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Export variety and economic growth in East European transition economies

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Abstract

Utilising panel data for 14 East European transition economies, we find support for the hypothesis that a greater degree of export variety relative to the U.S. helps to explain relative per capita GDP levels. The empirical work relies upon some direct measures of product variety calculated from 5-digit OECD trade data. Although the issue is far from settled, the emerging view is that the index of relative export variety across countries correlates significantly with relative per capita income levels.

Keywords: Product Variety, Transition Economies, Eastern Europe, Economic Growth, Panel Data
JEL Classification: C33, F43, O31, O33, O52

* The paper was written while the first author was a Visiting Scholar at the Bank of Finland Institute for Economies in Transition. The opinions expressed in the paper are strictly personal and do not necessarily reflect those of the Finland's central bank. Any remaining errors are our responsibility. Michael Funke; Hamburg University, Department of Economics, Von-Melle-Park 5, 20146 Hamburg, GERMANY, Email: funke@econ.uni-hamburg.de

Michael Funke* and Ralf Ruhwedel

Export variety and economic growth in East European transition economies

Tiivistelmä

Tutkimuksessa käytetään 14 Itä-Euroopan siirtymätalouden paneeliaineistoa. Työssä löydetään tukea hypoteesille, että suuri vientituotteiden valikoima auttaa selittämään suhteellista per capita -bruttokansantuotetta. Empiiriset estimoinnit on tehty OECD:n yksityiskohtaisella kauppa-aineistolla. Vaikka kysymys ei olekaan vielä lopullisesti ratkaistu, näyttää siltä, että vientituotteiden valikoima korreloi positiivisesti per capita -tulojen kanssa.

Asiasanat: tuotevalikoima, siirtymätaloudet, Itä-Eurooppa, kasvu, paneeliaineisto

1 Introduction

In the past two decades, the study of the forces that shape per capita income levels and growth rates over the long run has become one of the most attractive areas of economic research. On the theoretical front, various endogenous and semi-endogenous growth models were developed to explain why sustained growth occurs in the absence of exogenous growth in total factor productivity. On the empirical front, the Heston and Summers (1988, 1991) dataset initiated an impressive empirical growth literature.

In this paper, we present new empirical evidence on the determinants of economic growth across East European transition economies with a focus on the impact of product variety. Given the importance of product variety in the recent economic growth literature, one might expect that the widespread acceptance of the new approach arose from its empirical success. In fact, this is not the case. Although the theoretical papers make much of the *plausibility* of anecdotal evidence and their consistency with stylised facts, none test the new theory formally.[1] A possible reason for this discrepancy between economic theory and empirical and econometric evidence is that none of the most-well known international datasets used in the empirical growth literature (the Heston-Summers dataset, the Barro-Lee dataset and the World Bank World Development Indicators database) contain any information on product variety over time or across countries. Therefore, the impact of product variety has often been taken for granted although the evidence is scattered and the link between product variety and growth has not been subject to a fair amount of empirical scrutiny. This paper attempts to fill this gap.[2] A key ingredient of the transition process is the structural change consisting in the reallocation of resources on the basis of market incentives. Product variety is therefore a potentially useful concept in analysing the structural changes that has actually occurred in Eastern European transition economies.[3]

The remainder of the paper is organised as follows: In section 2, we formulate a simple theoretical model of the relationship between product variety and economic growth. Section 3 describes the methodology for estimating the degree of product variety in transition countries, explicates the data and presents the indices. Estimation results are given in section 4. Section 5 concludes with a general summary of the paper and a discussion of some outstanding issues.

[1] Moreover, Temple's (1999) survey of new growth evidence and the up-to-date growth resources available at www.bris.ac.uk/Depts/Economics/Growth contain no work on product variety. The reason is probably that direct measures of product variety are notoriously difficult to obtain even within a single country, and international comparisons yet more difficult. In this respect, few dimensions promise more benefits than a better empirical grasp of product variety. For a fascinating survey of trends in product variety in the US, see Cox and Alm (1998).

[2] Compare Addison (2002), Feenstra et al. (1999a) and (1999b) and Funke and Ruhwedel (2001). The thin empirical evidence is reviewed at www.worldbank.org/wbi/B-SPAN/sub_productivity_growth.htm. We are not, however, suggesting that the same people who make theoretical contributions should be expected to test their empirical validity – this would forego the benefits of division of labour within the economics profession.

[3] For a survey of the literature on growth in transition, see Campos and Coricelli (2002) and the references cited therein.

2 A semi-endogenous model of expanding product variety

To illustrate the interaction between product variety and economic growth and develop a testable hypothesis, we provide an informal discussion of the simple semi-endogenous growth model put forward by Jones (1998) in which economies become more productive as a widening of the product spectrum available occurs. Semi-endogenous growth means that (i) technological change itself is endogenous, while (ii) long-run growth is pinned down by exogenous factors. The importance of hypothesis (ii) lies in the property that the steady-state growth rate is independent of public policy.

There is a single final output, (Y), produced by labour (L) and differentiated capital goods (x_j), with $j \in [0, n]$. Without much loss of generality, we use the familiar constant-returns Cobb-Douglas production function and assume that labour supply is offered inelastically, so that

(1) $$Y = L^{1-\alpha} \int_0^n x_j^{\alpha}\, dj \quad ,$$

where $0 < \alpha < 1$, and

(2) $$\int_0^n x_j\, dj = K \quad .$$

Thus, the total number of differentiated intermediate goods used in production equals the total supply of capital.[4] We can also interpret n as a measure of the complexity of production. The basic idea is that a larger variety of intermediate goods allows producers to increase productivity through selection of intermediate inputs that more closely match their production requirements.

Intermediate products are treated symmetrically throughout the model, so that $x_j = x$ for all j. Therefore intermediate goods are used the same amount, x, and we can determine x as

(3) $$x = \frac{K}{n} .$$

Let us now look at the output dynamics in this economy. By rearranging, we get

(4) $$Y = K^{\alpha} (nL)^{1-\alpha}$$

Thus, aggregate production for the economy takes the familiar Cobb-Douglas form. The degree of product variety, n, enters the production function just like labour-augmenting technology. Capital evolves according to

(5) $$\dot{K} = s_K Y - \delta K \quad ,$$

where s_K is the investment share of output and δ is the rate of depreciation. The product variety dynamics obey

(6) $$\dot{n} = \phi \;\; A^{\gamma} n^{1-\gamma} ,$$

[4] The production function specification adopted in (2) proved very influential in growth theory. Romer (1987, 1990) has shown that this specification provides a rationale for increasing returns arising from specialisation in the production of intermediate inputs. Subsequent work on growth has made intensive use of this specification.

where ϕ is a reduced-form coefficient that reflects, among other things, the share of labour devoted to R&D. We assume $\phi > 0$ and $0 < \gamma < 1$. Equation (6) reflects the fact that every act of innovation builds on previous ideas, i.e. $\dot{n}$ is a function of n. The last two terms in equation (6) suggest that the change in product variety is a weighted average of the world frontier level of product variety, A, and the individual country's degree of product variety, n. In the following empirical part of the paper we think of the U.S. as the technological frontier. Equation (6) can be rewritten by dividing both sides by n, whereby

$$\frac{\dot{n}}{n} = \phi \left(\frac{A}{n}\right)^{\gamma} . \tag{7}$$

Equation (7) makes clear that the growth rate of product variety in the economy positively relates to the ratio (A/n). The closer an individual country's degree of product variety, n, is to the world frontier of variety, A, the smaller the ratio A/n, and the smaller the growth rate of n.

