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The Penn Effect and Transition: The New EU Member States in International Perspective

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Abstract

Recent panel studies have found relatively high point estimates for the elasticity of aggregate price measures with respect to productivity in (former) transition economies, while other studies report price-productivity elasticity estimates to depend positively on average productivity in the sample. We aim to reconcile both results by putting comparative price developments of transition economies in an international perspective. We argue that estimating simple price-productivity relationships without the inclusion of other real factors connected to reform effort might severely bias estimates for CEEC economies. Our results imply that, when controlling for reform effort and therefore avoiding this endogeneity problem, the price-productivity-elasticity for CEEC economies was not different from that of non-transition economies during the first 15 years of transition.

JEL-Classification: F40, F43

Keywords: Balassa-Samuelson, transition

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1 Introduction and motivation

Aggregate price levels expressed in a common currency at going nominal exchange rates are generally higher in richer than in poorer economies, an observation dubbed "Penn effect" in Samuelson (1994). Recent panel data studies (e.g., Dobrinsky, 2003; de Broeck and Sløk, 2006) have found comparatively high point estimates for corresponding price-productivity elasticities for (former) transition economies in Central and Eastern Europe (CEEC), which seems to contrast with findings from cross-section regression analyses, where the inclusion of poorer countries tends to generate lower elasticities (Maeso-Fernandez et al., 2005).

Whether or not a "special" status for (former) transition economies exists in the Penn effect appears important for two reasons. First, it might lead to inflation in these countries, which the ECB, among others, could be concerned about. Second, it might lead to losses in competitiveness, which policy makers in these countries should be concerned about.

The idea of this paper is to put the price-productivity behaviour of (former) transition economies into an international perspective. For this purpose, we first review the literature on the Penn effect, that seems to reveal a special status for (former) transition economies. In Section 3, we demonstrate that within the time-series dimension, estimated price-productivity elasticities for transition economies are indeed higher than for OECD countries. In the following, however, we argue that (i) the Penn-effect is by nature cross-section rather than time-series, and (ii) that estimations of price-productivity elasticities without the inclusion of other real factors might suffer from omitted variable bias and omitted variable inconsisteny. As a solution, we propose an extended approach in order to take account of reform effort as the driving force behind deregulation, reallocation, and restructuring during transition. Results of estimating the extended approach with panel data and fixed period-effects suggest that the price-productivity-elasticity for (former) transition economies is not different from that of OECD economies.

2 The Penn effect for (former) transition economies

Purchasing power parity (PPP) is linked to the tradability of goods and services. If all goods are tradable at no cost and enter each country's basket used to construct the aggregate price level with the same weight, arbitrage ensures that aggregate price levels, P_1 and P_2, are identical for each pair of countries when expressed in a common currency at the going nominal exchange rate. More generally, the deviation of the nominal exchange rate e_{12} from purchasing power is just the real exchange rate between countries 2 and 1, RER_{21},

$$RER_{21} = \frac{e_{12}}{P_1 / P_2} = \frac{P_2 / P_1}{e_{21}}, \tag{1}$$

equivalently defined as the deviation of the ratio of two countries' aggregate price levels from their nominal exchange rate. Absolute purchasing power parity, of course, is equivalent to $RER_{21} = 1$.

In fact, what we observe are systematic deviations from PPP: aggregate price levels expressed in a common currency at going nominal exchange rates are generally higher in richer than in poorer economies, an observation dubbed the "Penn effect" in Samuelson (1994).

By far the most prominent explanation for the Penn effect is the Balassa-Samuelson (BS) hypothesis (Balassa, 1964; Samuelson, 1964). Balassa and Samuelson rationalise the effect in a chain of arguments building on (a) purchasing power for tradables, (b) relative prices reflecting relative labour productivities, (c) homogenous national labour markets across sectors of production, and (d) overwhelming differences in (labour) productivity across countries to be found in tradable rather than in non-tradable production. Leaving (d) aside defines the productivity gap version of the BS hypothesis: the real exchange rate between each pair of countries 2 and 1 is the higher the higher country 2's ratio between its tradables and non-tradables sector productivities compared to country 1:

$$RER_{21} = \frac{P_2 / P_1}{e_{21}} = \frac{(A_2^T A_1^N)^{1-\theta}}{(A_1^T A_2^N)^{1-\theta}}, \tag{2}$$

where A_j^T and A_j^N are (labour) productivity in country j's tradable and non-tradable sectors, and equal preferences across countries are described by constant and equal consumption expenditure shares for tradables and non-tradables, θ and $1-\theta$, respectively.[1]

Adding observation (d), i.e., that cross-country productivity differences are concentrated in the tradable goods sector,[2] immediately implies the Penn effect: for each pair

[1] For a simple exposition, see e.g. Frensch (2006).

