inhabitants of the latter the physical and human capital endowments of the former would reduce raise per capita productivity to only about an eighth of US levels.

Table 1 presents the raw GDP growth rates in the period 1994-2003 for the EU-27 less Cyprus, Luxemburg, and Malta, but adding Norway, Switzerland, Albania, Croatia and Russia. Somewhat provocatively, we have divided up these nations into three groups: *Old Europe*, consisting of the larger continental economies which have been less prone to reform over the period; *New Europe,* comprised of the UK plus smaller, reform-friendlier countries and *Eastern Europe* meaning in fact the new market economies of central and eastern Europe – not only the new EU members but also Albania, Croatia, and Russia. Annual growth in New Europe exceeded that in Old Europe by almost 1.5 percentage points over the entire sample, but narrowed in the second half to 1.1%. In Eastern

Europe, in contrast, real growth matched that of New Europe but *accelerated* over the two periods by 1.9% to reach 4.6% per annum over the period 1998-2003.

This divergence of outcomes is not only interesting, it also corresponds to view that Central and Eastern Europe have recovered from the initial integration shock of the first half of the 1990s. To what extent have these countries moved closer to the frontier, defined by the leading technological nations of the industrialized world? To what extent has structural change, while painful in the first instance, released factors of production to more efficient uses which show up later in the productivity statistics? To answer this question we will need to take a closer look at total factor productivity in our sample.

TABLE 1. GDP GROWTH RATES 1994-2003

	1994-2003	*1994-1998*	*1998-2003*
Old Europe	**2.15**	**2.33**	**1.98**
Austria	2.22	2.48	2.03
Belgium	2.21	2.37	2.14
France	2.19	2.17	2.23
Germany	1.55	1.86	1.31
Italy	1.65	1.79	1.44
Portugal	2.68	3.49	1.75
Spain	3.43	3.13	3.61
Switzerland	1.25	1.32	1.33
New Europe	***3.59***	***4.09***	***3.11***
Denmark	2.43	3.30	1.62
Finland	3.56	4.36	2.89
Greece	3.44	2.65	4.28
Ireland	7.72	8.39	6.61
Netherlands	2.55	3.37	1.73
Norway	3.20	4.43	2.14
Sweden	2.83	2.98	2.84
United Kingdom	2.97	3.22	2.78
Eastern Europe	**3.57**	**2.75**	**4.64**
Albania	5.93	5.48	6.26
Bulgaria	1.36	-1.42	4.38
Croatia	4.40	5.43	3.43
Czech Republic	2.32	2.08	2.81
Estonia	4.95	4.39	5.85
Hungary	3.61	2.98	4.38
Latvia	4.97	3.50	6.75
Lithuania	3.62	2.27	5.27
Poland	4.44	5.92	3.33
Romania	2.00	0.71	4.09
Russia	0.70	-5.08	6.55
Slovak Republic	4.24	5.26	3.57
Slovenia	3.89	4.19	3.71

Source: Penn World Table 6.2

3. Problems in estimating TFP in the New Europe and Two Proposed Solutions

The gold standard of multifactor productivity growth measurement is the Solow-residual (Solow 1957). This measurement was conceived by Solow to deal with the case of two production factors, but was later extended by Denison (1963) and Griliches and Jorgenson (1967) to deal with any arbitrary number of production factors. Let Y_t, K_t, and N_t be real GDP, capital input and labor input measured in period t. Then the Solow residual measure is given by

(1) $$\Delta A_{SOLOW,t} / A_{SOLOW,t-1} = \Delta Y_t / Y_{t-1} - \omega_{t-1} \Delta K_t / K_{t-1} - (1-\omega_{t-1}) \Delta N_t / N_{t-1}$$

where ω_t is defined as an estimate of the elasticity of output with respect to capital in period t-1 and is generally estimated as a "Thörnquist index" $\omega_t = (s_{Kt} + s_{Kt-1})/2$, where s_{Kt} is the capital share in income share accruing in period t.