It can be argued that this Schumpeterian growth model is only relevant for a handful of advanced economies that undertake significant investments in R&D and are located on the frontier of technological development. On the other hand, the issue for most East European economies is not whether to devote resources to innovation and perform leading-edge R&D but whether to adopt and assimilate technologies that have been developed by others. The term (A/n) in equation (7) is a technical trick that captures this important aspect of technology adoption along the lines of Easterly et al. (1994) and Parente (1994).[5]

Finally, we assume that the world frontier expands at the constant leading-edge technology growth rate

$$\frac{\dot{A}}{A} = g \ , \tag{8}$$

and that the labour force of the economy grows at a constant rate m. To solve for the steady state growth path, we proceed in the usual fashion. Along the balanced growth path, we have $g = g_y = g_n = g_A$, i.e. the long-run growth rate is given by the (exogenous) growth rate of the technological frontier, A. The empirically implementable steady state output per capita y^* along the balanced growth path is given by

$$y^*(t) = \left(\frac{s_K}{m+g+\delta}\right)^{\alpha/1-\alpha} n^*(t) \ , \tag{9}$$

or

$$y^*(t) = \left(\frac{s_K}{m+g+\delta}\right)^{\alpha/1-\alpha} \left(\frac{\phi}{g}\right)^{1/\gamma} A^*(t) \ . \tag{10}$$

The economic interpretation of equation (10) is straightforward. The model proposes two answers to the question of why different economies have different steady state income

[5] What prevents East European countries from relying solely on intermediate goods invented elsewhere? A reasonable assumption is that introducing a new good into the production process requires teaching workers how to use a new technology. Parente (1994) has presented an endogenous growth model in which firms adopt more advanced technologies, and subsequent to these adoptions accumulate expertise in those technologies. Technology adoptions, however, incur a cost since only some of the firm's existing expertise can be applied to the new technology. The firm thus faces a trade-off. The more advanced the new technology, the greater its productive potential but the lower its starting level of expertise in that technology. Such a framework leads to an optimal (interior) use of intermediate goods. Keller (1996) also addresses the issue of absorptive capacity for technological change.

levels. First, the model emphasises the importance of product variety, providing a "new growth theory" interpretation of the basic neoclassical growth model since the steady state income level, y^*, depends upon the degree of product variety, n. In the model, increased product variety accelerates per capita income levels by more fully realizing dynamic economies of scale. Second, the initial term in brackets in (9) and (10) is similar to the basic Solow model. The term implies that countries investing more in physical capital will be richer.[6] To understand the mechanics of the model, consider a country that opens up its economy to the rest of the world. We can model this as an increase in ϕ. According to (10), a higher value of ϕ rises y^*. Starting from steady state, the higher ϕ causes the growth rate of n to be higher than g along the transition to the new steady state. Over time, however, the ratio A/n decreases, and therefore the growth rate of n returns to g.[7] In other words, a policy change such as opening up the economy (interpreted as an increase in ϕ) has a long-run *level* effect, but (just as in the original Solow model) no counterfactual long-run *growth* effect.[8]

3 Operational proxies for product variety across East European transition economies

Assuming that only estimation tied closely to theory can shed light on the empirical importance of the different determinants of economic growth, we address the following empirical section to the issue of whether the correlation between variety and growth can also be identified in samples covering transition economies in Eastern Europe. Obviously, it would be disappointing for those interested in economic growth if the gains from product variety were confined solely to OECD countries.

The construction of a consistent international dataset for product variety is a necessary first step in exploring the endogenous growth mechanism. To explore this question, we have to pick a value of n in actual economies, i.e. we have to measure the supply-side factor product variety. To get a measure of the variety of products across countries, the following two questions have to be addressed:

1. *Which methodology can be used to estimate the degree of product variety across countries?*
2. *What highly disaggregated data do we have on differentiated products that are consistent across countries?*

In the following empirical work, we adapt the method for measuring product variety mapped out by Feenstra (1994) and Feenstra and Markusen (1994). These studies show

[6] In extensive sensitivity analyses of cross-country growth regressions, Levine and Renelt (1992) and Sala-i-Martin (1997) have shown that investment in physical capital is the most robust variable explaining cross-country growth differences. Blanchard (1997) offers two complimentary microeconomic elements of the process of change: restructuring within firms in search for cost and productive efficiency (via investment and rationalisation) and reallocation of resources from old to new activities (via closures and establishment of new enterprises).

[7] Li (2000) has recently shown that growth is also semi-endogenous in more sophisticated two-R&D-sector models with technological advance in the dual form of new products and their quality improvement for $\gamma = 0$, i.e. when the increase in products ($\dot{n}$) is linear in the stock of already existing products (n).

[8] An increase in ϕ can also be thought of as a reduction of the "barriers to adoption" stressed by Parente and Prescott (1994).

how an exact measure of product variety can be constructed from a CES production function when the inputs enter non-symmetrically. The procedure considers two units of observations denoted by s and t representing two countries. Suppose that output y_t in country t is given by the production function

$$(11) \qquad y_t = f\left(x_t, I_t\right) = \left[\sum_{i \in I_t} a_i x_{it}^{(\sigma-1)/\sigma}\right]^{\sigma/(\sigma-1)},$$

where σ > 1 denotes the elasticity of substitution, x_{it} is the quantity of input i in country t, and the total set of inputs in country t is denoted by I_t. For example, when the inputs available in country t are numbered 1 through N_t, then $I_t = \{1,...,N_t\}$. The corresponding cost function is

$$(12) \qquad c\left(p_t, I_t\right) = \left[\sum_{i \in I_t} b_i p_{it}^{(1-\sigma)}\right]^{1/(1-\sigma)},$$

where p_{it} are the prices of the inputs and $b_i = a_i^{\sigma}$. Following Feenstra (1994) and Feenstra et al. (1992, 1999a, 1999b), we choose the set of intermediate products common to both countries as $I = I_s \cap I_t$. Relative product variety ΔPV_{st} is then defined as follows [see Feenstra (1994), Proposition 1]:

$$(13) \qquad \Delta PV_{st} = \ln \left(\frac{\dfrac{\sum_{i \in I_t} p_{it} x_{it}}{\sum_{i \in I} p_{it} x_{it}}}{\dfrac{\sum_{i \in I_s} p_{is} x_{is}}{\sum_{i \in I} p_{is} x_{is}}} \right).$$

What is the economic sense behind this result? To get a feeling for (13), consider, for example, the case where the set of inputs in country t in larger than in country s, i.e. we have two sets $I_s = \{1, ..., N_s\}$ and $I_t = \{1, ..., N_t\}$ with $N_t > N_s$. Here, the common set of products is $I = I_s$ and the denominator is 1. The numerator exceeds unity, indicating that product variety in country t is larger than in country s. In the special case where all inputs enter symmetrically, the numerator in (13) simplifies to $\ln(N_t/N_s)$.

Our goal in computing ΔPV_{st} is to gauge how well different economies are performing in terms of product variety. Since this is crucial to our argument, let us explain the logic by way of a textbook example depicted in Table 1 below. The table shows the quantities of the two goods (1 and 2) produced in two hypothetical economies (A and B) in a given year.