[2] For evidence based on the 1996 Penn World Tables benchmark study, see Herrendorf and Valentinyi (forthcoming).

of countries, their real exchange rate is a positive function of their ratio of overall productivities, with the consumption expenditure share for non-tradables corresponding to the elasticity of the real exchange rate with respect to relative productivity (the *price-productivity elasticity*):

$$RER_{21} = \frac{P_2 / P_1}{e_{21}} = \left(\frac{y_2}{y_1} \right)^{1-\theta} \tag{3}$$

Empirical work on the Penn effect like Bergstrand (1991), Lothian and Taylor (2008) or Chong et al. (2010) typically studies relationships between countries' multilateral real exchange rate measures and productivities. The most popular measures of countries' multilateral real exchange rates are (i) effective real exchange rate indices, i.e., weighted sums of each country's bilateral nominal exchange rates deflated by consumer price indices with weights corresponding to the relative importance of partner countries in trade; or (ii) comparative prices (or exchange rate gaps in much of the literature), as provided in the Penn World Tables (PWT), defined as the deviation of a country's nominal exchange rate against the international dollar from purchasing power.

Each country's comparative price level is by construction a weighted real exchange rate against the international dollar, where the weighting scheme is based on the relative prices that underlie the derivation of the international dollar, thus providing a measure of (1) that is conceptually close and highly correlated with a trade-weighted real effective exchange rate index. However, comparative price levels have the enormous advantages of being more widely available and of being internationally comparable in level terms, which is why we use them in the rest of this paper.[3]

– Figure 1 about here –

Figure 1 displays the benchmark price-productivity relationship for a number of OECD and (former) transition economies between 1992 and 2004, with average productivity proxied by PPP-adjusted income per capita. The literature on transition countries has, with the notable exceptions of de Broeck and Sløk (2006), Frensch (2006), and García-Solanes et al. (2008) so far been mostly confined to identifying Penn or BS effects within this country group's data, without putting them into an international perspective. Early results in this vein had been used as a basis for arguing that real appre-

[3] The IMF's *International Financial Statistics* (IFS) provide trade-weighted real effective exchange rate index series for a number of countries which cannot be compared in levels across countries in an economically meaningful way. Frensch (2006) performs simple OLS regressions of yearly changes of available IFS real effective exchange rate data for the decade between 1990 and 2000 on yearly changes of PWT comparative prices. The estimated slope coefficient of 0.40 is significant at the 1 per cent level, the intercept is insignificant at the 10 per cent level (R^2 = 0.29; sample size = 864). Specifying country and/or period fixed effects does not qualitatively alter the results. Increasing the time horizon and thus eliminating nominal disturbances even strengthens the link between the two measures. Also, differentials between rates of change of the two measures are not systematically related to PPP-adjusted income per capita.

ciation in the region is to a large extent due to BS (Halpern and Wyplosz, 2001). However, Égert and Halpern (2006) in their meta-regression analysis of studies on CEEC real exchange rate behaviour fail to find a significant influence of a simple BS-driven behaviour on real exchange rate developments in the region. Recent work has supported this view on the ground that even for tradables PPP need not necessarily hold, e.g. due to a quality adjustment bias (cf. Cincibuch and Podbiera, 2006). Égert et al. (2006) stress three stylised facts of real exchange rate behaviour in transition:

1. Until around the mid-1990s transition countries' currencies were substantially undervalued in terms of PPP.
2. Different from the BS pattern of explanation of the Penn effect, all types of goods, not only non-tradable services, were or still are undervalued in terms of PPP.
3. Different in extent across countries, the region has witnessed strong appreciation from the outset of transition.

Accordingly, the possibility of a special relationship between productivity and aggregate price levels for (former) transition economies, evident from Figure 2, arises because aggregate price levels of a former centrally planned economy (CPE) may *ceteris paribus* be biased downwards: price liberalization may still be incomplete, i.e., the output of a former CPE is not yet fully priced on the market, subsidization drives a wedge between prices and costs especially for services, i.e., non-tradables. Moreover, output quality is systematically lower in a former CPE than in a market economy (Frensch, 2004; García-Solanes et al., 2008). On the other hand, a number of (former) transition countries, especially in the CIS, are oil and gas exporters where related Dutch disease phenomena might drive up comparative prices. In terms of a theoretical foundation, Clague (1985) proposes that within a specific factors model increases in the endowment of specific factors – one of which is natural resources – lead to higher comparative price levels, as do productivity increases.

– Figure 2 about here –

3 Estimation and results

3.1 The time-series dimension

One drawback of using panel data lies in the potential non-stationarity of price and productivity data. This is of specific concern with panels too short for proper panel unit root testing. De Broeck and Sløk (2006, pp. 377–8) employ Pooled Mean Group (PMG) estimations for the long-run time series dimension of the relationship between productivity and real effective exchange rates stating "in case the variables are I(1), estimation is conducted under the untested assumption that there exists a long-run relationship such that the error term in the estimated long-run equation is stationary." However, their procedure is not completely without problems: PMG estimations focussing on the time-series dimension are done with a very short panel (1991–98) and are derived only for CEEC and CIS countries and not estimated for OECD countries or any other "control group."[4]

On the choice between fixed effects and alternative estimators for potentially non-stationary data, Fidrmuc (2009) in the gravity context uses cross-sectionally augmented panel unit root testing methods and confirms that trade and income variables used in gravity regressions are integrated of order one. However, Fidrmuc (2009, p. 436) finds that, although fixed effects estimators may be biased, they are not only asymptotically normal and consistent with large panels but also perform "relatively well in comparison to panel cointegration techniques" in finite samples, concluding the potential bias of fixed-effects gravity estimators to be rather small.

