Different Dimensions of Diversity across Europe /

Aspekte von Diversität im Prozess der Europäisierung

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Vorwort

Die beiden Aufsätze dieses Bandes betonen verschiedene Aspekte von Diversität, die durch die zentralen Konzepte „Europa und Europäisierung" der laufenden forost-Projektphase angestoßen wurden. Belegt wird, dass Diversität sowohl Chancen als auch Risiken für eine Gesellschaft in sich bergen. Frensch und Gaucaite-Wittich zeigen den Nutzen von Diversität in Gestalt einer höheren Vielfalt von Produkten, die sich – verfügbar gemacht durch Handel – in höherem volkswirtschaftlichem Wachstum niederschlägt. Dagegen demonstriert Dietz, dass Diversität in Migrationsmustern auf Seite der aufnehmenden EU Länder nicht nur positive Aspekte besitzt, sondern auch Gefahren in sich birgt. Das wiederum impliziert die Notwendigkeit konzertierter Aktion mit dem Ziel der Formulierung einer gemeinsamen Migrationspolitik in der Europäischen Union, um vom Zustrom der Menschen auch tatsächlich zu profitieren.

Der Aufsatz von Barbara Dietz widmet sich den neuen migrationspolitischen Herausforderungen an den Grenzen der erweiterten Europäischen Union im Osten. Hier konzentriert sich der Blick auf die Migrationsbeziehungen zwischen der Ukraine und der Europäischen Union, deren Dimensionen, Ziele und Ursachen untersucht werden. Die Studie zeigt eine zunehmende regionale Diversität dieser Wanderungsbewegungen seit dem Ende der neunziger Jahre. Während die starken Unterschiede des Lebensstandards und die wachsende Arbeitslosigkeit in der Ukraine die Wanderungen in die Europäische Union anstoßen, sind im Falle Deutschlands, Polens, Ungarns, der Tschechischen Republik und der Slowakei auch traditionelle Netzwerkbeziehungen dafür verantwortlich. Hingegen zeigen sich in anderen EU-Ländern wie z.B. Portugal, Spanien, Italien und Griechenland bemerkenswerte Migrationsströme aus der Ukraine, ohne dass es vorher besondere Beziehungen weder auf ökonomischem oder politischem Gebiet noch aufgrund von Migrationsbeziehungen in der Vergangenheit gab. In diesen Fällen war die Nachfrage nach geringqualifizierten, oft saisonalen Arbeitskräften ausschlaggebend für die Wanderungsbewegungen. Obwohl ein großer Teil dieser neuen Migrationen temporär und zirkulär sein dürfte, sehen sich die Mitgliedsstaaten der Europäischen Union einem wachsenden Immigrationsdruck aus der Ukraine gegenüber. Vor diesem Hintergrund ist es das Ziel der Europäischen Union eine gemeinsame Migrationspolitik zu entwickeln um den wirtschaftlichen und sozialen Nutzen dieser neuen Wanderungen zu realisieren.

Der Aufsatz von Richard Frensch beschäftigt sich mit der direkten Messung technologischer Zustände mit Hilfe von handelsbasierten Maßen der Produktvielfalt. Zählmaße der Vielfalt von Kapitalgütern verhalten sich – unter Berücksichtigung von Produktdifferenzierung nach Herkunftsland – tatsächlich wie Technologiemaße, wenn Änderung von Technologie als ein Lernprozess aufgefasst wird. Dies trifft hingegen nicht auf Zählmaße der Vielfalt von Vor- und Zwischenprodukten zu. Auf der Basis dieser Ergebnisse, die auf Paneldaten für OECD und Transformationsländern basieren, lässt sich konstatieren, dass es im Untersuchungszeitraum tatsächlich zu einer bedingten technologischen Konvergenz gekommen ist. Lässt man auch Einflüsse von Transformationsreformen auf die technologische Konvergenzgeschwindigkeit zu, so findet sich ein signifikanter, positiver Einfluss der Transformationsreformen im Finanz- und Bankenwesen auf die geschätzte technologische Konvergenzgeschwindigkeit.

Preface

The two papers in this volume stress different aspects of diversity, made possible by "Europe and Europeiasation," the central concepts of this forost project phase. The papers constitute evidence on that diversity incurs both benefits and risks for a society. Frensch and Gaucaite-Wittich stress the benefits of diversity, in as much as an increasing variety of products, available in an economy by way of trade, will result in higher growth. Dietz, however, demonstrates that the diversity of migration patterns may well be perceived as risk and chance on the receiving side, implying concerted action aiming at common migration regulations to benefit from the inflow of people.

The first paper tackles the issue of direct measurement of the state of technology by trade-based measures of product variety. A trade-based count measure of the variety of available capital goods, defined over an expanded product space allowing for product differentiation by country of origin, is indeed found to behave "as if" it represented technology when change of technology is understood as a learning process. Variety measures of available primary and intermediate inputs do not behave this way. Based on available capital goods variety estimations, there is conditional technological convergence among a panel of mostly OECD and transition countries. Extending the analysis to allow for transitional reforms to influence technological convergence shows that banking reforms exert a positive and significant effect on the speed of technological convergence.

In focussing on the migration policy challenges at the new Eastern borders of the enlarged European Union, the second paper of this report analyses the determinants, patterns and dimensions of recent migrations between the Ukraine and European Union member states. Concerning the choice of destination regions, the study reveals an increasing regional diversity in the movements between the Ukraine and European Union countries since the end of the 1990ies. Whereas high income differences and a lack of job opportunities in the sending country trigger these movements in general, they are additionally based on traditional migration patterns and network relations in states such as Germany, Poland, Hungary, the Czech and the Slovak Republic. In other countries, such as Portugal, Spain, Italy and Greece, labour migrations from the Ukraine have developed in the absence of networks, cultural and political ties. In these cases, the demand for low-skilled labour in segmented markets, particularly in the nontraded goods sectors of the economy seems to have supported the movement of Ukrainian labour migrants. Although a considerable part of these movements are expected to be temporary or circular, European Union countries face a potentially substantial labour migration from the Ukraine, further diversifying their immigrant populations. As the number of Ukrainian citizens willing to enter the European Union will almost certainly exceed the legal opportunities currently in force, illegal migrations are likely to occur. Although the European Union has undertaken some efforts to develop common migration regulations, many of the proposed policy measurements are still indeterminate, particularly in the case of low-skilled labour movements.

Bamberg, Nürnberg und Regensburg im November 2007
Friedrich Heckmann und Joachim Möller

Inhalt

Migration policy challenges at the new Eastern borders of the enlarged European Union: The Ukrainian case

Barbara Dietz

Abstract*

With the enlargement of the European Union, new bordering countries emerged in the East which are characterized by comparatively low incomes and living standards, incomplete democratization and a number of latent political conflicts. Against this background it can be expected that migrations from these countries into the European Union will be growing, although a considerable part of the expected movements might be temporary or circular. Focussing on the Ukraine which shares borders with four European Union countries (Poland, Slovakia, Hungary, Romania) and which entertains migration relations with a number of European Union member states, this study identifies the new migration challenges at the Eastern borders of the enlarged European Union. The study reveals, that some European Union states are particularly addressed by Ukrainian labour migrations. Whereas high income differences and a lack of job opportunities in the home country trigger these movements in general, they are additionally based on traditional migration patterns and network relations in states such as Germany, Poland, Hungary, the Czech and the Slovak Republic. In other EU member states, such as Portugal, Spain, Italy and Greece, the demand for low-skilled labour in segmented markets, particularly in the nontraded goods sectors of the economy seems to have primarily supported the movement of Ukrainian labour migrants. Although the European Union has recently undertaken some efforts to develop common migration regulations, many of the proposed policy measurements are still indeterminate, particularly in the case of low-skilled labour movements.

1 Introduction

The European Union is one of the most attractive parts in the world to migrate to, although some European Union member states have tried to reduce and control immigration as much as possible. This situation has been reinforced by the enlargement of the European Union which resulted in new migration challenges at its Eastern borders, facing Russia, the Ukraine, Belarus and Moldova. As in the case of many migrant sending states, the new East European neighbour countries of the European Union are characterized by comparatively low incomes and living standards,

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incomplete democratization and a number of latent political conflicts. Against this background it can be expected that migrations from these countries into the European Union will be growing, although a considerable part of the expected movements might be temporary or circular, meaning a repeated back and forth migration between sending and receiving countries. Presumably migrations in search for labour will dominate East-West movements, although ethnic return migrations, asylum and transit movements will also play a role. As the number of people willing to enter the European Union countries will certainly exceed the legal opportunities, illegal migrations are likely to occur.

Past experience shows that not all member countries of the European Union are confronted with a similar migration pressure from outside. Nevertheless, the free movement of people within the territory of the European Union led to the dependence of each member state on the immigration practice and policy of other European Union states. This situation calls for a unified and comprehensive European Union migration policy – a policy which has already been partly realized in the field of asylum regulations and border control and which is currently discussed in the field of labour migration.

This study identifies the new migration challenges at the Eastern borders of the enlarged European Union – focusing on the Ukraine which shares borders with four European Union countries (Poland, Slovakia, Hungary, Romania) and which entertains migration relations with a number of European Union member states. In the second part of the study it will be examined, how migration movements have developed since the Ukraine became independent in 1991. Against the background of theoretical considerations, migration motivations and the most important countries of destination will be portrayed. The third part reviews the discourse on the risks and chances of migrations in the European Union and the sending region Ukraine to identify economic and political concerns with respect to recent and potential movements. In a fourth part, the paper examines European Union migration policies currently in force and it surveys the discussion on future European Union migration policy options towards the new neighbouring countries in the East of its borders. The final part summarizes and concludes.

2 The Ukrainian migration experience: determinants, facts and figures

Since its independence in 1991 the Ukraine participated in international migrations which appeared as a result of the economic and political transformations of the country and of the fundamental geopolitical changes following the break up of the Soviet Union (Frejka et al. 1999, Tishkov et al. 2005). Although the area of today's Ukraine has been involved in numerous migration movements in its history, as for example the high emigrations in the late 19th and early 20th centuries[1], followed by resettlements, forced migrations and labour movements in the Soviet

[1] In that time emigrants left for the United States, Argentina, Brazil and Canada as well as for Siberia and Central Asia.

period, migration after independence was unique. In a comparatively short period, the Ukraine experienced considerable immigrations and emigrations because of ethnic reasons as well as refugee, transit and economic migrations.