Table 1. Production of two goods in two countries

	Country A	Country B
Product 1	100	150
Product 2	50	0

From these data and equation (13), we derive product variety in country A relative to country B ($\Delta PV_{Country\ A/Country\ B}$) as

(14) $$\Delta PV_{Country\ A/Country\ B} = \ln\left(\frac{150/100}{150/150}\right) = \ln(1.5) \approx 0.405\,.$$

In this simple example, $\Delta PV_{Country\ A/Country\ B}$ is positive and therefore (relative) product variety is country A is greater than in country B. The reason is that country A spreads its outputs thinly over both product categories. On the contrary, product variety in country B relative to country A ($\Delta PV_{Country\ B/Country\ A}$) is given by

(15) $$\Delta PV_{Country\ B/Country\ A} = \ln\left(\frac{150/150}{150/100}\right) = -\ln(1.5) \approx -0.405\,.$$

The negative sign for ΔPV indicates that product variety in country B is less than in country A. Admittedly, this is an extremely simple situation. In reality, product variety spans thousands of products, so the calculations inevitably become messier and more cumbersome. Nevertheless, the essential idea of the procedure is identical.

The procedure above is implemented using highly disaggregated trade data at the five-digit SITC level for the years 1993 to 2000 for 14 East European transition economies.[9] The most important advantage of these data is that the classification of goods is consistent across countries.[10] As a caveat, these data have distinct problems. First, the time series dimension of the data (eight years) is rather short. Second, a well-diversified exporter must be a well-diversified producer, although the converse is not necessarily true. Some intermediate goods produced at home are not traded internationally. Nevertheless, we believe the topic to be of such economic and social significance, that a willingness to experiment with trade data is justified, especially since the most important goods are probably exported and/or imported.[11] The consensus view is that trade liberalisation in the sample countries has been considerable since the fall of the Berlin Wall. Once trade with the EU was liberalised, a huge re-orientation took place. Today the EU is, by far, the most important trading partner for most sample countries.

Our first measure of product variety is export variety in country i (i = 1, ..., 14) relative to the US (ΔPV_{EX}). A country-by-country overview appears in Figure 1, which

[9] We have not included the more peripheral countries of the former Soviet Union in which the preconditions were much less favourable to reform in terms of tradition, history and institutions, and where the commitment to reform has been half-hearted.

[10] The classification distinguishes 1,473 commodities according to the Standard International Trade Classification (SITC Revision 2). The use of pre-established product categories makes it impossible to measure gains in product variety within any specific category and beyond the number of pre-established product categories. This puts a premium on the level of disaggregation in the data. One should expect a greater ability to differentiate between nations as the data become more detailed. All data were collected from the OECD database *International Trade by Commodities Statistics (ITCS) Classification*, Paris 2002 and are expressed in current US dollars. Given the data source, all proxies we derive pertain to exports (imports) to (from) OECD countries alone. Moreover, one can only count pre-defined categories up to the maximum number of categories in the ITCS coding system. In other words, we cannot see new products arriving within an existing category and one cannot see the invention of truly new categories because there is a de facto fixed frontier in observable product variety.

[11] It would be preferable in principle to use national production data, but they are neither available at a sufficiently disaggregated level nor are the available data consistent across countries. In extensive discussions of quality and variety, Grossman and Helpman (1991) and Coe and Helpman (1995) and Bayoumi et al. (1999) focus on levels of investment in R&D at home and abroad. An obvious problem with this indirect approach is that the lag between R&D expenditures and the production of new varieties is potentially very long. Furthermore, it is also the case that many improvements in quality and variety can be realised without any R&D costs. In particular, increases in variety can occur through imitation, which involves little or no R&D spending.

conveniently provides an idea of magnitudes. The first impression is that export variety in all countries under investigation (Belarus, Bulgaria, Czech Republic, Estonia, Georgia, Hungary, Latvia, Lithuania, Poland, Romania, Russia, Slovakia, Slovenia, Ukraine) is lower than in the US.[12] Furthermore, the export variety measures yield a rather plausible ranking of countries. The proliferation of varieties is highest in the front-runners such as the Czech Republic, Hungary, Poland and Russia, and other EU-accession candidates. In contrast to this group, the degree of export variety is much lower in Romania and Slovakia, and Georgia posts the lowest ratio. An "eyeballing" of the dataset immediately suggests that the variety gap is smaller in the more advanced transition economies with more Western-oriented industries. Nevertheless, keeping in mind the collapse of the Soviet Union and its implications for trade, the speed of re-orientation of trade in the transition economies is remarkable.[13]

One problem with indicators of product variety focusing solely upon export data is that, even when differentiated, inputs not produced at home are, in principle, available in other countries through trade. In other words, product variety in any country depends not only on exports but potentially also upon imports. We thus also calculate import variety relative to the U.S. (ΔPV_{IM}) and import and export variety ($\Delta PV_{EX\&IM}$). The results are given in Figures 2 and 3 below. It is apparent that import variety increased much faster than export variety for all countries in the sample. One of the first steps of the transition towards a market economy was the opening-up of trade, and therefore the lifting of existing restrictions to purchase of differentiated consumer and intermediate goods by domestic consumers and producers. Accordingly, we see an increasing spectrum of imported products. We also see a gradual rise in the variety of domestic production. The adoption of new technologies is, after all, a costly, time-consuming process.

[12] Negative (positive) values for the index indicate lower (higher) product variety than in the US. The negative numbers are a result of the log transformation in (13). Cross-country trade data arranged by highly disaggregated product categories suffer from the fact that some countries drop category codes, redefine codes and/or add codes. These changes may sometimes induce statistical artefacts in the data that look like variety changes. At this level of detail, the trade statistics also contain errors that may distort the overall results. We have not minimised potential outliers ("punch-in-mistakes") as removing outliers would be completely arbitrary and data mining.

[13] Boeri and Oliveira-Martins (2001), Brenton and Gros (1997), Havrylyshyn and Al-Atrash (1998) and Kaminski et al. (1996) discuss trade re-orientation during transition.

Figure 1. Relative export variety (ΔPV_{EX})