Solow derived equation (1) as a first order approximation to any continuous, constant returns aggregate production function under the assumption of competitive factor and output markets. While the "dual" measure of TFP growth (Jorgenson and Griliches 1967, Hall (1988), Roeger (1995), Barro (1998)) later gained popularity because it was robust to product market imperfections, it suffers from the lack of good data on all relevant factor prices. An important weakness of both primal and dual TFP growth measures is that they require clean estimate of the capital stocks time series. Capital stocks are measured the greatest degree of error of all factors of production, simply because they are not observed; rather they reflect the implications of a particular theoretical model for a series of observable measurements on gross increments to the capital stock (gross fixed domestic capital formation, or investment). In particular, they represent the solution of the "Goldsmith difference equation" or perpetual inventory relation

(2) $$K_{t+1} = (1-\delta_t)K_t + I_t$$

or, given an initial condition K_0,

(3) $$K_{t+1} = \prod_{i=0}^{t}(1-\delta_{t-i})K_0 + \sum_{j=0}^{t}\left[\prod_{i=0}^{j}(1-\delta_{t-i})\right]I_{t-j}$$

While measurements of investment are generally above reproach, the depreciation rate may be time varying and may even depend on the state of the business cycle. Most important in the current application, K_0 is not observed, and in fact is measured with massive error. Gollop and Jorgenson (1980) proposed taking the initial observation of investment as a measure of the initial capital stock; the US Bureau of Economic Activity (BEA), multiplies the initial observation of investment by a factor which is a function of an assumed trend growth rate and the capital depreciation rate.

The importance of initial conditions will disappear in the limit for capital stocks constructed from longer time series for investment. Yet for the new market economies of Central and Eastern Europe, measurement errors are likely to be severe. To underscore this point, we briefly review evidence presented elsewhere (Burda and Severgnini (2008)). In that paper we set up, calibrated and simulated a stochastic growth model driven by a single trend-stationary stochastic process for total factor productivity. This model was vintage RBC (e.g. King and Rebelo 1999), with two variations: first with constant depreciation and second, with depreciation modeled as a convex function of capacity utilitzation as in Wen (2000).

On the basis of 200 time series realizations of this trend-stationary process, each containing 1000 observations, we then simulated the stochastic general equilibrium model, creating 200 data sets, each containing a time series of 1000 observations of output, labor, investment, capital, consumption and the level of total factor productivity.

For each data set, we then constructed Solow residual measurements *excluding* the true capital stock, using instead estimates of an initial condition K_0 (à la Gollop-Jorgenson, Griliches and Jorgenson (1980), Caselli (2005), BEA). These data thus resemble those available to researchers who do not know the true capital stock, but are estimated from investment data and assumptions on the initial condition.

Since the model and the true evolution of TFP in this data set are known, it is possible to evaluate the "goodness" of the Solow-residual measure. Table 2 presents root mean squared error statistics of the Solow measure applied to our 100-realization experiment for two models (variable depreciation and constant depreciation) as well as for two different "true" starting values of the capital stock. The first, corresponding to a "mature" economy, is implied by a capital-output ratio close to the steady state value. A second, "transition" economy type is characterized by a true initial condition which lies 50% from the steady state value. For all cases, the Solow residual root mean squared error is in excess of 1.5% (on an annualized basis) and ranges as high as 2.7%. For both endogenous and exogenous depreciation cases, the RMSE rises as the sample size declines. For the 50 quarter sample, the RMSE computed using the Gollop and Jorgenson (1980) or Griliches (1980) measures is a whopping 4¾%.

Figure 1 provides graphical illustration of the same point. We display the evolution of the capital stock in the stochastic growth model for initial conditions which are far removed from the steady state. As is well known from the growth model, convergence takes a long time. The results is that a wrong estimate of the capital stock will take a while to become irrelevant in the Solow calculation – an issue that will be especially acute for assessing progress in Central and Eastern Europe.

TABLE 2. ROOT MEAN SQUARED ERRORS OF THE SOLOW RESIDUAL MEASURE FOR SIMULATED MATURE AND TRANSITION ECONOMIES, ENDOGENOUS AND CONSTANT DEPRECIATION CASES