2.1 Determinants of migration: theoretical considerations

In many studies, international migrations are nearly exclusively related to economic factors, such as income differentials and employment opportunities. This is rooted in the neoclassical theory of labour migration which emphasizes the responsibility of wage differences between different countries or regions for the movement of people. Given free mobility, workers move from countries with lower wages to those with comparatively higher wages (Bauer and Zimmermann 1998). In the framework of this model, where full employment, no migration costs and no insecurity exist and all individuals behave rationally, the larger the wage gap between sending and receiving areas, the more people will move. If wages increase in the sending area, migration will decrease, whereas a wage increase in the receiving country will lead to the opposite effect. In formulating a more realistic model, further theoretical work in the framework of neoclassics allowed unemployment in sending and receiving areas to exist. In this case, labour migration depends on the expected and not the absolute real wage differentials, thus taking the chance to find a job into account (Harris and Todaro 1970).

Modelling the migration decision in a micro context, human capital theory argues in the framework of neoclassics, but from a strictly individual point of view. This concept focuses on individual decision-making and highlights the importance of human capital characteristics in the migration process (Sjaastad 1962). According to human capital theory, people move if the expected returns to individual human capital - reduced by migration costs - are bigger in the immigration than in the home country. Incorporating migration costs which include the costs for travelling, information and income losses, as well as the psychological costs of leaving family, friends and the home country environment, obviously improves the explaining power of the model. If individual migration decisions are seen in dependence of human capital characteristics, sociodemographic factors influence the movement of people. In this framework, the demographic structure of sending countries is an important determinant for migration movements. As young people with a comparatively long working career ahead of them profit most from migrations, it can be expected that movements are stronger the younger the age structure of the sending countries is. This is reflected by many past and contemporary (labour) migration flows, which mostly consist of people in the beginning of their working career.

Apparently migration is a risky task, a fact that individual cost benefit approaches allow introducing. Dependent on individual risk aversion people decide to move in comparing a secure income at home with the expected value of earning abroad, discounted by risk aversion. Similar to risk aversion, expectations on future home country developments operate. In this context, the option value of waiting is a key argument, suggesting

that potential migrants have an incentive to wait, if they are not sure migration pays off (Burda 1995). Thus, migration decisions may become obsolete in the longer run; given economic conditions improve in the home countries. The high relevance of expectations in the context of migration decisions has been emphasized by a recent World Bank report which found decreasing migration trends in sending countries if people think that the quality of life there will improve (Mansoor and Quillin 2006: 13).

Rejecting a purely individual point of view and the dominance of wage differential in explaining the movement of people, the new economics of labour migration argue that households are the relevant decision making unit and that the failure of capital, credit and insurance markets are primarily responsible for migration movements (Stark 1991). In the case of developing countries rural households can only survive under market conditions if they make capital investments and insure their production against risks. Likewise, workers in poor countries and in a number of transition economies are not (fully) protected by governments from unemployment risks and old age pensions are not guaranteed. In the absence of insurance systems and functioning capital as well as credit markets, family members are sent abroad to earn money for capital-building and risk insurance. Consequently, the migration decision of households can be interpreted as a portfolio strategy to diversify family incomes. In a further argument, the new economics of migration identifies relative deprivation to determine migration movements. If households earn a low income compared to their home country reference group, they tend to send family members abroad to relatively improve their income position.

Whereas most economic theories refer to the labour supply side in the migration process, some economists point to the demand for labour in segmented labour markets as the initial incentive for international movements (Piore 1979). In advanced industrial societies labour market segmentation is characterized by a primary labour market with secure employment conditions, comparatively high wages and social security standards, and a secondary labour market with a highly variable demand, low wages, little security and difficult working conditions. Because native workers are drawn into the primary sector of the economy and in many cases are not willing to accept secondary labour market jobs, immigrant labour is recruited. Under these conditions a growing demand for workers in the secondary labour market presumably leads to an increase in immigration, since enterprises are not willing to pay higher wages and improve labour conditions in secondary markets as a precondition to attract native workers. Particularly nontraded goods sectors – that can not be outsourced and do not require a high skill level – can be expected to be characterized by segmentation and the demand for low skilled immigration.

In some cases, demand-driven labour migrations have been supported by governmental recruitment programs or bilateral contracts. An example is the labour movement from Southern European countries to Germany in the 1960s and 1970s which had been initiated by the so-called guest worker policy. Since the early 1990s, Germany and some other European Union countries again established recruitment schemes for short-term

labour by concluding bilateral agreements with East European and former Soviet Union states.

To understand the dynamics of international migrations, network theory has argued that across time and space migrant networks develop which stabilize and potentially increase population movements. In this context migration networks are defined as connections between migrants and non migrants in countries of destination and origin through ties of kinship, friendship, and shared community or ethnic origin. Because networks reduce the costs and risk of movements, they are expected to increase the likelihood of further migrations (Massey et al. 1998: 42). The development of migration networks influence the individual migration decision in such a way that the greater the number of migrants a person back home in the sending area knows, the greater the probability that this person will also migrate.

Although economic factors and supporting network relations have been proven to be key determinants in explaining international migrations (Mayda 2005), they have shortcomings. In a number of cases these are related to the fact that migration theories argue in the context of a world without migration barriers. In reality, however, migration policies and institutional barriers play a decisive role in channelling international movements (Hatton and Williamson 2002). Consequently state policy has to be introduced into migration models to capture the effects of legal migration regulations (Hollifield 2000). A further conceptual extension is needed in the case of refugee and (ethnic) return movements, which are closely related to political and ethno-national migration motivations, although economic hardship may play a role as well. Because of (civil) wars, political instabilities, national conflicts and ethnic discriminations in sending areas people are driven out, while asylum laws, citizenship regulations and the ethnic affinity of returning migrants towards receiving states act as pull factors. These migration determinants are best modelled in the framework of considerations which reflect historical, ethno-national and political preconditions in sending and receiving countries.

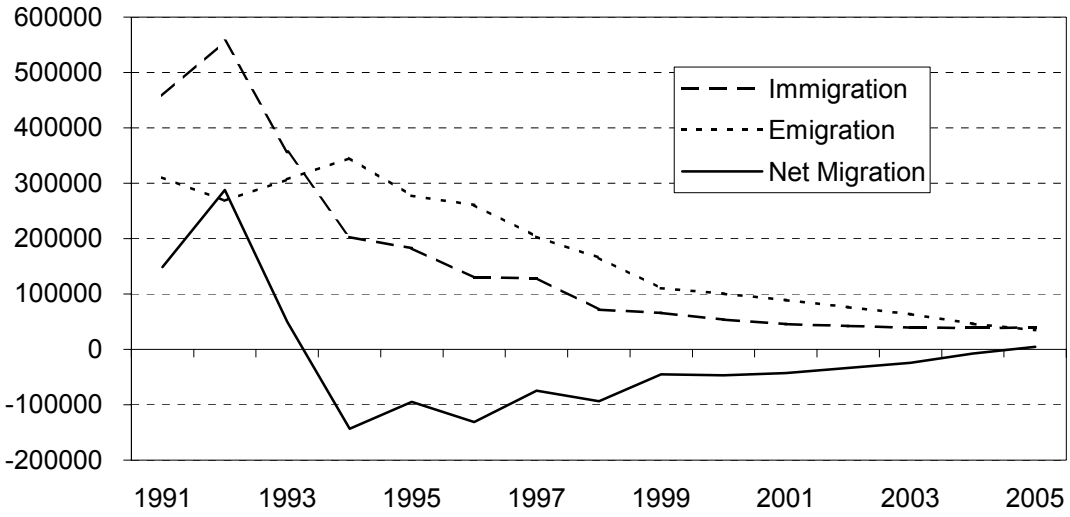
Although the theories described above focus on different levels of analysis and built on different assumptions and scientific disciplines, they are not mutually exclusive. To explore the complex determinants of empirical migration movements it is reasonable to draw on a combination of theoretical argumentations in identifying the economic, social and legal aspects that drive international movements.

2.2 Migration in the Ukraine: empirical evidence

In the two years following independence, the Ukraine experienced a high positive net migration which slowed down significantly in 1993 and turned negative between 1994 and 2004. In the year 2005 – after eleven years of out migration – a small migration surplus was achieved (see figure 1).[2]

Immigration into the Ukraine reached its peak in the year 1992 when more than half a million persons entered, most of them coming from the successor states of the USSR (Malynovska 2006). In subsequent years the number of immigrants decreased continuously, achieving its so far lowest figure (38 500) in 2004. As in the case of immigration, emigration was highest in the beginning of the nineties. With nearly 346 000 persons leaving, emigration mounted in 1994, slowing down year by year afterwards. Overall the Ukraine lost 246 000 people as a result of officially registered migration movements between 1991 and 2005 (TransMONEE 2006).

Figure 1: Immigration, emigration and net migration in the Ukraine (1991-2005)



Sources: TransMONEE 2006 database, State Statistics Committee of Ukraine

In the nineties a considerable number of border crossings occurred between the Ukraine and (neighbouring) states with no visa regime such as Poland and Hungary which were not reflected by migration statistics. These movements consisted of short-term, circular trips undertaken by

[2] The data presented here refer to the TransMONEE 2006 data base. In a number of years (1991, 1993, 1995, 1996, 1997, 1998, 1999, 2000 and 2001) the TransMONEE data differ from official Ukrainian migration statistics, presumably because of a different definition of immigrants with respect to citizenship categories. As negative net migration data delivered by the Ukrainian statistical office are higher in the respective years than those of TransMONEE it is suspected that a considerable number of ethnic Ukrainians who returned to the Ukraine from the former Soviet Union had not been counted as immigrants by the State Statistics Committee of Ukraine.

people engaged in petty-trade (shuttle trade). On both sides of the border, Ukrainian citizens bought and sold goods to profit from price and exchange rate differences. According to opinion polls conducted in the middle of the 1990ies regular trips abroad to improve income and living standard had become a key business activity for approximately 5% of the economically active population in the Ukraine while 20% of the working-age population attempted these trips occasionally (Frejka et al. 1999: 6).