Accordingly, we start by analysing the time-series dimension of the Penn effect in a panel OLS regression with country fixed effects to control for plausibly important time-invariant country-specific unobserved heterogeneity with the implication that no time-invariant influences can be estimated. Data on PPP-adjusted income per capita, y, to proxy average productivity and p are taken from the PWT, version 6.2 (see notes to Figure 1). The data cover 41 countries (i.e., 12 CEEC, 9 CIS, and 18 non-transition OECD, see Appendix table B1) over 1992–2004, resulting in a panel size of 484 observations.

– Table 1 about here –

Results reported in Column 1 of Table 1 confirm a significant benchmark Penn effect with special status for transition economies; in particular, we note an economically – though not statistically – significant positive coefficient for Central and Eastern Europe, and a negative price-productivity relationship for CIS economies. These results seem to confirm recent panel data studies (e.g., Dobrinsky, 2003; de Broeck and Sløk, 2006) that have found high point estimates for price-productivity elasticities for (former) transition economies in Central and Eastern Europe.

[4] We also experimented with PMG estimations. Probably due to the shortness of our panel, results were unstable.

However, while this feature is routinely explained by extraordinary reform efforts in these countries spurring productivity growth, the relevant literature does not directly include reform variables in its estimations. As a consequence, it is in fact unable to identify reform effects. What is more, structural reforms are likely to jointly influence p and y. So their omission entails an omitted variable problem, with y being endogenous and its estimated coefficient potentially biased and asymptotically inconsistent. More specifically, reforms in Central and Eastern European (former) transition economies can be expected to have pushed up both productivity and prices in these countries (cf. Dufrenot and Egert, 2005). Thus, the particularly high price-productivity elasticity in the transition context reported by much of the literature could be partly or even entirely due to the omission of reform variables.

In Appendix A, we exemplify a simple extension to the static BS-based approach to the Penn effect, focussing on real factors and reforms (like Coricelli and Jazbec, 2004 and García-Solanes et al., 2008). According to this extended approach, real exchange rate developments react to productivity developments, reform-driven quality improvements and sectoral reallocation, and the competition effect of trade liberalisation.[5] While trade liberalisation and competition are *per se* reform variables, all other variables are also influenced by various reform efforts, and potentially dominated by them – in particular in (former) transition economies. Rather than attempting a structural estimation, we take this extended BS approach as motivation to estimate price-productivity-elasticities controlling for reform effort.

A priori, we'd expect price liberalisation, i.e., lessening administrative price controls, to imply higher price levels, given prevailing shortages at the outset of transition.[6] In similar vein, trade and foreign exchange system liberalisation would have the same effect, while competition policy should *cet. par.* have a price decreasing effect. Small scale privatisation can be expected to be linked to positive price effects because private rather than state provision of private goods is linked to cost coverage. This mechanism should also be present for large scale privatisation. However, as Hanousek and Kocenda (2010) show, large scale privatisation often goes hand in with disinvestiments or the outright break-up of conglomerates which might lead to lower prices. Therefore, *a priori* the overall effect of large scale privatisation on prices is uncertain.

The EBRD Transition Indicators measure reform progress along several dimensions, in terms of price liberalisation, trade and foreign exchange system liberalisation, competition policy, large scale privatisation, and small scale privatisation on a scale with one-third steps between 1 and 4.33. We assume these indices to equal 4.33 for OECD economies, in line with their construction (cf. Table B2). While the EBRD transition indicators are often used as cardinal measures, they are probably ordered qualitative rather than cardinal and should not be used directly in linear regression analysis. For this reason, we construct dummy variables from these indicators in the general form of

[5] Empirically, the price reducing competition effect of trade liberalisation is not equal across sectors: less open economies tend to have higher investment to consumer goods price ratios than more open economies (see, among many others, Jones, 1994).

[6] Note that this would not contradict a potentially dampening role of price liberalisation upon inflation; for more on this, see Barlow (2010).

$ReformMeasure\_Level_{j,t}$, indicating whether or not country *j* has within a certain policy field made the step towards a certain level on the EBRD scale at some point in time. With reform progress measured in steps of one third of a point, quite a number of dummy variables are conceivable. Specifically, we construct dummy thresholds at median value for (former) transition countries to assess reform impact on comparative prices (for more on this, see Section 4 on sensitivity).

Results reported in Column 2 of Table 1 confirm the existence of a benchmark Penn effect in the time-series dimension. Much of the Column 1 special status for (former) transition economies is now picked up by the transition indicators broadly in line with *a priori* expectations. Competition policy, however, exhibits an insignificant coefficient.

Regressions reported in Columns 1 and 2 of Table 1 are problematic because the focus on the within-variation of the price-productivity relationship might aggravate measurement errors in the PPPs defining *p*, much of which is essentially unobservable. Between ICP rounds, changes in data and methods are regularly introduced.[7] Furthermore, available reform variables show rich between but little within country variation, which is especially true for structural reforms such as progress with competition policy. The inclusion of country fixed effects implies that no time-invariant parameters, such as potentially important natural resource endowments, can be included in the regression. Controlling for time-invariant country-specific unobserved heterogeneity makes it difficult to motivate *y* as a good proxy for productivity in a world of synchronised business cycles.