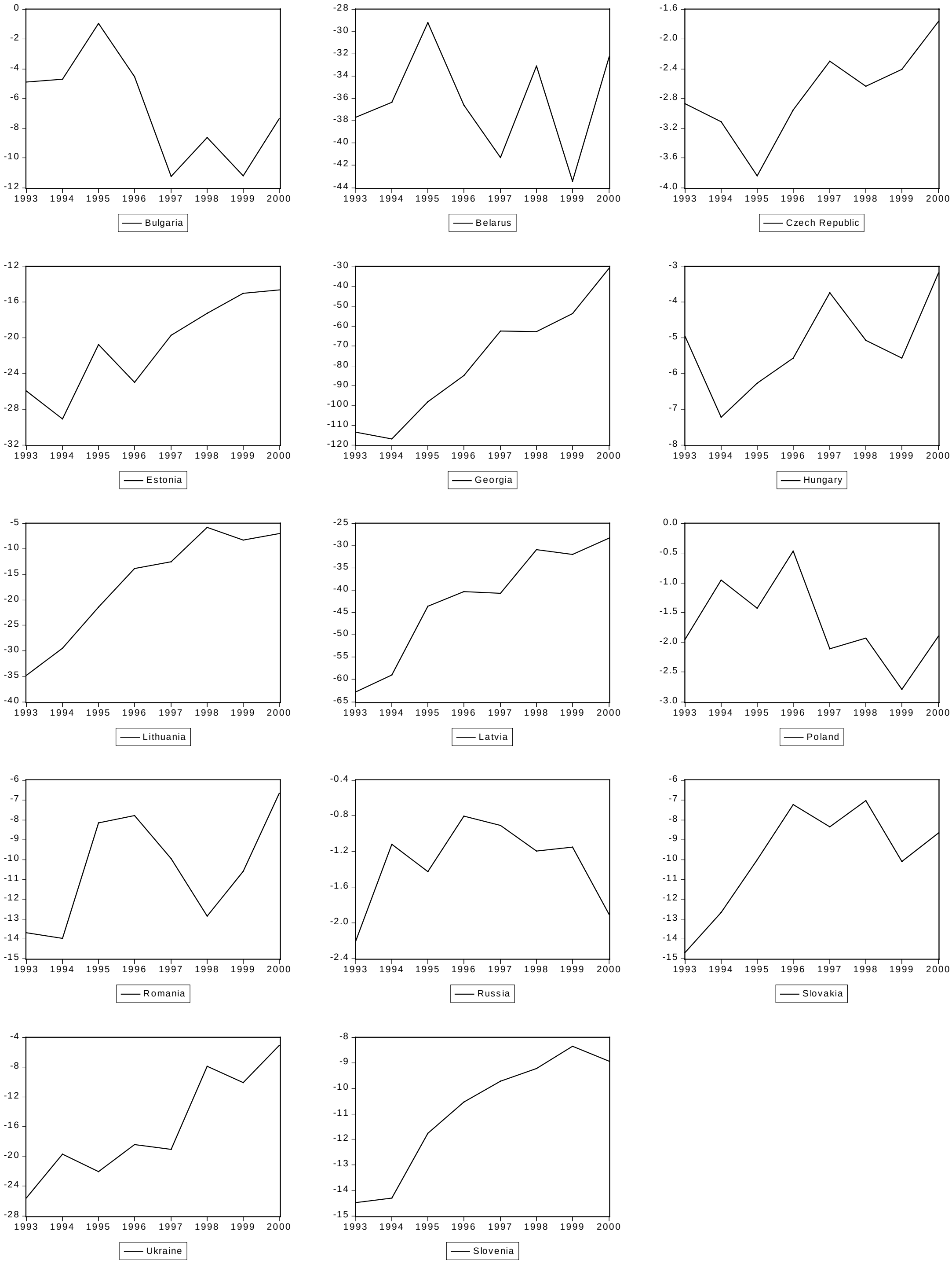


Figure 2. Relative import variety (ΔPV_{IM})

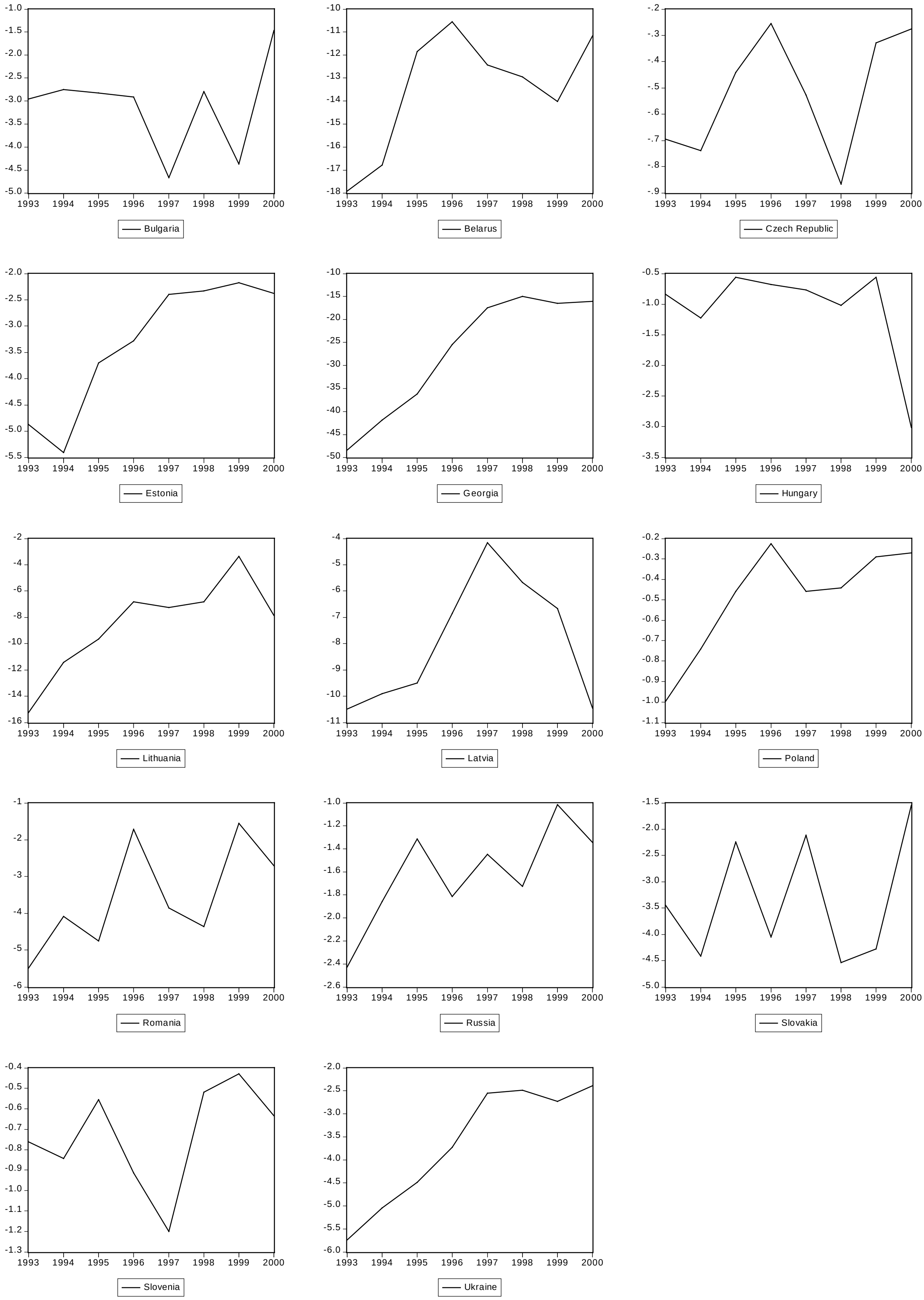
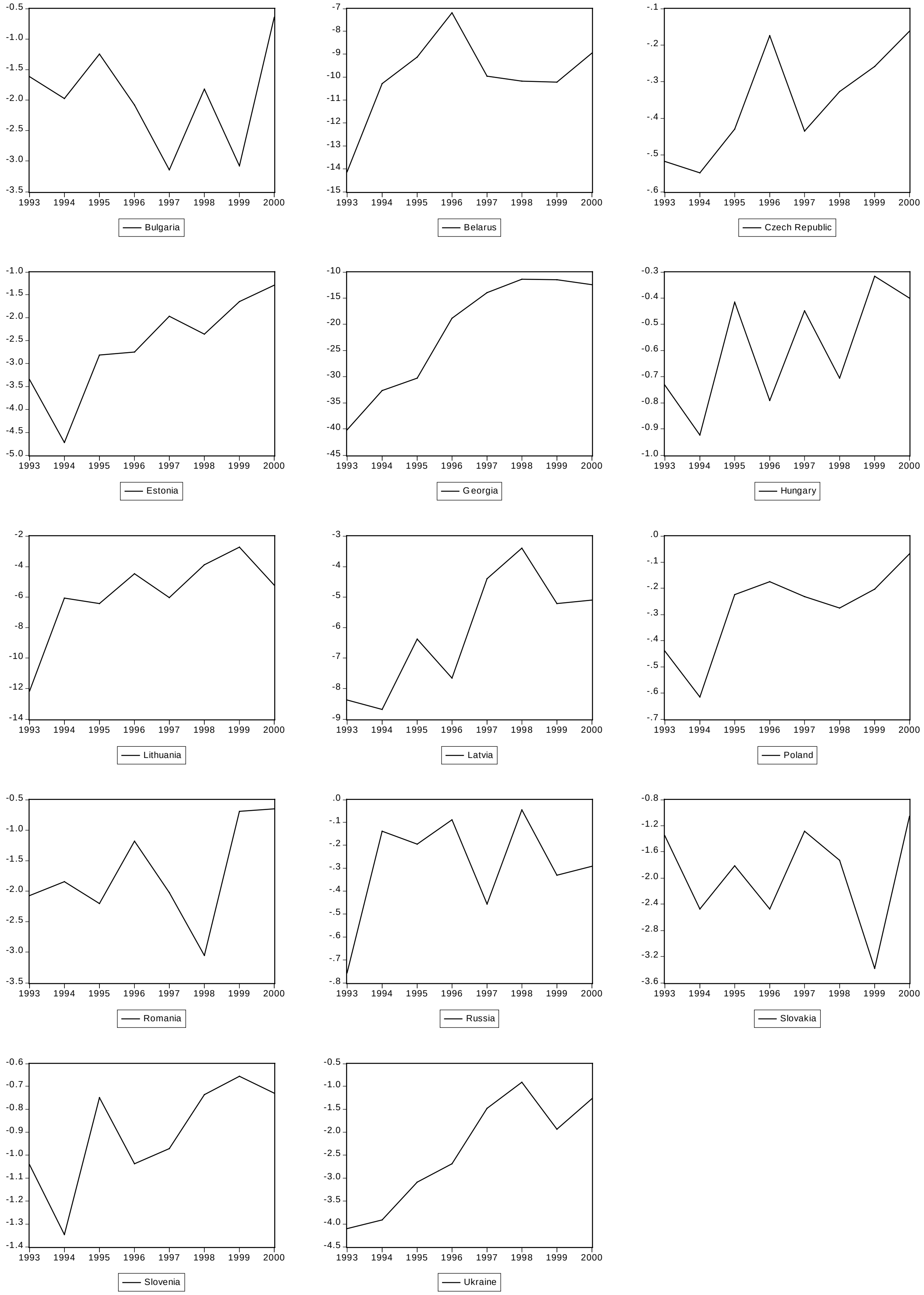