After independence immigrations into and emigrations from the Ukraine were characterized by the dominance of exchange movements with former Soviet Union states, first of all Russia. Between 1991 and 2004, over 90% of all immigrants into the Ukraine came from post Soviet countries, whereas 75% of all emigrants left for the successor states of the USSR (Malynovska 2006). Although overall officially registered emigration declined since 1994, the share of people leaving for the West increased from 20% in the beginning of the nineties to 33% in 2004, confirming the growing weight of Western, primarily European Union states as destination for migrants, leaving the Ukraine (Malynovska 2006).

Based on the data presented above, emigrations from the Ukraine followed a decreasing trend since the middle of the nineties which contradicts the empirical observation that Russia as well as a number European Union countries faced an increasing immigration from the Ukraine in that period (see table 4). This inconsistency is due to the fact that only persons who receive an official permission to reside abroad are registered by Ukrainian officials as emigrants. Ukrainian citizens, who leave the Ukraine on the base of a tourist visa, participate in bilateral agreements for short-term work or in a student exchange program are not counted in official emigration statistics. Besides, illegal border crossings add to an increased number of Ukrainians, living and working abroad.[3]

What were the basic determinants which drove migration movements in the Ukraine since its independence? Referring to the theoretical argumentations introduced earlier it will be argued that a combination of ethnic and economic motivations as well as of social and legal factors were responsible for migrations in the Ukraine, although the weight of the respective causes changed over time. Whereas ethnic and political migration motivations had been prevalent in the beginning of the migration exchange with post Soviet states, economic determinants increasingly won in importance since the end of the nineties. This reflects the dominance of ethnic return movements after the dissolution of the Soviet Union when national minorities had an opportunity to return to their newly founded nation states. A similar pattern was observed with respect to migrations into Western countries. While a decreasing number of emigrants left the Ukraine because of ethnic, religious and political motives, the number of people that entered Western countries in search for (short-term) work grew.

[3] The weak and often inconsistent data base is a general problem in documenting international migration. This study addresses the dilemma by using various statistical sources on migrants' stocks and flows, by referring to estimations in the case of illegal migrations and by taking survey studies into account.

Consistent with economic migration theory high differences in income between the Ukraine and Russia as well as between the Ukraine and Western states exist, which are expected to exhibit a strong migration incentive (see table 1). In 2005, for instance, the GDP per head in the Ukraine amounted to 32% of that in Russia and to 15% of that in the Czech Republic, providing a solid migration motivation since the middle of the 1990ies.

A look at real GDP growth rates in the Ukraine indicates an improvement of the economic situation since the turn of the century, although the Ukrainian economy has still not reached its size prior to transition. As in the case of developing countries where dynamic growing economies are consistent with high emigrations (Massey 2005) it is assumed that emigration pressure in the Ukraine will not be promptly reduced in the presence of GDP growth. This is related to the economic transformation from a planned to a market economy where the radical change of social structures encourages growth but creates a mobile population in search for employment opportunities.

A recent World Bank report found the labour market in the Ukraine in an early stage of transition, indicating that labour reallocation which will result in an increase in unemployment still lies ahead. While unemployment rates in the Ukraine are not remarkable in a transition country comparison (9% in 2003 according to ILO standards), a low labour participation rate points to job scarcity. Less than 60% of the Ukrainian working age population was employed in 2003 that is below the OECD average of 65% (World Bank 2005). In recent years, many workers had been discouraged by the poor job opportunities in the Ukraine and have withdrawn from the officially registered labour force. Besides working in the shadow economy, (short-term) migration is an option to obtain gainful employment.[4]

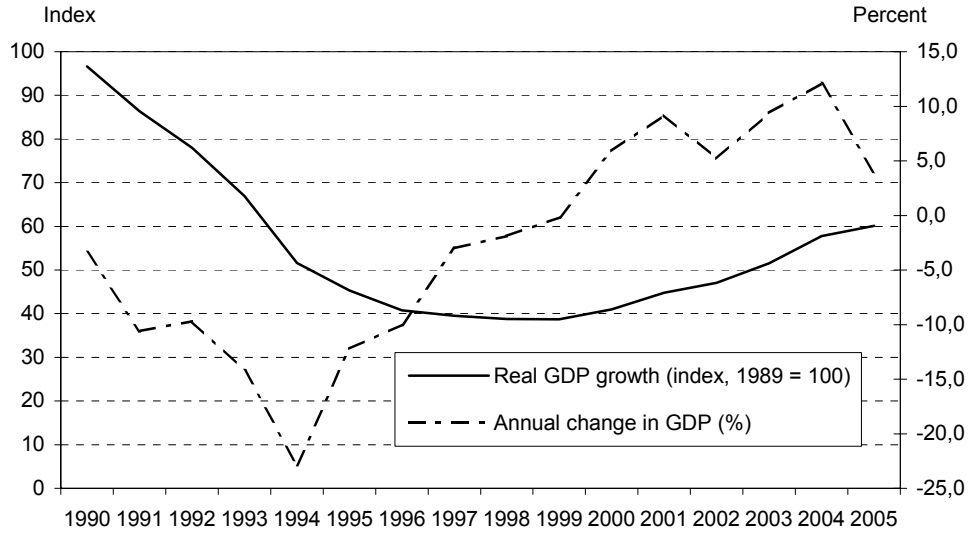
Table 1: GPD per capita (PPP, in US $), various European countries, Russia and Ukraine

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Germany	21 855	22 622	23 418	24 230	25 481	26 405	26 858	27 196	28 303
Italy	21 802	22 455	23 111	23 721	24 994	26 016	26 577	27 150	28 180
Spain	17 847	18 726	19 674	20 610	21 764	22 902	23 417	24 152	25 046
Greece	14 106	14 768	15 365	16 268	17 391	18 632	19 588	20 841	22 204
Portugal	14 696	15 575	16 416	17 220	18 255	18 933	18 974	18 932	19 628
Czech Rep.	13 745	13 919	13 981	14 442	15 373	16 428	17 211	18 064	19 408
Hungary	9 958	10 801	11 544	12 220	13 223	13 900	14 710	15 451	16 814
Slovakia	9 279	9 887	10 418	10 799	11 303	12 005	12 817	13 426	14 622
Poland	8 050	8 737	9 251	9 763	10 401	10 855	11 219	11 965	12 974
Russia	5 795	6 038	5 932	6 401	7 095	7 561	8 130	9 036	9 902
Ukraine	3 628	3 610	3 640	3 748	4 108	4 581	4 903	5 524	6 394

[4] The shadow economy in the Ukraine was estimated by the World Bank to reach 54% of GDP in 2003.

Source: United Nations Database

Figure 2: Real GDP growth, annual change in GDP, Ukraine



Source: Transmonee Database

Approaching the migration decision from an individual perspective, survey studies revealed income differences and a lack of job opportunities as the two most important reasons for Ukrainians to emigrate. In a study conducted by the IOM in 1998, more than half of respondents (58%) named wages as motivation to migrate and 37% referred to good employment chances abroad (IOM 1998: 25). A very similar result was attained by a research, the IOM organized in 2006 in Belarus, Bulgaria, Moldova, Romania, and Ukraine (GfK 2006). The number one reason for working abroad was low income at home, given by 81% of respondents, whereas a lack of job opportunities in the country was identified second, by 60.8% of respondents (GfK 2006: 27). Furthermore, the new economics of migration which identify the insufficiency of markets for insurance, capital and credit as root causes for migration seem to be relevant in the Ukrainian context as well. Insurance markets are not functioning appropriately in the Ukraine and access to credits is very limited for average families (Institute for Economic Research and Policy Consulting 2004). This makes it attractive for people that for example plan to finance home ownership, to overcome the deficiencies of the credit market at home by earning an additional income abroad.

While economic arguments point to a considerable emigration pressure in the Ukraine, which in general is not constrained by Ukrainian laws, emigration movements are severely restricted by legal measures on the part of most receiving countries. Particularly in the context of migrations from the Ukraine into the European Union, restraining migration policies control the inflow of authorized (labour) movements, for example in the context of bilateral contracts on labour migrations. Nevertheless, labour migrants from the Ukraine can be expected to enter or work illegally in economically better off countries, as long as basic migration incentives

persist. In this context human smuggling plays a decisive role in fostering movements into states that close their borders towards immigrants. Furthermore, human trafficking - where criminal networks transport men, women and children across borders for the purpose of sexual exploitation and forced labour – is a serious problem in comparatively poor countries with a high migration pressure. A recent U.S. Department of State report and an IOM study found the Ukraine the most important source country of human trafficking in Eastern Europe and Central Asia (U.S. Department of State 2006, GfK 2006).

2.2.1 The migration exchange with the successor states of the Soviet Union

The first two years after the break up of the Soviet Union were characterized by a high migration exchange between the successor states of the USSR, now being independent nations. This was particularly true for the Ukraine which received 984 000 immigrants from various parts of the former Soviet Union in 1991 and 1992 (Malynovska 2006). Most of these immigrants belonged to the group of ethnic Ukrainians (repatriates) who returned from Russia, Kazakhstan or Belarus. Furthermore Crimean Tatars resettled in large numbers in the Autonomous Republic of Crimea, their traditional homeland. A remarkable part of these movements was related to (forced) migrations in earlier periods of the Soviet era. In the 1930-50s, Ukrainians and other ethnic minorities (Crimean Tatars, Germans and Poles) living in the Ukraine had been subject to deportation and (forced) resettlement. They were sent to Northern and Eastern parts of Russia, to Kazakhstan and other regions of the Soviet Union. In later years the Soviet regime actively supported labour migrations which aimed at a population exchange within Union Republics. While the Ukraine was a net immigration republic throughout the Soviet era, ethnic Ukrainians were the most important group to leave while ethnic Russians were the biggest group to enter. In 1989, at the time of the last Soviet census there were 6.8 million Ukrainians living in the Soviet Union outside the Ukraine, predominantly in Russia (4.4 million) and Kazakhstan (890 000), whereas nearly half (44%) of those 11 million Russians who inhabited the Ukraine in 1989 had not been born there (State Statistics Committee of Ukraine).