3.2 The cross-section dimension

As stated in section 2 above and forcefully argued in Samuelson (1994) and Bergin et al. (2006) the Penn effect is fundamentally a cross-section phenomenon: aggregate price levels expressed in a common currency at going nominal exchange rates are generally higher in richer than in poorer economies.

In line with this, two strands of empirical literature suggest that a closer look at the cross-section dimension of this relationship might indeed be revealing. First, Maeso-Fernandez et al. (2005) report that price-productivity elasticity estimates from cross-section regressions vary greatly with sample composition. "(T)he inclusion of poor countries – particularly, African countries – tends to generate lower elasticities" (p. 139). Evidence in Frensch (2006) also suggests different strengths of the *p-y* relation-

[7] A "potentially important difference is that (compared to the 1993 and prior ICP rounds) stricter quality standards were used in the 2005 price surveys, to assure that the ICP was obtaining prices for internationally comparable commodities. This is important given that one expects that lower quality goods are consumed in poorer countries, creating a risk that (without strict standards in defining the products to be priced) one will underestimate the cost of living in poor countries by confusing quality differences with price differences" (Ravallion, 2010).

ship in sub-samples of countries, with an especially pronounced relationship for OECD countries.[8]

Second, Bergin et al. (2006, p. 4) conclude that in a sequence of PWT cross sections every 5 years between 1950 and 1995, the relationship has gradually strengthened, "with the slope estimate roughly quadrupling in size over half a century." Why the Penn effect has strengthened over time remains a question of active research. According to one straightforward explanation rooted in the underlying BS effect, the consumption expenditure share for non-tradables has increased over time. However, in fact, in 1950 traded shares of output were lower both than in 1913 or in 2000 (Taylor and Taylor, 2004). Rather, recent approaches to endogenise BS effects (see especially Bergin et al., 2006) start out with the hypothesis that declining trade costs increase tradability, such as in models of heterogeneous firms and trade (Melitz, 2003).[9]

Because of the relatively small number of cross-sectional observations, however, we are unable to strictly explore the between variation of the price-productivity relationship. We rather compromise by running a panel OLS regression with period-fixed effects; this controls for plausibly important time-specific country-invariant unobserved heterogeneity with the implication that synchronised business cycles are captured to better proxy productivity with PPP-adjusted per capita income, y.

In addition to the data used in the previous section, the IMF *Guide on Resource Revenue Transparency* (2007) is used as a source for dummies for hydrocarbon-rich countries.

Results reported in Column 3 of Table 1 confirm the existence of a cross-country benchmark Penn effect, quantitatively close to the one found for the time-series dimension. Most notably, there is no special status for (former) transition economies; rather, dummies for hydrocarbon-rich countries based on IMF (2007) and some transition indicators play an important role. In particular, price and trade and foreign exchange system liberalisation imply higher price levels; the same holds for privatisation, although not significantly so for large scale privatisation. Competition policy is again not associated with comparative price levels in a statistically significant way.

[8] With the exception of Choudhri and Khan (2005), testing the Penn effect has in general been confined to developed countries.

[9] Recently, the Penn effect may have been attenuated: the 2005 International Comparison Program (ICP) found substantially higher PPP rates, relative to market exchange rates, in most developing countries. Ravallion (2010) finds that more rapidly growing economies experience steeper increases in their price level index, while this effect has been even stronger for initially poorer countries.

4 Sensitivity

4.1 Choice of sample

The major qualitative results of the previous section are the existence of a Penn effect implying a price-productivity elasticity of about 0.5 and that within our cross-section specification, there is no special status for (former) transition economies. Rather, identifiable time-varying country-specific variables such as energy dependence and the extend of reforms *cet. par.* have a significant influence on aggregate price levels. These results are robust to excluding Armenia, Azerbaijan, Kyrgyzstan (for which we have very few observations) from the sample, or for extending the sample period to 1989–2004 (cf. Columns 4 and 5 of Table 2).

– Table 2 about here –

4.2 Variable definition

Our major results are also quite robust to variations in variable definitions: we first experiment by changing the definition of oil and gas exporters as to net energy exporters (as listed by IEA, 2008). Second, we vary the exact threshold for the definition of the transition indicator dummies: rather than to construct dummies at median value for (former) transition countries, we construct dummies by discriminating between first tercile of (former) transition countries versus the other two, or between the first two terciles of (former) transition countries versus the third. In none of these specifications do we find a significant special status for (former) transition economies in terms of a significantly higher price-productivity elasticity than for OECD economies. Rather, in our last specification (Table 3, Column 8), we even find a significantly lower price-productivity elasticity for CEEC than for OECD economies.[10]

[10] Table 1 time-series results are robust to all Table 2 specifications.