Figure 3. Relative export and import variety ($\Delta PV_{EX\&IM}$)



Simple product counts are an alternative measure of changes in product variety over time. To obtain the alternative measure, we simply count all product categories that show recorded exports or imports.[14] The results are shown in Tables 2 and 3 below.

Table 2. Export variety using the simple count-based measure

	1993	1994	1995	1996	1997	1998	1999	2000
Belarus	389	392	442	417	445	440	418	433
Bulgaria	818	836	821	794	791	812	813	857
Czech Republic	1104	1099	1099	1092	1091	1104	1117	1129
Estonia	693	684	708	702	711	727	777	809
Georgia	182	173	199	216	225	283	286	462
Hungary	1041	1044	1041	1032	1039	1042	1032	1053
Latvia	435	452	487	484	513	566	555	617
Lithuania	491	526	539	538	580	592	660	672
Poland	1067	1093	1092	1092	1101	1098	1104	1123
Romania	782	810	862	852	882	878	884	931
Russia	1013	1026	1003	984	958	965	967	970
Slovakia	846	863	856	872	856	887	858	900
Slovenia	887	900	914	893	904	915	909	909
Ukraine	603	622	619	714	663	689	701	756

Note: The maximum number of product categories is 1,473.

Table 3. Import variety using the simple count-based measure

	1993	1994	1995	1996	1997	1998	1999	2000
Belarus	721	778	806	827	841	830	815	855
Bulgaria	1047	1052	1068	1049	1074	1073	1082	1105
Czech Republic	1190	1196	1209	1192	1188	1188	1192	1198
Estonia	1015	1062	1069	1085	1081	1096	1116	1109
Georgia	371	469	472	632	739	787	742	739
Hungary	1189	1192	1186	1175	1185	1185	1183	1180
Latvia	830	936	975	976	1019	1034	1029	1035
Lithuania	802	931	973	993	1018	1022	1046	1042
Poland	1183	1204	1207	1196	1204	1201	1213	1214
Romania	1049	1088	1120	1114	1125	1146	1137	1153
Russia	1140	1183	1178	1183	1181	1174	1161	1172
Slovakia	1062	1079	1104	1084	1110	1092	1090	1118
Slovenia	1176	1171	1190	1175	1166	1186	1177	1168
Ukraine	924	982	991	1025	1045	1049	1021	1042

Note: The maximum number of product categories is 1,473.

The results in Table 2 and 3 lead to some unsurprising conclusions. First, import variety is generally higher than export variety. Second, Belarus and Georgia displayed the least export variety while the Czech Republic, Hungary and Poland generated the most. Third, among the three Baltic states, Estonia turned out to be more diversified than Latvia or Lithuania.

[14] It is obvious that this simple measure of PV is biased because each product category receives an equal weight.

4 The proof of the pudding: Testing the new growth theory

In this section, we discuss our main set of econometric results. Transition generates difficulties for the estimation for at least two reasons. First, transition marks a fundamental economic reorganisation. Second, transition in Eastern Europe covers only a rather short time period. We thus opt for an estimation method that exploits the full-time dimension of the data by using all the information from a panel rather than just the time-averaged information from a cross-section.[15] We are aware of the difficulties involved in this choice and subject our core results accordingly to a number of tests to gauge their robustness *vis-à-vis* endogeneity, potential reverse causality and omitted variables. Given the limited transition time period, any conclusion is necessarily tentative.

Let us now turn to our core set of results. The proper specification of the regression model depends upon equation (9). Consider writing (9) for one country, and then taking the ratio of that equation with the analogous for the US. We next obtain the relative per capita GDP of the two countries on the left, and obtain the relative savings/investments rates on the right, along with the relative number of product varieties. All variables are expressed relative to the US, since we designate the US as the technological leader. The relative investment share, IY, is added to the regressions to capture different per capita income levels arising from different levels of investment in physical capital. All data except PV are drawn from the *World Development Indicators 2002* database. The basic model for country i and time t presented above yields the following basic specification

(16) $$Y_{it} = \alpha + \beta IY_{it} + \gamma \Delta PV_{it} + \varepsilon_{it} \qquad i = 1,...,14;\ t = 1994,...,2000,$$

where Y_{it} is per capita GDP in country i relative to the US in per cent (PPP, international dollars), IY_{it} is defined as the share of fixed gross investment in GDP in country i relative to the US, and ΔPV_{it} is product variety relative to the US.[16] The sample period starts in 1994, i.e. after the initial GDP declines at the beginning of the 1990s. The initial period of transition from a planned to a market economy is too specific to be captured within a traditional growth theory framework.