In addition to groups, moving to the independent Ukraine because of ethnic and homeland reasons, a number of immigrants looked for refuge, having escaped ethnic tension, civil war and political conflicts in their post Soviet home countries. Among these populations were people from Moldova, Armenia, Georgia and Azerbaijan who sought protection in the Ukraine which had passed a law on refugees in 1993, based on the 1951 Geneva Convention (Malynovska 2006). In the course of the 1990s the Ukraine became the address of refugee groups from outside the former Soviet Union as well, which came from regions hit by (civil) wars and economic crisis such as Afghanistan, Pakistan, Sri Lanka, African countries and the Middle East (IOM 1996: 135, Kraler and Iglicka 2002: 40, Mansoor

and Quillin 2006: 42). Some of these asylum seekers found refuge in the Ukraine, others moved on to the West.[5]

As in the case of immigration, emigration from the Ukraine was characterized by ethnic return movements in the early nineties. Ethnic Russians, moving to Russia made up the most important part of emigrants in this period. However, in the middle of the nineties the motivation for leaving the Ukraine towards post Soviet states, primarily Russia, changed. Against the background of the economic crisis in the Ukraine, economic reasons were increasingly an incentive to move out of the country. In part, emigrants left permanently for economically better off post Soviet states, mainly Russia. Besides, labour migrants crossed the border primarily towards Russia in search for short-term and seasonal work. In addition to considerable GDP differences between Russia and the Ukraine (see table 1), movements were encouraged by a common history in the Soviet period, language proficiency and (ethnic) network relations. It is not surprising, therefore that an estimated number of one million Ukrainians worked in Russia in 2002 (Malynovska 2004: 14). Most of these migrants were occupied in semi legal and illegal jobs in construction, agriculture and services.

Between 1991 and 2004, the Ukraine lost 1 897 500 persons who moved to post Soviet states, while 2 229 870 entered from the successor states of the USSR (Malynovska 2006). Because these movements were primarily related to repatriations and ethnic return movements, they affected the ethnic composition of the population to a considerable extend (see table 2).

Table 2: Ethnic composition of the population in the Ukraine (in thousands, 2001, 1989)

	2001	in % of the population 2001	1989	in % of the population 1989
Total	**48 457**	**100.0**	**51 452**	**100.0**
Ukrainians	37 541	77.8	37 419	72.7
Russians	8 334	17.3	11 355	22.1
Crimean Tatars	248	0.5	46	0.0
Poles	144	0.3	219	0.4
Jews	103	0.2	486	0.9
Armenians	94	0.2	54	0.1
Azerbaijani	45	0.1	36	0.0
Georgians	34	0.1	23	0.0
Germans	33	0.1	37	0.1

Sources: State Statistics Committee of Ukraine, Vestnik statistiki, no.10, 1990

[5] Because a readmission treaty has been signed between the Ukraine and the EU in the year 2006, the Ukraine will be obliged to take back third country nationals (as well as its citizens) entering the EU illegally from Ukrainian territory.

Due to a negative natural population development and an overall net emigration between 1989 and 2001 the population of the Ukraine decreased by 5.8% in this period. However, because of ethnic return migrations, the share of Ukrainians in the total population which had made up 72.7% in 1989, increased to 77.8% in the year 2001. In a similar way, the return of Crimean Tatars led to an increase of this ethnic minority by 5 times.

As census data reveal, population groups from post Soviet states that found refuge in the Ukraine enlarged their share such as Armenians, Azerbaijani and Georgians, whereas groups that left to their nation states lost in importance. The most prominent example is the Russian population in the Ukraine which decreased by 26.6% between 1989 and 2001, reducing its share in the total population to 17.3% in 2002, while in 1989 it had made up of 22.1% (State Statistics Committee of Ukraine).

2.2.2 The migration exchange with Western states

Migration into Western states is not a new phenomenon for the Ukraine. As a part of the Soviet Union, the country has experienced three waves of emigration towards the West: After the revolution in 1917, in the course of World War II and after the 1960s. Although the constitution of the USSR never contained any guarantee of freedom of movement, Soviet legislation permitted a very limited number of people to emigrate in the post World War II period for the purpose of reuniting families.[6] This emigration policy was primarily the result of the intervention of foreign states on the part of groups wishing to emigrate.[7] The main beneficiaries were Jews and Germans whose families had been wrenched apart by the events of the war and whose potential recipient countries (the USA, Israel and Germany) supported their cause. In the case of Jews, anti-Semitism forced people to leave, in the case of Germans, ethnic repression and forced resettlement in earlier periods were push factors.

In October 1989, the debate over emigration policy in the Soviet Union took a new turn. The Supreme Soviet approved a draft law on its first reading which put travel in and out of the country for Soviet citizens on a new basis. Most importantly, the draft law accepted reasons for emigration other than family reunion and recognized the individual right to travel. Consequently, emigration from the Ukraine to Western countries increased in 1989, reaching its so far highest number of issued permissions to leave in 1990, when 95 000 persons were allowed to depart (Frejka et al. 1999: 5). In admitting 92% of all emigrants from the Ukraine in 1990, Israel was by far the most important receiving country in this year, followed by the USA (3%) and Germany (1.5%).

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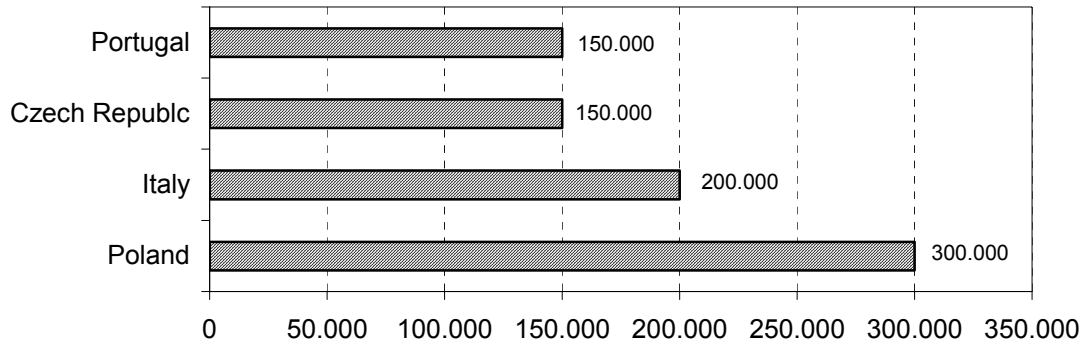
6 This refers to the "regulations on entry to and exit from the USSR" of June 1959. These rules of law were reviewed in 1970 and again in 1986, but were not fundamentally amended.

7 In this context the Jackson-Vanik amendment (1973) played a role, impeding trade unless Jews were allowed to leave freely. In addition the Soviet government signed the Helsinki accord (1975), pledging, among other things, to facilitate freer movements of its citizens.

Since the break up of the Soviet Union emigrants from the Ukraine to the West addressed new destination countries, many belonging to the European Union or becoming a part of it after May 2004 (Pribytkova 2006). In 1994, nearly every fifth emigrant (18%) from the Ukraine to the West chose a destination other than Israel, the United States and Germany. This development was related to a shift from ethnic to economic migration motivations originating in the economic crisis in the Ukraine which accompanied the transformation process. A labour movement towards the West established, which is reflected by the increase in registered labour migrants, rising from 11 800 persons in 1996 to about 40 000 persons in 2002 (Malynovska 2004). Besides, a high number of illegally employed Ukrainians are working in European Union countries. According to estimations of Ukrainians embassies about 800 000 Ukrainian labour migrants were occupied in various European countries in 2002, a considerable number of them illegally (figure 3).

Figure 3: Estimated numbers of Ukrainian labour migrants in Poland, Italy, the Czech Republic and Portugal (2003)



Source: Malynowska 2004

To channel the growing migration pressure and to prevent illegal labour movements, a number of European Union states has concluded bilateral agreements on temporary labour movements with the Ukraine or has established training programs for Ukrainian workers. Some European Union states which recently were exposed to (illegal) labour immigration from the Ukraine are discussing to introduce such bilateral agreements (see table 3). In the perspective of the Ukraine, bilateral agreements on labour migration became an increasingly relevant instrument to protect the rights of Ukrainian citizens working abroad.

What were the most important receiving countries in the European Union for Ukrainian labour migrants and which factors determined the choice of destinations? Although data sources are limited, the inflows of Ukrainian immigrants into selected European Union countries compiled by the OECD identify those states, which recently attracted Ukrainian (labour) migrants (see table 4). With respect to the background of Ukrainian immigration, the most important receiving European Union states can be classified into two groups, with Germany being a special case. One group consists of new East European Union member states, such as Poland, the Czech Republic, Slovakia and Hungary which formerly belonged to the Warsaw pact. No visa regimes had existed between these states and the Ukraine before

2003 (in the case of Slovakia before 2000), thus facilitating border crossings, shuttle trade and short-term work. A second group that hosts Ukrainian labour migrants includes Portugal, Spain, Italy and Greece. In these countries that transformed recently from emigration into immigration regions labour migration from the Ukraine is a new phenomenon. Besides, Germany entertains migration relations with the Ukraine, primarily in the context of ethnic, family and refugee movements. Other European Union member states have not admitted a considerable number of Ukrainian (labour) migrants yet, although empirical studies point to a growing population of Ukrainians, working (illegally) in the United Kingdom and in the Netherlands (Trades Union Congress 2004, Shakhno and Pool 2005).

Table 3: Bilateral agreements on temporary labour migration between the Ukraine and European Union countries

Country	Agreements on temporary labour migration
Czech Republic	up to 12 month with possible 6 month extension for work permit
Latvia	not specified
Lithuania	not specified
Germany	12-18 months
Poland	12-18 months
Portugal	12 months with possible 24 months extension
Slovakia	not specified
Belgium	in discussion
Greece	in discussion
Hungary	in discussion
Spain	in discussion

Sources: OECD 2004, Cipko 2006

The new members of the European Union, for example the Czech Republic, Poland, Hungary and Slovakia experienced little immigration in the past. However, the encouraging economic development in recent years and the accession to the European Union turned them into an attractive destination for refugees and labour migrants from poorer and more unstable regions in the East (Wallace 2002). Although Ukrainians belong to one of the most important new immigrant groups in the Czech Republic, Poland, Hungary and Slovakia, their immigration patterns differ somewhat in a country to country comparison. In the Czech Republic, immigration from the Ukraine is characterized by circulating labour and partly by long-term movements. Married men with a relatively high education, coming without their families, dominate the group of Ukrainian labour migrants in the Czech Republic. In Poland, Hungary and Slovakia migrants from the Ukraine were engaged in petty trade until the middle of the 1990s while in later years they performed primarily seasonal or short-term work (Drbohlav and Janska 2004).