5 Conclusions

We find a robust and stable Penn effect over all our specifications, with an implied price-productivity elasticity of about 0.5. Within the pure time-series dimension, our results confirm earlier findings reporting the existence of a special status for (former) transition economies in form of a significantly higher (lower) price-productivity elasticity for CEEC (CIS) than for OECD economies. However, we argue that (i) the Penn effect is fundamentally a cross-section phenomenon and (ii) the omission of real factors connected to reform effort might lead to omitted variable bias and omitted variable inconsisteny. In our preferred specification, which treats the Penn effect as a cross-section phenomenon and in which resource dependence and the extend of reforms are included as additional control variables in order to take account of possible endogeneity of the productivity variable, there is no special status for (former) transition economies. These results are very robust with respect to choice of sample and variable definition.

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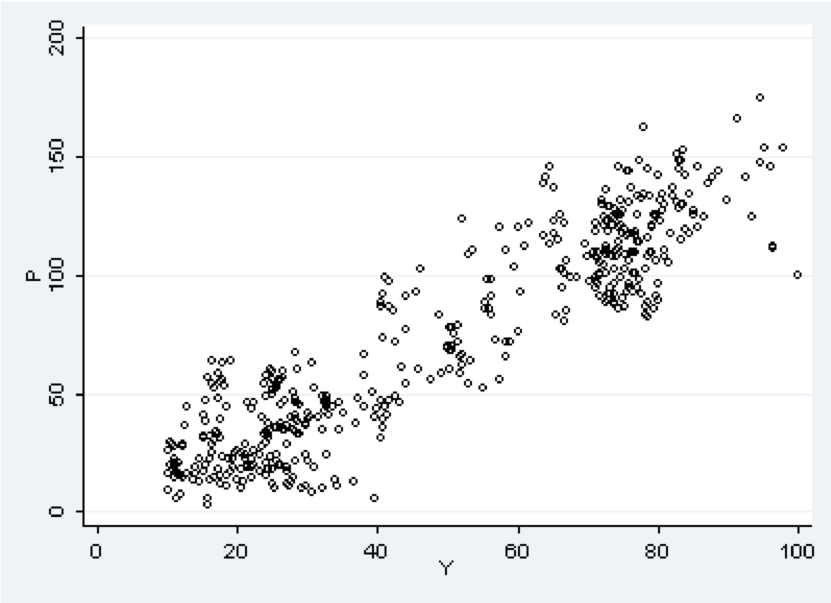
Text figures and tables

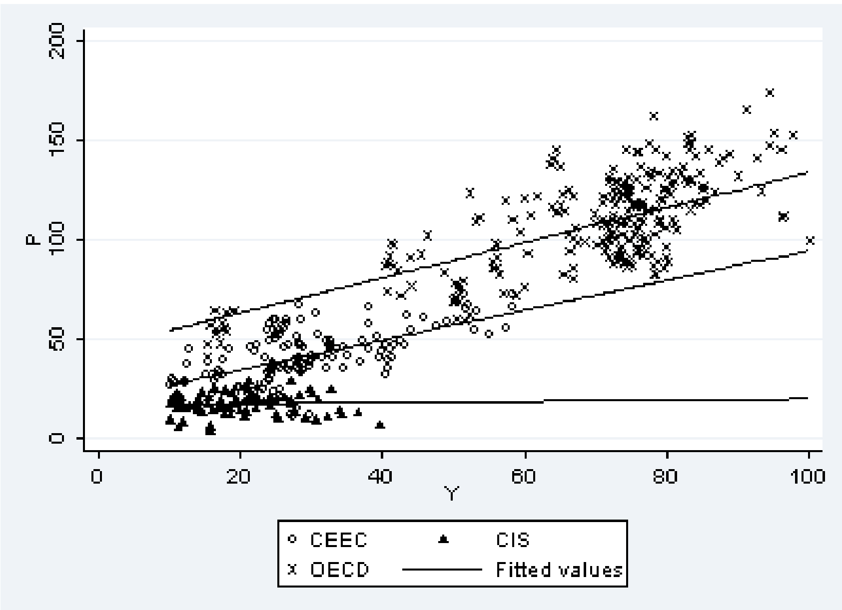
Figure 1: **The Penn effect for 39 countries (OECD, CEEC, and CIS), 1992–2004**



Notes: PPP-adjusted income per capita, *y*, and comparative prices, *p*, both measured relative to the U.S., are taken from the Penn World Tables version 6.2; for definitions, see Appendix Table B2.

Source: Penn World Tables 6.2.

Figure 2: **The Penn effect for OECD, CEEC and CIS economies, 1992–2004**



Notes: PPP-adjusted income per capita, *y*, and comparative prices, *p*, both measured relative to the U.S., are taken from the Penn World Tables version 6.2; for definitions, see Appendix Table B2.

Source: Penn World Tables 6.2.