The fundamental problems in estimating (16) involve unobservable factors that affect per capita GDP across countries, the potential endogeneity of the right-hand side regressors and spatial autocorrelation across countries.[17] The first concern is that the unconditional estimates may be spurious, merely reflecting the joint impact of unmeasured variables on growth. To account for unobservable country characteristics (somewhat heroically assumed to be constant within the sample period), we remove fixed effects by taking

[15] We have used panel data estimation techniques because cross-section estimation has important limitations. The first, and most obvious, is that the number of observations it too small. On a more technical ground, the cross-section framework only permits a very limited treatment of the problem of estimation bias resulting from parameter heterogeneity and omitted variables. Islam (1995) and Caselli et al. (1996) have demonstrated that panel data estimation techniques can be used to overcome some of the limitations of the cross-section approach, although panel data models are not immune to methodological issues.

[16] We use PPP GDP as opposed to GDP at current market exchange rates to avoid any mechanical association between GDP and an exporter's price through the value of its market exchange rate – with a caveat about data quality and comparability. This should be kept in mind when interpreting the results below.

[17] Linder's (1961) demand theory, for example, suggests that high-income countries have a more advanced and differentiated consumption structure. Therefore, the causal link runs from real income per capita to the degree of product variety.

deviations from mean as we are unsure of what these factors are or because we lack the necessary data.[18] The second concern is that the estimates may be plagued by bias arising from the endogeneity of the regressors. Endogeneity creates contemporaneous correlation between the regressors and the residual, thus creating biased and inconsistent coefficient estimates. We follow the usual tactic in such cases and rely on instrumental variables.[19] The third concern is that the estimates are polluted by spatial correlation. Spatial correlation can be expected when growth is driven by stochastic shocks common to all countries in the sample. While one does not usually worry about cross-sectional correlation for randomly drawn samples at country level, these aggregate units are likely to exhibit cross-sectional correlation that has to be dealt with in a non-random sample of countries.[20] Spatial dependence will generally not interfere with consistent parameter estimation, but standard techniques that fail to account for the presence of spatial correlation will yield inconsistent standard errors of these parameters.[21] The spatial error component model is given by

(17) $$y_{it} = X_{it}^{'}\beta + u_{it} \qquad i = 1, \ldots, N;\ t = 1, \ldots, T,$$

here y_{it} is the observation on the ith country for the tth time period, X_{it} denotes the $k\times 1$ vector of observations on the regressors and u_{it} is the disturbance. In vector form, the disturbance in (17) is assumed to have random country effects, as well as spatially auto-correlated remainder disturbances, i.e.

(18) $$u_t = \alpha + \varepsilon_t,$$

with

(19) $$\varepsilon_t = \rho W \varepsilon_t + v_t,$$

where $\alpha' = (\alpha_1, .., \alpha_N)$ denotes the vector of random country effects. ρ is the scalar spatial autoregressive coefficient with $|\rho| < 1$. W is a known $N\times N$ spatial weight matrix; its diagonal elements are zero. W also satisfies the condition that $(I_N\text{-}\lambda W)$ is nonsingular. Finally, v_{it} is assumed to be INN$(0, \sigma_v^2)$. Parametric corrections for spatial correlation are

[18] Fixed effects allow, for example, controlling for the extent to which institutions encourage technology adoption and investment across countries. Another reason for adding country dummies is that those countries that achieved earlier restructuring were able to reorient their exports quickly to new markets. Thus, exports and product variety may not so much have led to growth, but rather restructuring tended to promote export variety. Of course, controlling for fixed effects is no guarantee that that we completely control for unobserved heterogeneity. We therefore cannot completely rule out the possibility of spurious correlation.

[19] Instrumenting variables with predetermined lagged values also helps to rule out reverse causality, since expanded trade can be the result, rather than the cause, of increased productivity. Please note that we have instrumented our measures of product variety, although these measures are constructed from highly disaggregated trade data and therefore unlikely to suffer from the endogeneity problems that plague traditional openness measures as discussed in Frankel and Romer (1999).

[20] Even without common stochastic shocks, rising vertical specialisation tends to accelerate the global propagation of shocks as industry-specific shocks are immediately transmitted to countries along the production chain. An extensive literature deals with this type of correlation. Space constraints do not permit investigation of econometric techniques in too much detail. A textbook treatment of several of these issues can be found in Baltagi (2001), pp. 195-197.

[21] Monte Carlo simulations in Driscoll and Kraay (1998) indicate that the presence of even modest spatial dependence can impart large bias to OLS standard errors.

possible only if W is known.[22] Driscoll and Kraay (1998) conveniently present a simple modification of the standard nonparametric time series covariance matrix estimator that are robust to general forms of *spatial* and *temporal* dependence and *heteroscedasticity*. The model is identified by an $l\times1$ vector of orthogonality conditions $E[Z_{it}'u_{it}] = 0$, where Z_{it} is an $l\times1$ vector of instrumental variables with $l \geq k$. Thus, the Spatial Correlation Consistent (SCC) *IV* estimator simultaneously handles the issue of endogeneity of right-hand side variables. A further advantage of this flexible spatial dependence estimator is that calculation of the estimator is quite straightforward. The estimation results are presented Table 4.

Table 4. The baseline regression model

	(1)	(2)
Constant	-0.08	-0.12
	(0.3)	(0.7)
$\Delta PV_{EX\&IM}$	0.02	-
	(0.2)	
ΔPV_{EX}	-	0.03
		(2.3)
IY	3.72	2.85
	(2.2)	(2.3)

Note: We have used a Bartlett kernel and select the bandwidth $m = 2$. The qualitative results obtained are robust to changes in the window specification. The z-values in parentheses are based on the heteroscedasticity and spatial correlation consistent standard errors as discussed in the text. See text for data definitions and sources. The sample period is 1994 – 2000.

Table 4 gives the point estimates and the z-values allowing for dependence using the SCC estimator. What do these results reveal? For the investment share, highly significant coefficients indicate that investment in physical investment had a pronounced positive impact on growth. The results also suggest a statistically significant (albeit small) direct effect from export variety (ΔPV_{EX}) on economic growth, implying that investment in physical capital does not carry all the information relevant for economic growth. While far from conclusive, the results evidence that export variety matters for growth.[23] On the other hand, trade variety ($\Delta PV_{EX\&IM}$) is not found to show a significant statistical association with growth.[24]

In Table 4, we showed that export variety is beneficial for growth in transition economies. How robust is this result *vis-à-vis* omitted variables? Introducing a wider range of explanatory variables beyond our fixed effects is one way to deal with this issue. Table 5 below summarises our attempts to deal with the effects of omitted variable bias. We have re-estimated our equations adding the time-varying aggregate EBRD transition indicator

[22] The ad hoc first-order contiguity matrix W that embodies spatial relationships of the adjacent-neighbour variety has been used most frequently in the literature. Unfortunately, economic behaviour is often more consistent with spatial weight matrices that allow neighbours to have differential impacts. Estimating W, however, is impossible without imposing restrictions since the number of spatial correlations increases at the rate N^2, while the number of observations grows at rate N.

[23] This result is consistent with recent contributions looking at the impact of exports as conveyors of productivity [see, for example, Bernard and Jensen (1999) and Clerides et al. (1998)]. Other channels beyond the model presented above through which export variety may affect output include foreign demand to spur recovery, creating incentives for inward foreign direct investment and exposing domestic production to international competition.

[24] These results may explain why the explanatory power of overall openness measures often turned out insignificant in previous growth regressions [see, for example, Havrylyshyn et al. (1999), pp. 35-38].