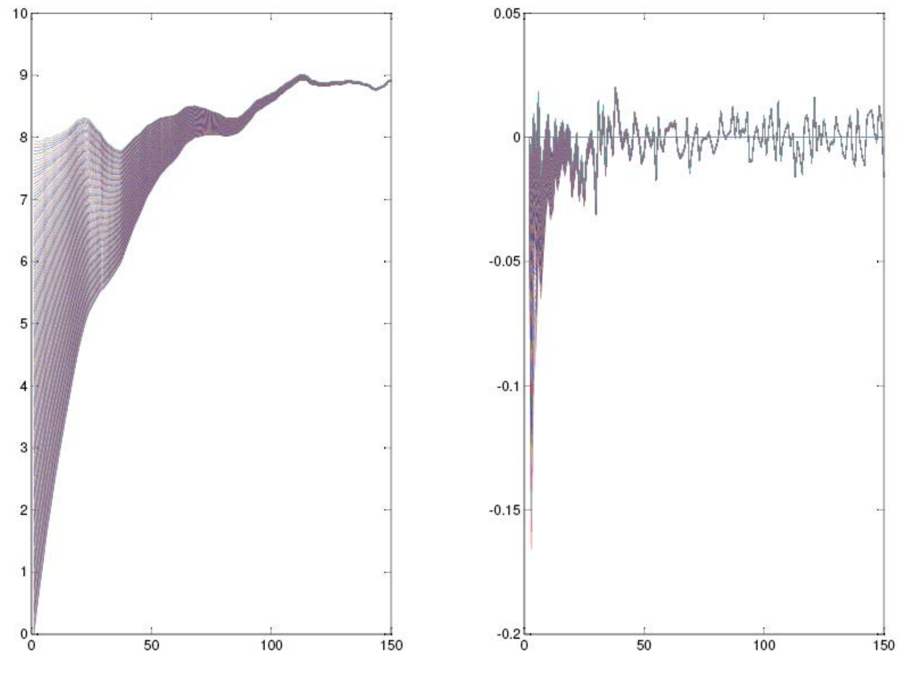
Mature Economy(100 realizations, standard errors in parentheses)

Method	Endogenous Depreciation		Constant Depreciation	
	Av. RMSE (%) T=50	Av. RMSE (%) T=200	Av. RMSE (%) T=50	Av. RMSE (%) T=200
Traditional Solow Residual				
-Gollop and Jorgenson (1980)	3.86 (0.16)	2.58 (0.10)	4.65 (0.12)	2.54 (0.08)
-Griliches (1980)	3.90 (0.09)	2.60 (0.07)	4.69 (0.59)	2.56 (0.40)
-Caselli (2005)	1.88 (0.17)	1.90 (0.14)	1.65 (0.79)	1.66 (0.13)
-BEA	2.73 (0.10)	2.04 (0.08)	3.20 (0.83)	1.88 (0.50)

Transition Economy (100 realizations, standard errors in parentheses)

Method	Endogenous Depreciation		Constant Depreciation	
	Av. RMSE (%) T=50	Av. RMSE (%) T=200	Av. RMSE (%) T=50	Av. RMSE (%) T=200
Traditional Solow Residual				
-Gollop and Jorgenson (1980)	4.73 (0.20)	2.71 (0.10)	4.61 (0.15)	2.52 (0.07)
-Griliches (1980)	4.79 (0.10)	2.73 (0.38)	4.65 (0.81)	2.54 (0.50)
-Caselli (2005)	1.87 (0.18)	1.90 (0.14)	1.63 (0.16)	1.66 (0.13)
-BEA	3.33 (0.11)	2.11 (0.08)	3.16 (0.09)	1.87 (0.06)

FIGURE 1: THE ROLE OF INITIAL CAPITAL STOCKS FOR SOLOW RESIDUAL TFP ESTIMATES IN THE STOCHASTIC GROWTH MODEL



a) Capital stocks b) Solow Residuals

Source: Burda and Severgnini (2008)

Burda and Severgnini (2008) propose two alternatives to the Solow residual measure of TFP growth. The first, which we call the direct substitution measure (DS), is based on the same neoclassical production and market assumptions made by Solow (1957). Rewrite (2) and substitute in (1) to obtain

(4) $$\Delta A_{t,DS} / A_{t-1,DS} = \Delta Y_t / Y_{t-1} - \kappa_{t-1}\left(I_{t-1} / Y_{t-1}\right) + \omega_{t-1}\delta_{t-1} - \left(1-\omega_{t-1}\right)\Delta N_t / N_{t-1}$$

where κ_t is the rental rate of capital in time t. In effect, the DS approach eliminates the capital stock by reducing its presence to its (possibly time-varying) depreciation element.