Table 1: **Comparative prices regressions**

	(1) OLS with country-fixed effects	(2) OLS with country-fixed effects	(3) OLS with period-fixed effects
constant	2.62 73*** (.7260)	1.8333** (.6878)	2.1913*** (0.1689)
log *y*	0.4514* (.2538)	0.4514* (.2552)	0.4760*** (0.0219)
CEEC * log *y*	0.4822 (.4830)	0.2046 (.3651)	–0.0784 (0.0715)
CEEC			–0.2303 (0.2587)
CIS * log *y*	–1.6241*** (.4310)	–.0971** (.4130)	–0.2230 (0.1768)
CIS			–0.3320 (0.5121)
OIL			0.1972*** (0.0556)
Price Liberalisation		0.2053** (0.0823)	0.2366* (0.1251)
Trade Liberalisation		0.2633*** (0.0789)	0.2433** (0.0975)
Competition Policy		0.0946 (.1410)	–0.0749 (.0876)
Large Privatisation		0.0734 (0.0655)	0.0089 (0.0712)
Small Privatisation		0.2510** (0.0953)	0.1935*** (0.0530)
Observations (cross sections)	484 (41)	484 (41)	484 (41)
R-squared	0.33	0.51	0.92

Notes: Dependant variable: log *p*; unbalanced samples of countries with 10 < y_{jt} < 110; 1992–2004;
* (**, ***) indicate significance at 10 (5, 1) per cent; heteroskedasticity robust standard errors in parentheses; results are robust to the use of bootstrapped standard errors and bias correction (200 replications), except for the y and small privatisation coefficients in column 1' which become significant at the one per cent level and the CEEC**y* coefficient in column 2, which becomes significant at the ten per cent level.

Table 2: **Comparative prices regressions with period-fixed effects**

	(4) Without Armenia, Azerbaijan and Kyrgyzstan	(5) Extended sample: 1989–2004	(6) Oil dummy for all net energy exporters according to IEA (2008)	(7) Reform dummies at 1/3 of cumulative distribution	(8) Reform dummies at 2/3 of cumulative distribution
constant	2.1735***	2.2902***	2.2040***	2.3086***	2.0698***
	(0.1680)	(0.1310)	(0.1709)	(0.1821)	(0.1703)
log *y*	0.4841***	0.4736***	0.4752***	0.4797***	0.4744***
	(0.0214)	(0.0205)	(0.0225)	(0.0227)	(0.0216)
CEEC * log *y*	–0.0610	–0.0200	–0.0740	–0.0425	–0.1601**
	(0.0714)	(0.0625)	(0.0722)	(0.0589)	(0.0713)
CEEC	–0.2818	–0.4152*	–0.2405	–0.3683*	0.1018
	(0.2573)	(0.2271)	(0.2609)	(0.2123)	(0.2576)
CIS * log *y*	–0.2083	–0.1204	–0.1747	–0.2442	–0.2542
	(0.1957)	(0.1866)	(0.1902)	(0.1900)	(0.1880)
CIS	–0.2864	–0.6718	–0.4216	–0.3741	–0.1515
	(0.5438)	(0.5173)	(0.5224)	(0.5178)	(0.5138)
OIL	0.1240***	0.1844***	0.0942**	0.1700***	0.2109***
	(0.0459)	(0.0534)	(0.0396)	(0.575)	(0.0531)
Price Liberalisation	0.2835**	0.1629	0.2416*	0.2059	0.2222*
	(0.1126)	(0.1046)	(0.1252)	(0.1477)	(0.1287)
Trade Liberalisation	0.2420**	0.2022**	0.2291**	0.0687	0.2378**
	(0.1025)	(0.0847)	(0.0979)	(0.1793)	(0.0981)
Competition Policy	–0.1979**	–0.1904**	–0.0993	–0.0846	0.1149**
	(.0868)	(.0829)	(.0877)	(.0748)	(.0522)
Large Privatisation	0.0565	0.0314	0.0201	–0.0735	–0.0273
	(0.0738)	(0.0678)	(0.0711)	(0.1430)	(0.0707)
Small Privatisation	0.2088***	0.1752***	0.2013***	0.3558***	0.1812***
	(0.0550)	(0.0498)	(0.0527)	(0.0739)	(0.0535)
Observations (cross sections)	472 (38)	568 (41)	484 (41)	484 (41)	484 (41)
R-squared	0.92	0.90	0.91	0.91	0.92

Notes: Dependant variable: log *p*; unbalanced samples of countries with $10 < y_{jt} < 110$; 1992–2004 (1989–2004 in Column 4);

* (**, ***) indicate significance at 10 (5, 1) per cent; heteroskedasticity robust standard errors in parentheses; results are qualitatively robust to the use of bootstrapped standard errors and bias correction (200 replications).