(*EBRD-I*) to the list of regressors.[25] The aggregate EBRD transition indicator is the most frequently used transition indicator. The EBRD's indicator ranges from 1 to 4+, with 1 representing conditions unchanged from those prevailing in a centrally planned economy with dominant state ownership of means of production and 4+ for conditions in an advanced market economy. In the empirical work below we assign a value of 1/3 to a "+" sign and –1/3 to a "-" sign. The aggregate indicator covers key areas of structural reform including privatisation and restructuring, foreign trade liberalisation and competition and financial markets reform.

Table 5. The augmented growth regressions

	(1)	(2)
Constant	-0.09	0.10
	(0.4)	(0.4)
$\Delta PV_{EX\&IM}$	0.04	-
	(0.5)	
ΔPV_{EX}	-	0.14
		(3.5)
IY	3.78	4.04
	(2.3)	(1.7)
EBRD-I	0.41	3.47
	(0.6)	(2.4)

Note: We have used a Bartlett kernel and select the bandwidth $m = 2$. The qualitative results obtained are robust to changes in the window specification. The *z*-values in parentheses are based on the heteroscedasticity and spatial correlation consistent standard errors as discussed in the text. See text for data definitions and sources. The sample period is 1994 – 2000.

The main feature is that the overall pattern of results remains. Table 5 invites two major conclusions. First, the signs of the coefficients are in conformity with the theoretical model. The coefficients of the relative investment share and the product variety measures are still significant.[26] Second, economic policy as reflected in the aggregate EBRD transition indicator investment has significantly contributed to the productivity recovery in Eastern Europe, all else being equal. In other words, government policies in a wide range of areas is important in explaining both the time and cross-sectional dimension of output paths during the transition phase.

With 1,473 commodity groups, apart from estimating the growth equation for the entire list of products, the data can also be broken down into subgroups. Although somewhat arbitrary, the theoretical growth literature features two competing models: "intermediate goods" and "love of variety."[27] The first model assumes that R&D leads to an increasing variety of intermediate inputs used in the production process. This becomes a vehicle for higher productivity. In the second approach, "love of variety" modelling, consumers prefer to purchase a larger range of goods as compared to purchase a smaller product spectrum. Increasing product variety raises utility by giving consumers more of what they actually want rather than forcing them into one-size-fits-all choices. Given the

[25] We have not added an indicator of initial conditions because Krueger and Ciolko (1998) have shown that government's reform is to some extent determined by initial conditions leading to multicollinearity problems. Favourable starting conditions might generate better results with respect to growth, making it easier to accept the negative effects of reform, resulting in faster and more encompassing reform.

[26] This result is consistent with the empirical evidence for Korea, Taiwan and Japan and the OECD countries in Feenstra et al. (1999a, 1999b) and Funke and Ruhwedel (2001).

[27] The empirical product variety measures in Figure 1-3 are hybrid measures covering both model variants.

size of our dataset, we have additionally computed export variety in “investment goods” ($\Delta PV_{EX\text{-}CAP}$), as well as export variety in “consumer goods” ($\Delta PV_{EX\text{-}CON}$), to determine whether both modelling approaches are equally important for the transition economies.[28] The resulting disaggregated variety measures for both classes of goods are given in Figure 4 and 5 below.

[28] All manufacturing industries are classified into “Basic Goods Industries,” “Capital Goods Industries” (437 Commodity groups including structural metal products, mechanical engineering, road vehicles, shipbuilding, aircraft and spacecraft, electrical engineering, precision and optical instruments, tools and finished metal products and office machinery) and “Consumer Goods Industries” (370 commodity groups including musical instruments, ceramic products, glass products, wood processing, paper products, printing, plastic products, leather products, textiles and wearing apparel). We do not consider product variety in the basic goods industries because these industries rely more heavily on natural resources and therefore do not seem to fit the idea of endogenous growth very well. The non-trivial mapping of SITC trade data to the ISIC industry typology was done using the trade and industry concordances offered by Jon Haveman (see www.macalester.edu/research/economics/PAGE/HAVEMAN/Trade.Resources/TradeConcordances.html).

Figure 4. Relative export variety of capital goods ($\Delta PV_{EX\text{-}CAP}$)