The second alternative measurement of TFP growth, the GD approach, applies a generalized difference to data from an economy which is relatively close to its steady state, in which it grows at constant rate g. Denote the log deviation of variable X_t from it steady state as $\hat{X}_t$, and write the production function and state equation for the capital stock as log-linearized relationships governing deviations from steady states values:

(5) $$\hat{Y}_t = \hat{A}_{DS,t} + \omega\hat{K}_t - \left(1-\omega\right)\hat{N}_t$$

(6) $$\hat{K}_{t+1} = \frac{1-\delta}{1+g}\hat{K}_t + \iota\hat{I}_t$$

Under constant depreciation and using the lag operator *L*, equation (2) can be inverted to express investment as a generalized difference operator applied to the capital stock: $I_t = \left(1-(1-\delta)L\right)K_t$. Now apply the operator $\left(1-(1-\delta)L\right)$ to both sides of (1) and rewrite

(7) $$\left(1-\frac{1-\delta}{1+g}L\right)\hat{A}_{GD,t} = \left(1-\frac{1-\delta}{1+g}L\right)\hat{Y}_t - \iota\omega\hat{I}_t - \left(1-\omega\right)\left(1-\frac{1-\delta}{1+g}L\right)\hat{N}_t$$

where $\iota = \frac{\overline{I/K}}{1+g} = \frac{\overline{I/Y}}{\left(\overline{K/Y}\right)\left(1+g\right)}$ and g is the steady-state growth rate of the economy. Equation (7) can be integrated from an initial condition of growth in period 0; Burda and Severgnini (2008) employ a simplified version of the Malmquist index to estimate that initial condition.

We then applied the DS and GD measures of total factor productivity growth to the same data set used above to assess the RMSE of the Solow-Thörnqvist TFP growth indicator. To summarize: On 100 independent realizations (samples) of 200 quarters of data generated by the endogenous depreciation model, the RMSE was improved significantly in all cases by the DS measure and in almost all cases by the GD method. In the shorter sample and for the transition economy the improvement was sometimes dramatic; for example, the RMSE of the Solow residual constructed using Gollop-Jorgenson or Griliches estimates of the initial capital condition were sometimes almost three times that of the DS approach, which was roughly 1.5%. Furthermore, this reduction of RMSE is statistically significant, since we are drawing 100 realizations from the same data-generating process.[1]

Figure 2 shows the relevance of this point for the application at hand – new market economies with difficult-to-value capital stocks. While the Gollop-Jorgenson approach – setting the initial capital stock to investment in that period –will converge in accuracy to the DS method, it will only do so on average only after 400 quarters or 100 years of data.

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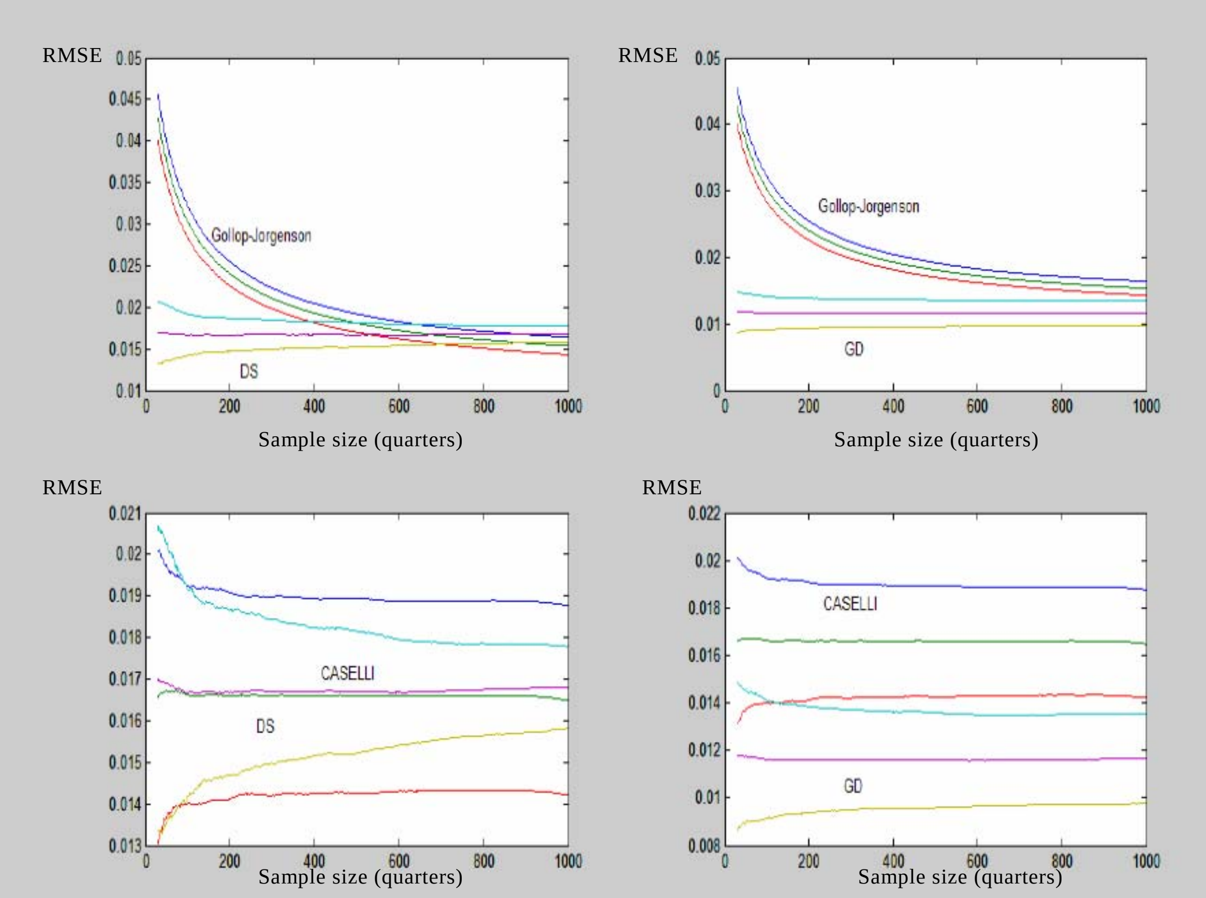
[1] Detailed results are tabulated in Burda and Severgnini (2008).