Appendix A: An extended static BS framework for motivating Penn effects in transition

In the simple set-up of section 2, the only alternative to a deepening productivity gap to imply a more pronounced BS-type relationship is by a rise in the share of non-traded goods in GDP, which seems heavily at odds with empirical developments. The argument in Frensch (2000, 2006), on which we build here, however, allows to separate tradability from reallocation in terms of changes in income shares spent on services and industrial goods. For further analysis, we return to the arbitrage view of the BS set-up, extending the framework to incorporate the effects of transition, defined as institutional reform driven resource *reallocation*, corporate *restructuring*, and *liberalisation* (Blanchard, 1997). Then,

$$\ln RER_{21} = \ln P_2 - \ln P_1 - \ln e_{12}, \tag{A1}$$

following the notation in section 2 omitting time. Rather than differentiating only between tradables and non-tradables, we assume two sectors, industry (*I*) and services (*S*), with products entering price levels with potentially different weights such that,

$$\ln P_j = \phi_j \ln P_j^I + (1 - \phi_j) \ln P_j^S \tag{A2}$$

We make a few simplifying assumptions to modify the set-up of section 2:

(ASS. 1) While all services are non-tradable, only some part of industrial goods, τ_j, is tradable due to the existence of barriers to trade, i.e.,

$$\ln P_j^I = \tau_j \ln P_j^{I,T} + (1 - \tau_j) \ln P_j^{I,NT} \tag{A3}$$

(ASS. 2) Prices are proportional to unit labour costs,

$$\ln P_j^h = \lambda^h + \ln w_j - \ln A_j^h, \tag{A4}$$

where h = *S; I,T; I,NT, w* is the wage rate and *A* is labour productivity, which is the same in all of industry.

(ASS. 3) Exposure to international trade increases the intensity of competition, i.e.,

$$\lambda^S = \lambda^{I,NT} = \lambda^{NT} > \lambda^T = \lambda^{I,T} \tag{A5}$$

(ASS. 4) PPP, as usually, does not hold for non-tradables; for tradables, PPP is restricted by quality differentials according to

$$\ln P_2^{I,T} = \ln P_1^{I,T} + \ln e_{12} + \kappa_{21}^{I,T}, \tag{A6}$$

where country 2 product quality of tradables, $\kappa_{21}^{I,T}$, is defined relative to country 1.

From (A1) and (A6),

$$\ln RER_{21} = (\ln P_2 - \ln P_2^{I,T}) - (\ln P_1 - \ln P_1^{I,T}) + \kappa_{21}^{I,T}, \tag{A7}$$

where (A2) implies that

$$\ln P_j - \ln P_j^I = (1-\phi_j)(\ln P_j^S - \ln P_j^I), \tag{A8}$$

and from (A3)

$$\ln P_j^I - \ln P_j^{I,T} = (1-\tau_j)(\ln P_j^{I,NT} - \ln P_j^{I,T}) \tag{A9}$$

From (A8) and (A9),

$$\ln P_j - \ln P_j^{I,T} = (1-\phi_j)(\ln P_j^S - \ln P_j^I) + (1-\tau_j)(\ln P_j^{I,NT} - \ln P_j^{I,T})$$

$$= (1-\phi_j)\ln P_j^S - \ln P_j^I + \phi_j \ln P_j^I + (1-\tau_j)(\ln P_j^{I,NT} - \ln P_j^{I,T}) \tag{A10}$$

Substituting from (A9),

$$\ln P_j - \ln P_j^{I,T} = (1-\phi_j)\ln P_j^S - \ln P_j^{I,T} + \phi_j \ln P_j^I,$$

and from (A3),

$$\ln P_j - \ln P_j^{I,T} = (1-\phi_j)\ln P_j^S - \ln P_j^{I,T} + \phi_j \ln P_j^{I,T} + \phi_j(1-\tau_j)(\ln P_j^{I,NT} - \ln P_j^{I,T})$$

$$= (1-\phi_j)(\ln P_j^S - \ln P_j^{I,T}) + \phi_j(1-\tau_j)(\ln P_j^{I,NT} - \ln P_j^{I,T}) \tag{A11}$$

Substituting for prices according to (A4) and collecting terms yields

$$\ln P_j - \ln P_j^{I,T} = (1-\phi_j)(\ln A_j^I - \ln A_j^S) + (1-\tau_j\phi_j)(\lambda^{NT} - \lambda^T) \tag{A12}$$

Then, equation (A7) implies,

$$\begin{aligned} \ln RER_{21} &= [(1-\phi_2)(\ln aA_2^I - \ln A_2^S) - (1-\phi_1)(\ln A_1^I - \ln A_1^S)] \\ &\quad + \kappa_{21}^{I,T} + (\tau_1\phi_1 - \tau_2\phi_2)(\lambda^{NT} - \lambda^T) \end{aligned} \tag{A13}$$

After total differentiation and again collecting terms, we decompose the rate of change of the real exchange rate of country 2 relative to country 1 into four separate effects (where a Δ of a logarithmic value indicates a growth rate),

$$\Delta \ln RER_{21} = (1-\phi_2)(\Delta \ln A_2^I - \Delta \ln A_2^S) - (1-\phi_1)(\Delta \ln A_1^I - \Delta \ln A_1^S) \tag{A14}$$

(a) Productivity gap effect

$$+\Delta\kappa_{21}^{I,T}$$

(b) Corporate restructuring effect on quality

$$+\Delta\phi_1\left[\left(\ln A_1^I-\ln A_1^S\right)+\tau_1\left(\lambda^{NT}-\lambda^T\right)\right]-\Delta\phi_2\left[\left(\ln A_2^I-\ln A_2^S\right)+\tau_2\left(\lambda^{NT}-\lambda^T\right)\right]$$