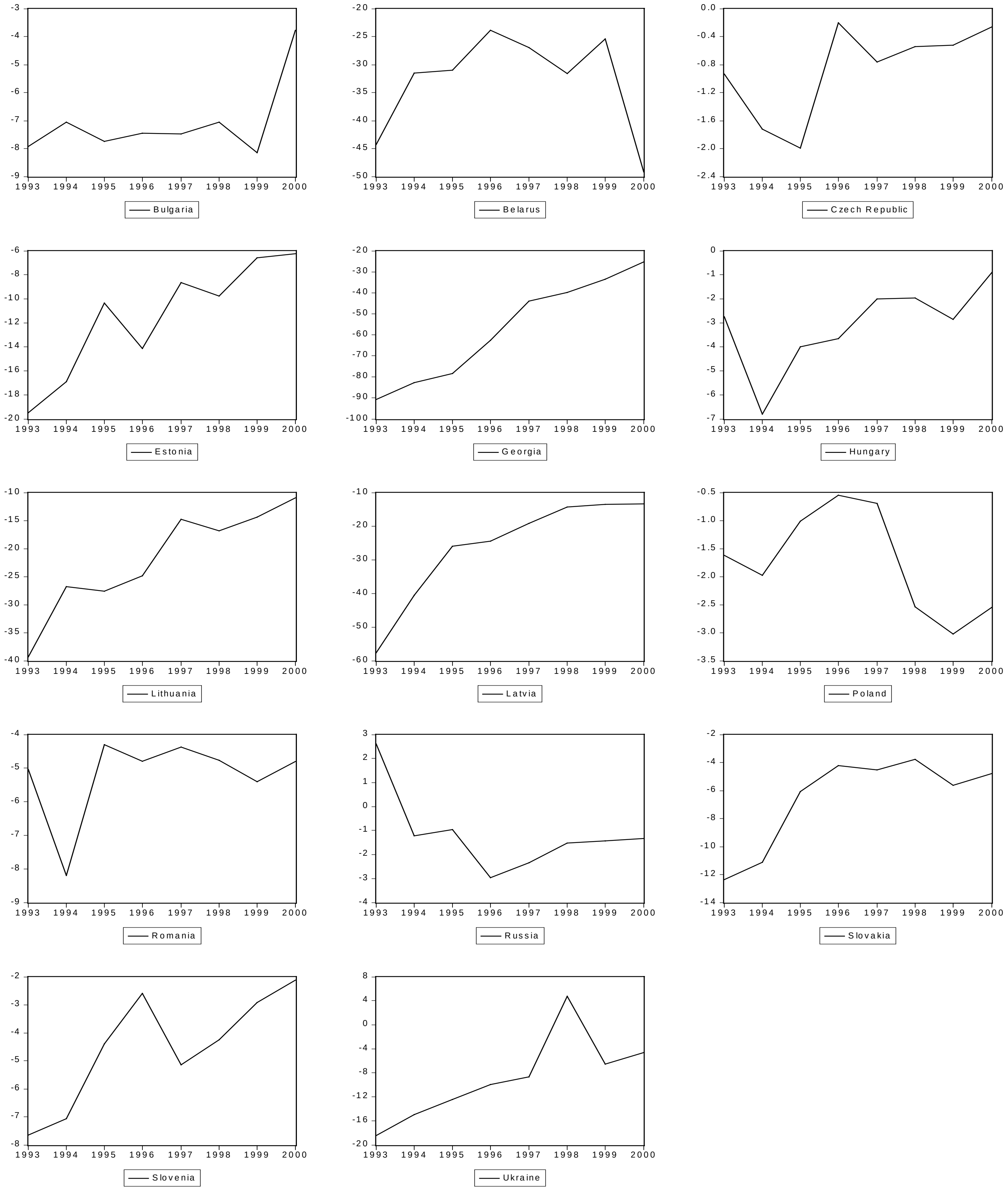
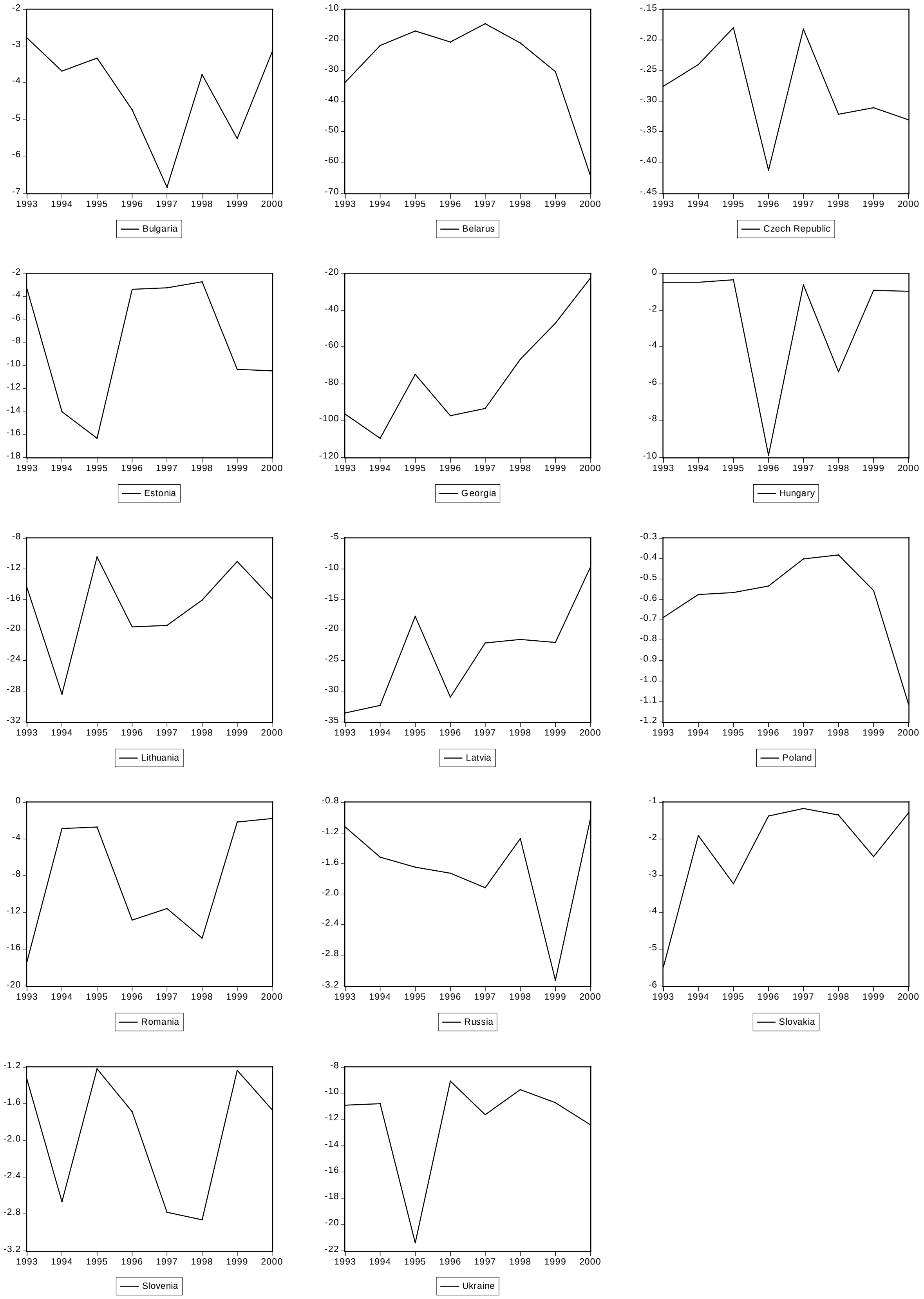


Figure 5. Relative export variety of consumer goods ($\Delta PV_{EX\text{-}CON}$)



Does one of the explanations "trump" the other? Sorting this turns out to be a worthwhile exercise. The disaggregated regression results are presented below.

Table 6. Regression results for investment good variety versus consumption good variety

	(1)	(2)
Constant	-0.05	-0.09
	(0.2)	(0.4)
$\Delta PV_{EX\text{-}CAP}$	0.10	-
	(4.3)	
$\Delta PV_{EX\text{-}CON}$	-	0.07
		(0.8)
IY	2.29	3.67
	(1.7)	(2.6)
EBRD-I	2.34	0.41
	(2.6)	(0.7)

Note: We have used a Bartlett kernel and select the bandwidth $m = 2$. The qualitative results obtained are robust to changes in the window specification. The *z*-values in parentheses are based on the heteroscedasticity and spatial correlation consistent standard errors as discussed in the text. See text for data definitions and sources. The sample period is 1994 – 2000.

The decomposition into "investment goods" and "consumption goods" in Table 6 produces a surprise. The data fail to reject the null hypothesis that consumption variety does not contribute to growth. Indeed, to the contrary, export variety is still the factor that determines which the pace of economic development. In a simplified way, the conclusion from Table 6 is that export variety matters for growth of transition economies, but not all industries. While this is an important result in itself, it tells us little about the reasons behind inter-industry differences. One interpretation might be that production of capital goods is, on average, higher-skill intensive.[29]

5 Summary and implications

Economic growth is a complex phenomenon, but economists like parsimony. They have long speculated that increasing product variety may generate higher per capita incomes and economic growth. Yet, despite significant policy implications, systematic empirical evidence on the actual magnitude of product variety is just beginning to emerge. Using contemporary econometric methods, our empirical results indicate that productivity gains from export variety are empirically relevant to Eastern European transition economies, i.e. GDP per capita (in PPP) is linked to the widening of the product spectrum.[30] However, the importance of variety in determining per capita income depends upon the characteristics of the sector. This evidence provides a better understanding of transition mechanics, and thus export variety constitutes a useful indicator for measuring progress in transition that has

[29] The capital goods industries include the ISIC industry codes 382-385 (manufacture of metal products, engines, turbines and transport equipment) which have been classified by Wood (1994) as high-skill industries.

[30] This evidence is consistent with the "integration view," which gives market integration and impediments to it a starring role in fostering economic growth between rich and poor regions of the world. Notable recent research in this area includes Frankel and Romer (1999).

been generally neglected in the literature. We hope that our findings, which are based on a highly disaggregated empirical approach, encourage researchers to pursue these issues further.

The product variety data presented above also suggest a wide heterogeneity across countries. The crucial question for policy is whether this heterogeneity is inherent in the way competitive markets operate and evolve over time, or also depends on policy and institutional settings in product and labour markets that might be amenable to reforms in the context of a growth-oriented strategy. Certainly, it suggests an area for further investigation.

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