FIGURE 2: ROOT MEAN SQUARED ERROR (RMSE) FOR SOLOW RESIDUAL COMPARED WITH ALTERNATIVE TFP ESTIMATES AS A FUNCTION OF SAMPLE SIZE, DATA FROM THE STOCHASTIC GROWTH MODEL (VARIABLE DEPRECIATION)



Source: Burda and Severgnini (2008)

4. Evaluating TFP growth in New and Old Europe and Growth Accounting

We now return to the real world and apply all three measurements – Solow-Thörnqvist, DS and GD – to construct TFP growth estimates using data from the Penn World Tables for the 29 nations listed in Table 1. These estimates can be found in Table 3. First, regardless of which measure is employed, all confirm the suspicion that the anemic rate of growth in Old Europe compared with New Europe reflects a low rate of total factor productivity growth. This conclusion is supported by both the traditional Solow measure as the two alternatives. Furthermore, all measures point to a *slowdown* in Old Europe since 1998. Although the measure here does not account explicitly for investment in internet and communications technology (ICT) goods, it is well-known that this is a distinguishing feature between the United States and Europe (van Ark et al 2008). It is all the more striking that TFP growth has also declined in the economies of New Europe, on all three measures, even in Scandinavian countries and the Netherlands, which have been touted as heavy users and investors in ICT. In sharp contrast to the Western European experience, TFP growth in all countries and on all measures in Central and Eastern Europe has increased over the two sub-samples, by 0.6% per annum for the GD approach to 1.7% per annum on the basis of the Solow-Thörnqvist measure.

TABLE 3: TFP ESTIMATES: SOLOW-THÖRNQUIST (ST), DIRECT SUBSTITUTION (DS) AND GENERALIZED DIFFERENCES (DS), GROWTH RATES % PER ANNUM