(c) Sectoral reallocation effect

$$+\left(\phi_1\Delta\tau_1-\phi_2\Delta\tau_2\right)\left(\lambda^{NT}-\lambda^T\right).$$

(d) Competition effect of trade liberalisation

Separating tradability from income shares spent on services and industrial goods allows to show that, in addition to the productivity gap effect, reallocation from industry towards services in country 2, relative to country 1 ($\Delta\phi_2<0$), also implies a real exchange rate appreciation assuming that productivity in industry is higher than in services. Also, quality improvements drive up the real exchange rate. A unilateral reduction in country 2 versus country 1 foreign barriers to trade in industrial products ($\Delta\tau_2 > 0$ and $\Delta\tau_1 = 0$) implies a real depreciation for country 2. Symmetric reduction in barriers to trade ($\Delta\tau_1 = \Delta\tau_2 > 0$) implies a depreciation for country 2 as long as the share of this country's services sector in total production is smaller than in country 1. While this depreciation effect is rooted in the pro-competition effect of trade liberalisation, trade liberalisation, along with all other reform measures described in section 3, influences and even dominates restructuring efforts and sectoral reallocation, specifically pronounced during transition.

Appendix B: Data

Table B1: **Countries covered**

1	Albania	15	France	29	Netherlands
2	*Armenia*	16	United Kingdom	30	Norway
3	Austria	17	*Georgia*	31	Poland
4	*Azerbaijan*	18	Germany	32	Portugal
5	Belgium	19	Greece	33	Romania
6	Bulgaria	20	Croatia	34	*Russia*
7	*Belarus*	21	Hungary	35	Slovakia
8	Canada	22	Ireland	36	Slovenia
9	Switzerland	23	Iceland	37	Sweden
10	Czech Republic	24	Italy	38	*Turkmenistan*
11	Denmark	25	*Kazakhstan*	39	Turkey
12	Spain	26	*Kyrgyzstan*	40	*Ukraine*
13	Estonia	27	Lithuania	41	United States
14	Finland	28	Latvia		

Notes: CEEC countries underlined, CIS countries in *italics*. Other countries are OECD as of 1992.

Table B2: **Variables used in regressions (1) – (8) in Tables 1 and 2**

Variable	Definition	Source	Notes	Descriptive Statistics			
p	Comparative prices, measured relative to the U.S.	Penn World Tables version 6.2	*p* is the PPP over GDP divided by the exchange rate times 100. PPP and the exchange rate are both expressed as national currency units per US dollar. PPP is the number of currency units required to buy goods equivalent to what can be bought with one unit of the base country. In the PWT, PPP is calculated over GDP, i.e., PPP is the national currency value of GDP divided by the real value of GDP in international dollars. The international dollar has the same purchasing power over total U.S. GDP as the U.S. dollar in a given base year.	Mean	Std. Dev.	Min	Max
				73.1749	42.6816	3.42	174.79
y	PPP-adjusted income per capita, measured relative to the U.S.	Penn World Tables version 6.2	*y* is obtained from an aggregation using price parities and domestic currency expenditures for consumption, investment and government of August 2001 vintage.	Mean	Std. Dev.	Min	Max
				49.83053	26.57781	10.09431	100
OIL	Dummy for hydrocarbon-rich countries	IMF (2007)		Azerbaijan, Kazakhstan, Norway, Russia, Turkmenistan			
	Dummy for net energy exporters	IEA (2008)		Azerbaijan, Canada, Denmark, Kazakhstan, Norway, Russia, Turkmenistan			
Price Liberalisation, Trade Liberalisation, Competition Policy, Large Privatisation, Small Privatisation	Policy reform dummies defined on the basis of EBRD transition indicators	EBRD	EBRD transition indicators are measured on a scale between 1 and 4+ (=4.33) in steps of one third of a point each. 1 represents no or little progress; 2 indicates important progress; 3 is substantial progress; 4 indicates comprehensive progress, while 4+ indicates that countries have reached the standards and performance norms of advanced industrial countries. Accordingly, non-transition countries in the sample are evaluated at 4+. Respective dummy variables indicate whether or not a country has reached a certain level on the EBRD scale in the respective policy area within a given period.	Value	Indicator (Percent)		
					Prize Liberalisation	*Trade Liberalisation*	*Competition Policy*
				1	.41	3.72	6.20
				1.67	.62	.21	1.03
				2	3.72	1.24	15.91
				2.33	-	1.03	10.12

Variable	Definition	Source	Notes	Descriptive Statistics			
				Value	Indicator (Percent)		
					Prize Liber-alisation	*Trade Liber-alisation*	*Competition Policy*
				2.67	1.03	0.41	3.51
				3	29.75	6.20	9.50
				3.33	4.55	1.45	-
				3.67	.21	.41	-
				4	1.86	14.67	-
				4.33	57.85	70.66	53.72
					Large Privatisation	*Small Privatisatio n*	
				1	4.34	1.03	
				1.67	1.45	.62	
				2	7.44	5.17	
				2.33	1.24	.62	
				2.67	1.45	.21	
				3	13.64	3.10	
				3.33	6.82	2.69	
				3.67	1.65	4.13	
				4	8.26	13.84	
				4.33	53.72	68.60	