Table 4: Inflows of Ukrainian citizens into various European Union countries (in thousands)

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Germany*	13.7	12.5	14.1	15.3	18.2	20.5	20.6	17.7	15.0
Italy	–	–	1.0	2.8	4.1	5.1	8.1	–	11.2
Spain	–	–	0.2	0.6	6.3	11.0	10.8	9.1	10.3
Portugal	–	–	–	–	–	45.2	16.5	2.5	0.7
Czech Rep.	1.1	1.4	1.5	1.6	1.0	2.4	13.0	23.7	15.0
Hungary	1.4	1.4	1.8	2.4	2.4	2.5	2.1	2.6	2.5
Slovakia	–	–	–	–	–	–	–	0.7	0.7
Poland	–	–	0.9	2.6	3.4	4.8	6.9	8.4	10.2

* ethnic German immigrants (*Aussiedler*) are not included

– not available

Source: OECD 2006

Next to geographic proximity, Ukrainian labour migration into the new European Union member states was triggered by income differences and job opportunities. In East European Union countries neighbouring the Ukraine, a substantial demand for (seasonal) unskilled labour exists which can not be satisfied by native workers. In addition, established network relations between ethnic minorities on both sides of the border strengthen potential movements in reducing costs and risks. In Zakarpathia (Ukraine) for example, near to the border of Hungary, approximately 151 000 ethnic Hungarians live, whereas the Polish minority in the Ukraine which settles near to the Polish border consists of 140 000 people. Ethnic ties to the Ukraine prevail on the Polish side as well where 312 000 Polish citizens are registered, who have been born in the Ukraine (OECD 2006: 269).

In the context of global migration movements it is a puzzling question why South European Union countries attracted Ukrainian migrants although no traditional economic, social or cultural relations exist and a comparatively far distance has to be overcome to reach these countries. In a European Union comparison, South European Union countries do not display the highest wages, which otherwise could be an explanation for the choice of this region. Nevertheless, existing income differentials between the Ukraine and South European Union countries can be considered high enough to make labour migrations pay off (see table 1). In addition, two further arguments have to be put forward to explain the new movements from the Ukraine into Portugal, Spain, Italy and Greece. On the one hand, a demand for low skilled, flexible labour exists in these countries, primarily in construction, agriculture, services and tourism. On the other hand, a comparatively inexperienced migration control and regularisation procedures attract Ukrainian migrants into these regions.[8]

The regularisation of immigrants is a controversially debated issue in European Union member states (Heckmann and Wunderlich 2005). While

[8] In recent years a number of efforts have been undertaken by Southern European countries to enforce immigration control.

North and West European Union countries usually oppose the legalization of illegals, South European Union states have practiced it frequently. The basic contra argument identifies legalization as an incentive to further (unwanted) immigrations. However, countries with a high number of illegals face a growing economic inequality, a loss of governmental incomes, distorted competition and social tensions. Thus, South European Union countries with little experience in regulating and controlling immigration use legalization procedures in order to manage migration after it has occurred. The high number of Ukrainian citizens which participated in recent regularisation programs in South European Union member states confirms a considerable illegal immigration from the Ukraine. In 1998 for example, Greece legalized 9 800 Ukrainians, Italy legalized 100 100 immigrants from the Ukraine in 2002 and Portugal 63 500 in 2001 (OECD 2005: 100).

Among European Union states that received Ukrainian immigrants in recent years, Germany represents a unique case. According to officially registered immigrations, between 1996 and 2004 Germany has been the most important receiving country for Ukrainian immigrants in the European Union (see table 4). This is related to the fact that Germany entertains migration relations with the Ukraine that date back to the beginning of the 1950ies. Since that period ethnic Germans (*Aussiedler*) return from the (former) Soviet Union to Germany where they are admitted on the base of the German constitution (Dietz 2006). They are entitled to receive the German citizenship and to obtain governmental support for economic and social integration. Although Ukraine is fourth behind Russia, Kazakhstan and the Kyrgyz Republic in sending ethnic Germans, approximately 40 000 return migrants of German origin had left the Ukraine between 1992 and 2006 to settle in Germany.[9] Next to ethnic Germans, Jewish immigrants from the former USSR – a considerable number form the Ukraine - were admitted in Germany since 1991 (Dietz 2004). This immigration is related to a decision of the last GDR government to grant asylum to Jewish citizens from the Soviet Union who had come to East Germany because they were threatened by persecution in their home country. Following German reunification, entry visas for Jewish immigrants from the former Soviet Union were provided on the base of the so-called quota refugee regulation, guaranteeing a residence permit for an indefinite period and entitling Jewish immigrants to various rights and integration benefits.

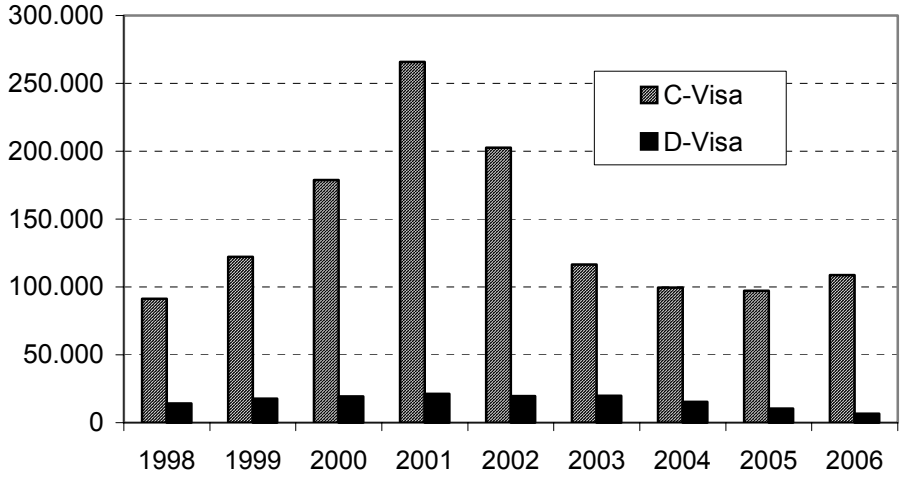
As a result of the admission regulations for ethnic Germans and Jewish refugees, immigration from the Ukraine to Germany was predominantly related to an ethnic and political background, although a limited number of labour migrants entered as well. Survey studies reveal that Germany is the number one destination country for Ukrainians, who plan to go abroad for work (IOM 1998, GfK 2006). Although (labour) migration from the Ukraine to Germany is strictly controlled, the increasing immigrant

[9] This number includes all persons who have come to Germany in the context of the '*Aussiedler*' regulation. A considerable part of them were not registered as Germans in the Ukrainian census, as they entered Germany as non German family members of *Aussiedler*. In addition to the return movement of ethnic Germans from other parts of the former Soviet Union into the Ukraine, this explains the comparatively small decrease of Germans in the Ukraine between 1989 and 2001 (see table 2).

population from the Ukraine in Germany fostered family reunification and attracted co-citizens who were inclined to live and work in Germany.

With the intention to facilitate travel and visits from the Ukraine, the German embassy relaxed visa procedures for Ukrainian citizens in the year 2000. As a result, the number of Ukrainians who received a German tourist visa (Schengen visa) jumped up (figure 4). Although the relaxation of visa procedures had been withdrawn in the year 2003, a considerable immigration of Ukrainian citizens into various European Union countries manifested.

Figure 4: C- and D- Visa, issued by the German embassy to Ukrainian citizens



C-Visa are short-term Schengen visa (max. 90 days) that relate to business, tourism, family visits

D-Visa are national visa for family reunification, students, au-pairs

Source: Foreign Office, Germany

In the recent decade, tourist visa regulations have been used by a number of Ukrainian citizens to legally leave the Ukraine for an illegal job in European Union countries, particular in Portugal, Italy or Spain. Furthermore, criminal networks that smuggle and traffic people across European Union borders take advantage of tourist visa procedures. Smuggling networks demand a substantial amount of money to transport Ukrainian citizens with the help of regular tourist visa to perform illegal work in the European Union (Cipko 2006). As recent regularisation procedures in South European Union states, for example in Portugal, prove a high number of illegally occupied Ukrainians had entered the destination region between 2001 and 2002 with a Schengen visa issued in Germany (Baganha et al. 2004). In a similar way, survey studies with Ukrainian immigrants found a considerable share of illegal workers in the Netherlands and in Portugal having left the Ukraine with a German Schengen visa (Baganha et al. 2004, Shakhno and Pool 2005). Nevertheless, no evidence exists that a great number of those Ukrainians who used a German Schengen visa to leave the Ukraine for illegal work, actually stayed in Germany.

Labour migrants from the Ukraine in the enlarged European Union earn their wages predominately in low-skilled jobs, often on a short-term base and in economic sectors that are typically characterized by labour market segmentation, such as agriculture, construction, care and services (Drbohlav and Janska 2004, Baganha and Fonseca 2004, Cipko 2006). This supports an argumentation introduced earlier by segmented labour market theory which points to the demand for low paid labour in segmented markets as a driving force for the international movement of people.

In recent years, Ukrainians citizens became an important new group in the foreign population of some European Union countries (see table 5). They can be found in Germany, Italy, Greece, Portugal, Spain, Hungary, Slovakia, the Czech Republic and Poland. In the year 2004, Ukrainian citizens were among the top two foreign nationalities in the Czech and Slovak Republic, in Hungary, Poland and Portugal (Baganha and Fonseca 2004, OECD 2006). In Germany, with a total foreign population of 6.7 million, Ukrainians were on place eight in 2004, ahead of traditional migrant populations from Spain and Portugal.