	% Average 1994-2003			*% Average 1994-1998*			*% Average 1998-2003*		
	ST	DS	GD	ST	DS	GD	ST	DS	GD
Old Europe	***0.1***	***0.2***	***0.7***	***0.1***	***0.6***	***0 9***	***0.1***	***-0.2***	***0.6***
Austria	0.8	0.8	1.1	0.8	1.2	1.3	0.7	0.3	0.8
Belgium	0.2	0.5	0.8	0.1	0.8	0.9	0.3	0.2	0.6
France	0.0	0.4	0.7	0.1	0.8	0.8	0.0	0.1	0.5
Germany	0.4	0.5	0.8	0.2	0.7	0.9	0.6	0.3	0.7
Greece	0.7	1.1	1.1	-0.4	0.4	0.7	1.7	1.8	1.5
Italy	-0.3	-0.1	0.5	0.2	0.8	0.9	-0.8	-0.9	0.1
Portugal	0.3	0.3	0.9	0.8	1.4	1.4	-0.2	-0.8	0.5
Spain	-1.0	-1.0	0.3	-0.7	-0.3	0.5	-1.3	-1.7	0.0
Switzerland	-0.4	-0.5	0.4	-0.4	-0.1	0.6	-0.4	-0.9	0.2
New Europe	***0.8***	***1.3***	***1.1***	***0.9***	***1.9***	***1.3***	***0.6***	***0.7***	***0.9***
Denmark	0.3	0.9	0.9	0.3	1.6	1.2	0.2	0.3	0.7
Finland	1.2	1.4	1.2	1.9	2.3	1.6	0.6	0.5	0.8
Ireland	2.1	2.9	2.1	1.9	3.2	2.1	2.4	2.7	2.0
Netherlands	-0.6	-0.4	0.4	-0.3	0.4	0.8	-1.0	-1.2	0.0
Norway	0.6	1.3	1.1	0.5	1.7	1.3	0.8	0.9	0.9
Sweden	1.1	1.6	1.1	1.5	2.4	1.5	0.6	0.8	0.8
United Kingdom	0.6	1.4	1.0	0.4	1.7	1.1	0.7	1.1	0.9
Eastern Europe	***2.8***	***3.0***	***2.1***	***2.0***	***2.6***	***1.8***	***3.7***	***3.5***	***2.4***
Albania	4.9	6.5	3.9	3.0	5.6	3.2	6.8	7.4	4.5
Bulgaria	0.5	1.1	0.7	-1.8	-1.2	-0.6	2.8	3.4	2.0
Croatia	3.2	3.5	2.4	4.4	5.2	3.1	2.0	1.8	1.6
Czech Republic	1.0	0.5	1.2	0.0	0.1	1.0	2.0	1.0	1.5
Estonia	5.2	4.8	3.2	5.5	5.3	3.3	4.9	4.2	3.0
Hungary	1.7	2.0	1.6	1.6	2.4	1.7	1.8	1.7	1.6
Latvia	5.3	5.6	3.3	5.9	6.5	3.5	4.7	4.6	3.1
Lithuania	4.3	4.5	2.7	2.2	2.7	1.7	6.3	6.3	3.7
Poland	3.3	4.1	2.6	3.0	4.6	2.7	3.6	3.7	2.5
Romania	2.2	2.7	1.8	1.1	2.2	1.5	3.3	3.3	2.1
Russia	1.4	0.4	0.6	-3.2	-4.6	-1.7	6.0	5.3	2.9
Slovak Republic	2.9	2.1	2.1	3.1	2.8	2.4	2.6	1.4	1.7
Slovenia	1.1	1.7	1.5	0.7	2.0	1.5	1.4	1.4	1.5
ST: Solow Thörnqvist. DS: Direct Substitution. GD: Generalized Difference									

Source: Penn World Tables 6.2, authors' calculations

It is natural to expect a significant degree of heterogeneity among the Central and Eastern European estimates, and indeed for Croatia, Estonia, Hungary, Latvia, and Poland, the individual estimates point rather unequivocally to slowdown just as in the West. A further breakdown of the second sub-period 1998-2003 can be found in Table 4, which presents conventional and less conventional growth accounting breakdowns of observed growth into components due to observable and unobservable determinants.