Table 5: Stock of Ukrainian citizens in various European Union countries (in thousands)

	1996	1997	1998	1999	2000	2001	2002	2003	2004
Germany	40.0	51.4	63.8	76.8	89.3	103.5	116.0	126.0	128.1
Italy	1.3	1.9	3.1	6.5	9.1	12.6	14.8	117.2	–
Greece	–	–	–	–	–	13.6	–	–	–
Portugal	–	–	–	–	–	46.4	62.0	64.8	65.8
Spain	–	–	–	–	–	–	26.2	–	47.6
Czech Rep.	46.3	43.4	52.7	65.9	50.2	51.8	59.1	62.3	78.3
Hungary	12.0	7.2	9.9	11.0	8.9	9.8	9.9	13.1	13.9
Slovakia	3.0	3.5	3.8	3.9	4.3	4.8	4.7	4.9	4.0
Poland	–	–	–	–	–	–	9.9	–	–

– not available

Sources: Portugal: Baganha and Fonseca 2004, Spain: Eurostat, others: OECD 2006

Whereas traditional international labour migrations, for example the so called guest worker movement in Western and Northern Europe, resulted in a domination of men in the immigrant population, this can only partly be confirmed in the case of the Ukrainian population in European Union countries. Although in the Czech Republic and in Portugal, the immigration from the Ukraine is dominated by men who are occupied in construction and agriculture (Drbohlav and Janska 2004, Baganha and Fonseca 2004), significantly more Ukrainian women work in Italy and Slovakia, where they are engaged in (household) services and care. This reflects the

feminisation of international migrations in response to the growing demand for female labour[10].

Although the migration exchange between the Ukraine and Western states is nearly exclusively characterized by an out migration from the Ukraine, a very small West-East labour movement can be observed recently, linked to the inflow of capital and to the establishment of various programs sponsored by international organizations. Generally, labour migrants involved in these movements are highly-skilled professionals, experts and specialists, mainly coming from European Union countries, Canada and the USA.

2.3 Future migration tendencies between the Ukraine and the European Union

In recent years, the Ukraine newly appeared as a sending country of (labour) migrants heading towards European Union states. With respect to future trends, some basic tendencies can be identified which are expected to shape the migration exchange between the Ukraine and European Union countries in the years ahead.

Against the background of persistently high income differences between the Ukraine and European Union member states and the substantial (hidden) unemployment in the Ukraine, labour migrations can be predicted to continue. First of all migrants performing low skilled jobs are assumed to be involved in movements directed towards those European Union countries that demand flexible and short-term workers in low skilled occupations. According to survey studies, potential Ukrainian migrants name a broad range of European Union countries as target for potential labour migrations (IOM 1998, GfK 2006). This indicates the readiness of Ukrainians to move to those places where job opportunities have opened up. After Germany, East and South European Union states, France and Great Britain have been identified to be particularly favoured by Ukrainian labour migrants.

With respect to the time dimension of labour migrations, empirical studies reveal a preference of Ukrainians towards (repeated) short-term trips and longer term temporary labour movements (IOM 1998, Mansoor and Quillin 2006). However, in the case of long geographic distances and restrictive migration policies in receiving countries, labour migrants indicated to stay longer as wanted, because frequent back and forth movements between destination and home country may be related to high risks and costs (Shakhno and Pool 2005).

As a general trend, irregular labour migrations between the Ukraine and a number of European Union countries can be assumed to persist. This has to be understood against the background of a considerable migration pressure in the Ukraine which is not controlled by Ukrainian laws any more, while European Union countries stick to a strict migration regime,

[10] The increasing number of women participating in the labour force of advanced economies creates the demand for low paid female migrants who work in care and household services. This phenomenon has been described as global care chain (Ehrenreich and Hochschild 2002).

opening few options for legal labour migrants. At present, only a small part of labour migrations are based on bilateral (guest worker) agreements, to meet the labour market demands of receiving European Union states in a regulated way. Nevertheless, a number of European Union countries discuss the introduction of bilateral agreements on short-term and seasonal labour migrations with the Ukraine. Whereas in the view of European Union countries bilateral agreements are understood as an effort to reduce illegal migrations, in the view of the Ukraine they are expected to contribute to the protection of the rights of Ukrainian labour migrants.

A further group of migrants from the Ukraine into the European Union will consist of refugees, (ethnic) return migrants, students and persons, eligible for family reunion. In the case of (ethnic) return or diaspora migrants, predominantly Germany will be the destination region. Because legal provisions for admitting ethnic Germans and Jewish refugees from the Ukraine have recently been strengthened in Germany, these forms of movements can be expected to decrease. With respect to family reunification the opposite trend may establish, as an increasing migrant population from the Ukraine in European Union countries is eligible to invite following family members.

Furthermore, transit movements, passing through the Ukraine in an attempt to reach the West, will contribute to population flows from this country into the European Union. Because of its geographic location, its comparatively generous immigration provisions and because of network relations with Asian and African countries, reaching back to the Soviet period, the Ukraine has emerged as an important transit route between East and West (Mansoor and Quillin 2006). Most migrants addressing the Ukraine for transit have experienced (civil) war, economic crisis, ethnic repression or ecological catastrophes in their home countries. They come from Afghanistan, Sri Lanka, the Middle East and a number of African states. Because the European Union has tightened border controls in the East and restricted asylum regulations, many transit migrants got stuck in the Ukraine as they failed to enter those European Union countries they had originally addressed. Primarily because of its geographic location, the Ukraine can be expected to face considerable transit movements in the time to come.

Table 6: Natural population development, population aged 65 and more in the Ukraine (in percent)

	1991	1992	1993	1994	1995	1996	1997	1998
natural population decline	-0.8	-1.9	-3.5	-4.7	-5.8	-6.0	-6.2	-6.0
population aged 65+	12.0	12.6	12.7	13.1	13.5	13.7	13.8	14.0

	1999	2000	2001	2002	2003	2004	2005	2006
natural population decline	-7.1	-7.6	-7.6	-7.6	-7.5	-7.0	-7.6	
population aged 65+	14.0	14.0	14.0	14.0	14.3	14.8	15.9	16.0

Source: State Statistics Committee of Ukraine

Although economic, social and policy factors identify the Ukraine as a potentially important migrant sending country with respect to the European Union, the demographic development in the Ukraine speaks against high emigrations (Zimmer 2007). Since 1991, the natural population development in the Ukraine is negative, the population is decreasing and ageing (see table 6).

While the Ukraine lost 9.6% of its population between 1991 and 2006 due to the natural population decline, the percentage of people over 65 increased from 12% to 16% in the same period. Projecting the natural population development for the year 2050, the United Nations population division found the Ukrainian population to decrease to 30.9 million people, predicting a natural population decline of 39% between 2006 and 2050, whereas the percentage of people in the age of 65 and older would reach 27% in 2050. In the light of this demographic perspective, the Ukraine may not be capable in the longer run, to send large part of its working age population abroad. To the contrary, the decline in the working-age population will create a demand for labour in the Ukraine which most likely will have to be met by immigrants.

3 The discourse on migration challenges in the enlarged European Union and the Ukraine

The policy debate on the impact of migration plays a prominent role in all European Union countries, including the new East European Union member states. This has to be understood against the background of the demographic development in the European Union on the one hand and a generally reluctant attitude towards immigration in most European Union member states on the other. While long-term demographic projections of Eurostat point to the dependence of the future population growth in the European Union on net migration, politicians and the public in many European Union countries associate a number of negative economic and social consequences with the inflow of migrants. In contrast to these perceptions the results of economic studies on the impact of migration in receiving countries reveal a much more complex picture.

3.1 The impact of migration on receiving countries

Although the inflow of (labour) migrants bears the risk of increasing the unemployment of natives and depressing their wages, economic research has shown that these potential impacts depend on the labour market sectors and skill groups involved. If workers, performing low skilled jobs enter, low qualified natives may face unemployment or wage decreases (Borjas 1999). However, if immigration reacts to labour market shortages in specific sectors or skill groups, immigrants may not crowd out natives and may have – particularly in the case of highly-skilled workers – a positive effect on economic growth (Bauer et al. 2004: 32). Concerning the consequences for the welfare system, migrants' skills and employment perspectives are decisive. Whereas highly-skilled labour migrants in secure labour market positions are expected to contribute to the welfare system,

low-skilled immigrants in jobs at risk are more likely to put a burden on the welfare state.

Most economic studies find a comparatively low overall impact of labour migrations on the receiving economies, although migrations hold the risk of specifically affecting regional or sectoral labour markets (Friedberg and Hunt 1996, Longhi et al. 2005). Rather, migrations have been identified to contribute to economic prosperity in satisfying the demand for otherwise unavailable labour in demographically aging societies (Bauer et al. 2004: 19). In recent migrations from the new East European Union member countries into the EU-15 immigrant workers have been found to complement native labour and thus ease labour market shortages (Heinz and Ward-Warmedinger 2006). Nevertheless, immigrations potentially result in a redistribution of incomes from native workers competing with immigrant labour to natives who are complements to labour migrants and to employers of immigrants. In the light of this consideration it is decisive to focus on the winners and losers from migration processes (Camarota 2005: 10, IOM 2005: 168).

Specific problems are related with illegal labour migrations as they challenge the concept of welfare states in the European Union in undermining the principle of solidarity on which the welfare states are based. Because illegal immigrants do not pay taxes and contributions into the national social security systems, their direct impact on publicly financed activities is negative. Furthermore, distorted competition may result as a consequence of illegal occupations because labour costs are lower for firms hiring illegals than for enterprises, paying official wages. Next to fiscal and economic concerns, the protection of human rights of irregular migrants is a pressing issue in European Union societies. Modern democracies can hardly accept an - however small - part of the population living in an extreme weak legal position, potentially subject to discrimination and exploitation (Mansoor and Quillin 2006: 16).

Besides the economic impact of migration, European Union societies are confronted with the political and cultural consequences of migration movements as well. In the case of a high migration pressure from poor and instable countries, single European Union states and the European Union on the supra-national level are concerned of loosing control of borders and (national) sovereignty. This is particularly true in the case of illegal migration movements or human trafficking and smuggling which recently challenge the European Union at its Eastern borders. Furthermore, many European Union nation states and local communities oppose migration because of an anticipated increase of cultural diversity which is considered a challenge to national identity formation (Niessen et al. 2005: 5).

3.2 The impact of migration on sending countries

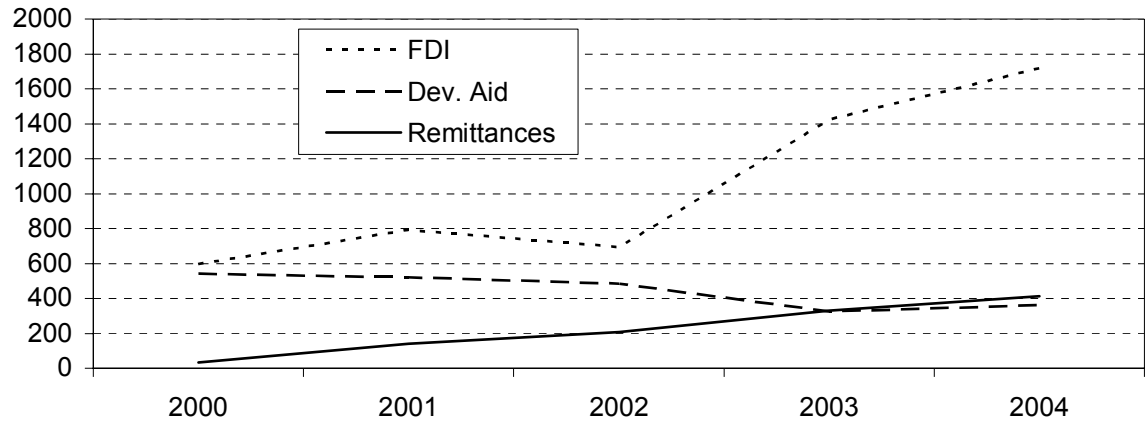
International migrations do not only have an impact on receiving, but also on sending states. In this context, two topics are of primary importance: the sending of remittances and the out migration of highly-skilled workers, i.e. brain drain.

Recent studies have pointed out that remittances are increasingly relevant for the transfer of resources to migrant sending states, predominantly in the case of developing and transition countries, such as the Ukraine (Buch and Kuckulenz 2004, Mansoor and Quillin 2006). After foreign investment, remittances are the second-largest source of financial flows to developing countries and they are generally higher than development aid (Ratha 2003). In the case of the Ukraine this trend has manifested in the year 2003, when remittances – which had been negligible before - surpassed development aid (see figure 5). It has to be considered though, that the official recording might severely underestimate remittances in the Ukraine, as a number of Ukrainian labour migrants do not send money back home by the banking system (Cipko 2006: 124). Particularly when the stay of workers abroad is short or when their occupation is illegal, migrants tend to use individual channels for sending money home.

Among other factors such as education, income level, intention to invest or to insure the family at home against risks, the motivation of migrants to remit depends on the duration of stay. A recent study has shown that temporary migrants seem to be much more concerned in sending remittances home than permanent migrants (Glytsos 1997). This result suggests that countries as the Ukraine, where the share of short-term migrants is high, will particular profit from remittances.

With respect to the effects of remittances for sending countries of labour migrants, different views are currently discussed. First of all, a number of positive impacts are expected, as remittances provide the home country's economy with foreign exchange and additional means for consumption and investment. Although some studies found remittances to primarily increase family consumption but not investments in productive assets (Taylor 1992), there is evidence that both, the spending of remittances for consumption and for investment will sustain economic growth (Ratha 2003). However, remittances might deteriorate the payment position of the economy (Dutch disease) and have distributive effects as well, as remittances are only transferred to a part of the home countries' population therefore potentially leading to wealth disparities and social tensions (Buch and Kuckulenz 2004). Nevertheless remittances provide an important and stable additional source of income, which in the case of transition countries results in a reduction of poverty, at least in the short-run (Manssor and Quillin 2006: 67).

Figure 5: Foreign direct investment (FDI), development aid and remittances in the Ukraine (millions, in US $)



Source: World Bank Development Indicators

In the recent discussions on the consequences of migrations in Eastern Europe and the former Soviet Union, brain drain has been a crucial topic, although the dimensions of brain drain are difficult to identify, due to a lack of data. According to survey studies, conducted with Ukrainian migrants in the Czech Republic, the Netherlands and Portugal, a remarkable number of labour migrants from the Ukraine are highly educated, although they perform low-skilled work in the receiving economies.[11]

Concerning the effects of brain drain, usually negative economic consequences are associated with the emigration of highly-skilled professionals. However, recent studies have shown that the emigration of highly-skilled may encourage natives left behind to accumulate skills to also have an option for emigration. If these natives delay emigration and actually fill the gaps of skilled emigrants, negative economic effects would be reduced (Lundborg and Rechea 2002). Because the proportion of tertiary-educated persons in the Ukraine is high, the negative consequences of brain drain might have been mitigated. Furthermore, the increase of the enrolment ratio in tertiary education in the Ukraine that occurred between 1998/99 and 2002/2003 indicates a potential compensation of brain drain (see table 7).

[11] In the Netherlands, a survey found 88% of questioned Ukrainian migrants having a tertiary education; while in Portugal 69% of the respondents in a survey study were highly educated (Shakhno and Pool 2005, Baganha et al. 2004).

Table 7: Gross enrolment ratio, tertiary level in the Ukraine

(regardless of age, as a percentage of the population of official school age for that level)

	1998-1999	2002-2003
Men	44.1	56.5
Women	50.5	67.2

Source: UNESCO Database

In the case highly-skilled migrants move back home after having acquired new skills abroad, they may contribute to the economic prosperity in their country of origin. In addition to valuable management experience, entrepreneurial skills and access to global networks, returning skilled migrants may even bring venture capital, enhancing economic growth and welfare at home. In less favourable conditions, comparatively skilled labour migrants return who have been occupied in jobs and sectors that required low qualifications (brain waste). Although these migrants can be expected to bring money back, positive consequences of migration on workers' experience are not likely to materialize.

4 European Union policy response towards external migration challenges: a first look

After the European Union abolished internal border controls in 1997, common rules regarding visas, asylum rights and checks at external borders were adopted. With the enlargement of the European Union, a new migration space opened up at the common external borders in the East which made the need for a comprehensive European Union migration policy evident. As has been pointed out by European Union organizations and by NGO's (for example the United Nations and the International Organization for Migration) the basic challenge for a comprehensive European Union migration policy is to move from migration control towards migration management in order to realize the potential gains of migration movements and to minimize its burden for receiving and sending states.

So far the European Union has put most emphasis on the control and restriction of migration flows, to ensure what is considered the internal security of the European Union and to protect the labour markets and welfare systems of its member states. To a certain extend, this policy contradicted the new neighbourhood policy, admitted by the European Union commission in 2003 which aimed to strengthen the cooperation between the enlarged Europe and the countries bordering in the South and the East, such as the Ukraine (Aliboni 2005). Whereas European Union countries were primarily interested in an increased cooperation with migrant sending states neighbouring the European Union in the field of migration restriction and border control, the neighbouring non European Union states were demanding simplified visa procedures and an ease of access to European Union labour markets.

In managing migration movements from non European Union states, the enlarged European Union has agreed to address the following topics in a common effort: the control of external borders (preventing illegal migration and human smuggling and trafficking), the creation of a common asylum law and – in the longer run – the regulation of labour migrations. With respect to external border controls, i.e. fighting an expected inflow of illegal immigrants and preventing human smuggling and trafficking, the European Union primarily focused on traditional border security policy as well as on legal measures discouraging illegal immigrants and fighting people, involved in human smuggling and trafficking. First of all, the European Union strongly supported the new East European Union border states with financial and logistic resources to improve external border control.[12] In a similar way, the negotiations with non European Union neighbouring states, such as the Ukraine focused on border security and immigration restraint. This policy approach has been reinforced by the agreement on the readmission of illegal migrants between the European Union and the Ukraine which has been signed in October 2006. In the view of the European Union this treaty has been a precondition for the negotiation of a simplified visa regime for Ukrainian citizens travelling into the European Union.

In the field of asylum and refugee migration, the European Union member states reached a general agreement on minimum standards for granting and withdrawing refugee status in the European Union in April 2004. However, in the view of leading refugee assisting organizations, the European Union minimum standards on refugee protection were a step back with respect to asylum rights. The standards of refugee protection were considered to be minimal, indicating that asylum agreements have been reached at the lowest common denominator. The policy objective to reduce the inflow of asylum seekers and irregular migrants has materialized in the safe country concept which excludes persons from demanding asylum who either are citizens or enter from a country, defined safe.

While the European Union has decided on a number of common regulations with respect to border controls and asylum procedures, labour migrations into the European Union have not yet been regulated on a common base. In recent years most European Union member states competed for highly-skilled labour migrants while the immigration of low-skilled workers was seen with concern. However, unskilled, flexible labour is in demand in some sectors of a number of European Union economies, thus opposing a policy that tries to prevent the immigration of people, performing unskilled jobs (Castles 2006). In this context it has been proposed to work out policies – for example flexible systems for temporary and circular labour migration – that match the domestic sectoral demand for low-skilled migrant workers in European Union countries with the high migration potential in non European Union states, prepared to perform low-skilled work (GCIM 2005: 18). Nevertheless, these policies have to be

[12] The European Union provided more than 900 million € in the period between 2004 and 2006 to help the new EU member states to finance initiatives at the new external borders of the Union.

backed by a strong enforcement of rules on workers rights, to avoid the formation of a second-class category of workers.

With respect to the planned common management of labour migrations, several European Union policy proposals have been presented so far which intended to channel labour migrations according to labour market requirements. A basic suggestion was to define the conditions of entry and residence of third country nationals with respect to categories of immigrants, such as seasonal workers, intra-corporate transferees, especially skilled migrants and remunerated trainees. In addition a common fast-track procedure was proposed to admit migrants in the case of specific labour market and skill gaps (COM 2004: 5). While European Union member states in general agreed upon the necessity to introduce common European Union criteria for labour migration from non European Union countries, it was demanded to regulate the number of economic immigrants to be admitted on the national level.

Experience with labour migrations in many European Union countries show that migrant workers tend to not return home if the chance to come back to the immigrant country is low. Thus the proposition has been formulated to guarantee an admission preference to those economic migrants who have already worked for some years in the European Union before returning temporarily back to their home country. This procedure could encourage "brain circulation" as migrant workers can count on a more favourable admission treatment if they wish to come back to a European Union country, after having returned to their country of origin.

In order to manage labour migrations more effectively in the interest of sending and receiving countries alike, the European Union envisaged a closer cooperation with the sending countries of labour migrants. A step in this direction was the effort to provide solid information on the conditions of entry and work permissions into the European Union. This will be accomplished by setting up a European Union Immigration Portal and by the revision and development of the European Job Mobility Portal (EURES). Besides, the problem of "brain drain" has been put on the agenda which should be addressed in a common initiative of sending and receiving states, primarily by encouraging return or circular movements.