TABLE 4: GROWTH ACCOUNTING USING THE THREE METHODS FOR THE PERIOD 1998-2003

	$\frac{\Delta Y_t}{Y_{t-1}}$	$\Delta \frac{\Delta N_t}{N_{t-1}}$	ST	$\frac{\Delta K_t^{ST}}{K_t^{ST}}$	DS	$\frac{\Delta K_t^{DS}}{K_{t-1}^{DS}}$	GD	$\frac{\Delta K_t^{GD}}{K_{t-1}^{GD}}$
Old Europe	***2.22***	***1.09***	***0.07***	***0.92***	***1.06***	***-0.18***	***0.56***	***0.57***
Austria	1.95	0.32	0.71	0.92	0.33	1.30	0.81	0.82
Belgium	2.05	0.76	0.33	0.96	0.17	1.12	0.64	0.65
France	2.21	1.18	-0.01	1.04	0.07	0.96	0.51	0.52
Germany	1.25	-0.21	0.62	0.84	0.31	1.15	0.73	0.73
Greece	4.22	1.11	1.69	1.42	1.75	1.36	1.54	1.57
Italy	1.52	1.33	-0.79	0.98	-0.92	1.11	0.09	0.10
Portugal	1.87	0.91	-0.24	1.20	-0.84	1.80	0.47	0.49
Spain	3.73	3.70	-1.26	1.29	-1.66	1.69	0.01	0.02
Switzerland	1.18	0.71	-0.39	0.86	-0.86	1.33	0.24	0.23
New Europe	***2.93***	***1.18***	***0.60***	***1.15***	***0.71***	***1.04***	***0.86***	***0.89***
Denmark	1.57	0.25	0.16	1.16	0.27	1.05	0.66	0.66
Finland	2.76	1.19	0.60	0.97	0.51	1.06	0.77	0.80
Ireland	7.06	2.93	2.36	1.77	2.66	1.47	2.01	2.12
Netherlands	1.74	1.75	-1.03	1.02	-1.23	1.22	-0.01	0.00
Norway	1.96	0.15	0.79	1.02	0.85	0.96	0.90	0.91
Sweden	2.68	1.10	0.59	0.99	0.83	0.75	0.78	0.80
United Kingdom	2.72	0.86	0.72	1.14	1.11	0.75	0.92	0.94
Eastern Europe	***4.40***	***-0.52***	***3.71***	***1.21***	***3.50***	***1.43***	***2.44***	***2.48***
Albania	6.37	-2.70	6.75	2.32	7.44	1.63	4.52	4.55
Bulgaria	4.15	0.11	2.82	1.22	3.41	0.63	2.01	2.03
Croatia	3.37	0.12	1.98	1.27	1.83	1.42	1.61	1.64
Czech Republic	2.55	-0.43	1.98	1.00	0.95	2.03	1.48	1.50
Estonia	5.52	-0.57	4.93	1.16	4.24	1.85	3.00	3.09
Hungary	4.24	1.09	1.78	1.37	1.69	1.46	1.56	1.59
Latvia	6.45	0.17	4.69	1.59	4.63	1.65	3.09	3.19
Lithuania	4.98	-2.42	6.32	1.08	6.26	1.14	3.71	3.69
Poland	2.96	-2.03	3.62	1.37	3.65	1.34	2.49	2.50
Romania	3.29	-0.99	3.32	0.96	3.30	0.98	2.13	2.15
Russia	6.49	0.49	6.02	-0.02	5.29	0.71	2.94	3.06
Slovak Republic	3.21	-0.23	2.63	0.81	1.36	2.08	1.71	1.73
Slovenia	3.59	0.57	1.43	1.59	1.41	1.61	1.49	1.53

ST: Solow Thörnqvist. DS: Direct Substitution. GD: Generalized Difference

Note: Contributions do not add exactly to total GDP growth due to rounding error.
Source: Penn World Tables 6.2, authors' calculations

It is tempting to speculate on these differences. For one, the slowdown coincides with a cyclical downturn for the later years of the 1998-2003 period. Yet a number of countries with strong cyclical upturns experienced weak or falling TFP growth: most of New Europe and some of the Old Europe success stories such as Spain can be placed in this category of employment-intensive growth, while Italy and France may be following suit. In contrast, the CEE countries have continued to see employment declines in the most recent period, despite high real GDP growth. The success of economic reforms in these countries designed to bring low productivity workers back into the labor market is a natural interpretation of Tables 3 and 4.

Another interpretation of the results might be simply sustained efficiency gains for the later movers (e.g., Albania, Bulgaria, Romania, Russia). In these countries, significant gains from reorganization of production continue to be realized. A number of well-founded theoretical models would predict important roles for such investment made early in the transition later on (Roland and Verdier (1999), Blanchard and Kremer (1997)). It may well be the case that TFP growth is overestimated due to lack of more complete data on investment in intangibles such as organizational capital (see Corrado et al 2005).

In any case, the gain from using the DS and GD methods is due to a more accurate estimation of the amplitude of the fluctuations of TFP growth. These series tended to be smoother than the original Solow residual measure, a result which is supported by the lower RMSE and mean average error results in the Monte Carlo results reported by Burda and Severgnini (2008). This would suggest that despite the growth slowdown experienced in the second half of the sample, the DS and GD point to robust overall TFG growth, strengthening one of the major claims of this paper: in central and eastern Europe total factor productivity is a major contributor to economic growth.

5. Explaining TFP growth in Europe: Some Preliminary Results

One of the leading explanations of sluggish growth in Europe – in particular Old Europe – is the predominance of labor and product market inflexibilities that have been amply documented by, among others, the OECD and the IMF. In particular, one leading view is that the adoption of key general purpose technologies associated with the ICT revolution has been slowed or impeded by excessive regulations of the employment relationship or the freedom to do business (van Ark, et al. 2008, Jorgenson, et al. 2008). While our data do not permit a direct investigation of this hypothesis, we are able to look for econometric evidence of correlation between established product and labor market summary indicators promulgated by the OECD (Nicoletti, Scarpetta and Boylaud 2000, Bassanini and Duvall 2006). We will present some evidence for econometric models of the form:

$$(8) \qquad \begin{aligned}(\Delta A/A)_{j,t} &= \alpha_0 + \alpha(L)(\Delta A/A)_{j,t-1} + \beta(L)\Delta \ln X_{j,t-1} \\ &\quad + \gamma_1 \ln A_{j,t-1} + \gamma_2 \ln A_{j,t-1} + \gamma_3 \ln X_{j,t-1} + u_t\end{aligned}$$

Where, as before, $\Delta A/A$ denotes an estimate of TFP growth for $j \in \{ST, DS, GD\}$, A is the associated level estimate, X denotes indicators of labor and product market regulation: EPL (employment protection legislation) and PMR (product market regulation), and u_t denotes a disturbance term which satisfies the usual minimum conditions for a regression. The coefficients on the levels in this error correction equation could be interpreted as a cointegrating vector, and under ideal conditions with longer data series, we would test the underlying series for integration of the variables and their possible cointegration. Since most of the series are rather short, we choose not to implement this approach. The results are presented in Table 5.

If interpreted as an error correction, the levels of TFP and regulatory indicators should have point estimates with the same signs, signifying that in the long run, the intensity of product and labor market regulations as well as their interaction should negatively affect the evolution of total factor productivity. Similar results have been obtained for pure difference specifications and in general for the other TFP measures and are not reported here. Product market regulation almost always enters significantly and with the correct sign in levels and differences, while employment protection is less frequently significant and of opposite sign in the change, consistent with the ambiguous theoretical predictions in the literature (Ljungqvist (2002)). Similarly, the sample detects a negative impact effect of product market regulation changes on employment growth, while changes in EPL show no significant effect. Interaction effects between PMR and EPL or as a triple-interaction with the level of TFP are not estimated to be significant.

TABLE 5. REGRESSION RESULTS FOR ONE ESTIMATE OF TFP GROWTH
Dependent Variable: $(\Delta A/A)_{jt-1}$

Explanatory Variables			
A_{jt-1}	0.2859 (1.22)	0.2902 (1.23)	0.6486 (1.73)
Lagged PMR	3.6543 (4.64)	2.0440 (1.69)	1.868 (1.48)
Lagged EPL	1.243 (1.53)	4.152 (1.88)	4.674 (2.02)
Lagged PMR*EPL		0.7908 (1.58)	-7.146 (-1.29)
Lagged PMR*EPL*A_{jt}			0.0797 (1.42)
Lagged ΔPMR	-10.38 (-4.13)	-11.09 (-4.36)	-10.99 (-4.29)
Lagged ΔEPL	.5057 (0.12)	.5740 (0.14)	.3602 (0.09)
$(\Delta A/A)_{jt-1}$	-.2701 (-1.23)	-.3260 (-1.28)	-.2032 (-0.87)
Constant	-14.68 (-0.59)	-20.60 (-0.78)	-57.82 (-1.40)
Obs.	160	160	160
R^2	0.1601	0.1678	0.1742

Note: t-statistics in parentheses based on robust standard errors, clustered on countries (13)

6. Conclusions

The mending of the great economic, political, and social divide between East and West Europe is a project that will go on for decades. Its ultimate success will depend on the economic integration between the two regions, and in particular on policy choices made in the new market economies, a choice between market dynamism of New Europe and that of Old Europe. Part of this policy choice will involve the promotion of factor mobility and trade, and will rely on the positive force of the European Union. Other aspects will tend to involve moving factors to their best uses and the more efficient use of given factors. Here it is not always clear that the EU has acted to promote more efficiency.

Whether interpreted either as technological improvement or increased factor efficiency, as the acquisition and implementation of new technologies or simply a move to the efficient frontier, sustained total factor productivity growth is a key to long-run economic development. In the context of the new market economies, it is imperative to understand the evolution of multifactor productivity growth and to anticipate its evolution. Using measures better adapted to deal with severe measurement error present in the transition economies, we presented evidence that the new economies of Central and Eastern Europe have achieved high and increasing rates of TFP growth. Mismeasurement error which is inevitably present in capital stock data is likely to cause underestimation of the true underlying gains in multifactor productivity. Finally, we present some preliminary evidence that moving to the frontier may be inhibited by product market regulations, while the evidence employment protection is ambiguous (as is the case theoretically). Arguably, dynamic output markets are keys to adaptation to new challenges of technology and globalization. It remains to be seen which of the post-transition countries will pursue strategies congruent with staying on the cutting edge.

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