In general, recent intentions of the European Union to regulate labour migrations from outside have favoured the support of short-term and circular movements. To a certain extend, this is a reasonable policy option, particularly because migrants from non European Union states in the East seem to prefer to return home in the longer run. Nevertheless this policy approach bears risks, because short-term labour migrants who happen to stay in the longer run potentially face constant marginalization in the receiving country (de Palo et al. 2006).

5 Summary and conclusion

After becoming independent in 1991, the Ukraine turned into a new migration space attracting and sending migrants to the successor states of the USSR and to the West. Whereas ethnic return movements dominated in the beginning of the 1990ies, economically motivated migrations prevailed in later years. This study demonstrated that migrations from the

Ukraine into European Union countries have increased recently and that a growing migration potential is envisaged in the years to come. Although a considerable part of these movements are expected to be temporary or circular, European Union countries face a potentially substantial labour migration from the Ukraine. As the number of Ukrainian citizens willing to enter the European Union will almost certainly exceed the legal opportunities currently in force, illegal migrations are likely to occur.

In analyzing recent labour movements from the Ukraine into European Union countries, it becomes clear that some European Union states are particularly addressed by Ukrainian labour migrations. Whereas high income differences and a lack of job opportunities in the sending country trigger these movements in general, they are additionally based on traditional migration patterns and network relations in states such as Germany, Poland, Hungary, the Czech and the Slovak Republic. In other countries, such as Portugal, Spain, Italy and Greece, labour migrations from the Ukraine have developed in the absence of migrant networks, cultural and political ties. In these cases, the demand for low-skilled labour in segmented markets, particularly in the nontraded goods sectors of the economy seems to have supported the movement of Ukrainian labour migrants. With respect to the characteristics of Ukrainian migrants in European Union states, comparatively skilled persons – working in low-skilled jobs - prevail, who mostly favour short-term and circular movements. Furthermore, the inflow from the Ukraine into European Union countries is dominated by females in some European Union countries and by males in others, depending on the demand structure for migrant labour. Concerning the choice of destination regions, the movements between the Ukraine and European Union countries reveal an increasing regional diversity since the end of the 1990ies.

Although most European Union countries react reluctantly towards (labour) immigration from outside, long-term demographic projections point to its necessity in the light of a decreasing and ageing population in nearly all European Union states. While national migration experiences and national migration policies are different in European Union member states, the free movement of people within the territory of the European Union which signed the Schengen agreement resulted in the dependence of each member state on the immigration practice and policy of the others. Thus a common European Union migration policy was envisaged, aiming at the installation of a comprehensive and cooperative migration system which facilitates the movement of legal (labour) migrants, controls asylum seekers as well as refugees and prevents illegal border crossings. In response to a considerably migration pressure from outside its territory, the European Union additionally opted for an increasing cooperation with migrants' sending states. Although the European Union has depicted a number of important issues in the context of common migration regulations, many of the proposed policy measurements are still indeterminate, particularly in the case of low-skilled labour movements.

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Product Variety and Technical Change

Richard Frensch / Vitalija Gaucaite-Wittich

Abstract:*

Motivated by growth models based on the variety of capital goods, recent empirical studies have established links between productivity and various trade-based measures of product variety, carrying the implication that these measures may represent technology. We study this implication by explicitly proposing the variety of capital goods available for production as a direct measure of the state of technology. Within the growth and development framework of Jones (2002, ch. 6), we derive a "conditional technological convergence" hypothesis on how this variety should behave if it were indeed to represent the state of technology. The hypothesis is tested with highly disaggregated trade data, using tools from the income convergence literature. The results suggest that a trade-based count measure of the variety of available capital goods, allowing for product differentiation by country of origin, indeed behaves "as if" it represented technology when change of technology is understood as Jones' (2002, ch. 6) learning process, and that there is conditional technological convergence among our panel of mainly OECD and transition economies.

JEL-Classification: F14, O33

Keywords: Product variety, diffusion, adoption, technical change

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1 Introduction: the variety of capital goods as a potential measure of technology

New theories of growth emphasise ideas as the centre of innovative activity. As ideas are non-rival and partially excludable, innovation, by tying ideas to new products or processes, obeys increasing returns to scale (Romer, 1990). When introducing this concept into a monopolistic competition model, technical progress is reflected in a higher variety of intermediate capital goods, and is thus embedded in a deepening division of labour, as already illustrated in Adam Smith's example of the making of pins.

In spite of the advances of theories of growth, there has so far been little reflection of this insight in empirical attempts at measuring technical change. In a recent overview, Keller (2004, p. 757) does not mention product variety as a potential measure of technology but rather holds that "technology is an intangible that is difficult to measure directly. Three widely used indirect approaches are to measure (1) inputs (R&D), (2) outputs (patents), and (3) the effect of technology (higher productivity)." This paper fills this gap by defining the state of technology as the range of specialised production processes, by proposing *the variety of capital goods available for production*, as a direct measure of the state of technology, and by deriving and testing a hypothesis how this variety should behave if it were indeed to represent the state of technology.

While this seems unrelated to trade, trade enters the picture when it comes to measuring product variety, as trade data are best suited to meaningfully measure variety. Consequently, we proxy the variety of available capital goods by *the variety of traded (i.e., exported and/or imported) capital goods*. This measurement issue relates our work to a recently emerged and rapidly growing field, the study of trade-based measures of product variety.

2 Recent developments in studying disaggregated trade data

There is an increasing tendency to use highly disaggregated trade data to infer information both on trade and – in the absence of equally highly disaggregated production data – also on productivity issues. All of these approaches are united by the idea that there is something systematic in the structure or composition – beyond the sheer volume – of trade. A large part of this work "re-aggregates" the disaggregated information, not in volume, but in terms of measures of product variety or quality found in the trade data.[13] These papers usually come in two versions: they either

[13] While we follow this line of making use of disaggregated trade data here, there is also work that questions the implicit assumption that the product space is homogeneous and independent of the specialisation of a country. According to this type of work, comparative advantage is determined by costly search for goods associated with higher productivity levels (Hausmann and Klinger, 2006), and initial specialisation in products – rather than industries –

study the determinants or the effects of the variety/quality aspects of traded goods. In both respects, they may do so from two different potential perspectives, i.e. trade or productivity. So far, the determinants of the variety or quality of traded goods have mostly been studied from the trade perspective, while on the effects side, studies on productivity implications prevail.

As for the determinants of the variety or quality of traded goods in the trade perspective, Hummels and Klenow (2005) find that the higher exports of larger economies are to a considerable extent due to their exporting a wider set of goods – or categories of a trade classification –, with larger economies generally exporting a given category to more countries. Within the same categories, richer countries export higher quality goods, confirming Schott (2004). On the trade effects side, Funke and Ruhwedel (2002) find a positive link from the variety of exports to export performance in volume terms.

In this paper, we are not interested in trade related determinants or effects of trade-based measures of product differentiation, rather we want to know whether they carry information on technology. That they might can be theoretically motivated, as spelled out in Feenstra et al. (1999, p. 318): "The idea that productivity is enhanced by increases in product variety is central to the endogenous growth models considered by Romer (1990) and Grossman and Helpman (1991)." As this link is so basic, it might be worth wile to stress that the product variety driving productivity in Romer-type models in fact is the *variety of intermediate capital goods used in production*. Specifically, this particular variety is a measure of the state of the endogenous technology in Romer (1990) and related growth models, which we will henceforth refer to as capital-goods-variety-based growth models.

The alleged productivity-increasing property of more product variety has recently been studied in attempts to relate levels or growth rates of productivity to several measures of variety. The results suggest that across OECD and selected east Asian or east European countries one can find trade-based measures of variety, which – together with physical investment – are significant for explaining variations in per capita income levels,[14] and contribute to differences in productivity growth.[15] Although implicitly (or even explicitly, as Feenstra et al., 1999; or Funke and Ruhwedel, 2001 and 2005) rooted in capital-goods-variety-based growth models, these papers typically report *export variety measures over all goods* to be correlated with productivity.[16]

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exported by higher income countries is associated with faster growth (Hausmann et al., 2005).

[14] See Funke and Ruhwedel (2001 and 2005) and this paper's authors' earlier work in UNECE (2004).

[15] This has been shown to be the case for the productivity lead of South Korea over Taiwan (Feenstra et al., 1999). Addison (2003) suggests that a relationship between the variety of exported industrial goods and total factor productivity might also hold in terms of growth rates across a sample of 29 developed and developing countries.

[16] As an exception, Amiti and Konings (2005) suggest a link from the import variety of intermediate inputs to productivity gains at the firm level for Indonesia, concluding from the comparatively large productivity gains accruing from lowering input versus output tariffs.

Consequently, as claiming to be rooted in capital-goods-variety-based growth models, two limitations hold for this type of studies. First, as formulated in Feenstra et al. (1999, p 326), "... the variety of exports from one country are in principle available to *other* countries through trade, so that productivity in each country does not depend on only the export variety from the same country: it would also depend on the matrix of *import* varieties from all of its trading partners. We do not have the data to measure this, however ... Ignoring import variety is clearly a limitation on our approach." Second, the relevant product group to be examined when testing for productivity implications of variety, rooted in capital-goods-variety-based growth models, is not *all goods* but rather *intermediate capital goods used in production*. Taking both limitations together, when using trade-based variety measures to explicitly or implicitly test capital-goods-variety-based growth models, the alleged productivity effect to be studied would in fact stem from *the variety of traded (i.e., exported and/or imported) intermediate capital goods* to productivity, where the variety of trade proxies the variety of available capital goods, due to the absence of highly disaggregated production data. This is not to deny the possibility of links between other trade-based variety measures and productivity. In fact, there may be a number of channels for productivity effects of an increased variety of goods, and *tfps* differ across countries and time for reasons other than differences in technology (Prescott, 1998). However, these links should not be interpreted as rooted in capital-goods-variety-based growth models, but rather in the light of other models that allow for productivity effects from variety, when variety is specifically not a measure of technology, such as in Acemoglu and Ventura (2002), stressing the returns to diversifying export bundles.

Furthermore, when taking the foundation in capital-goods-variety-based growth models seriously, trade-based measurement of product variety should enable a direct test why there should be productivity effects of the variety of traded capital goods in the first place: If this particular variety is a measure of the state of technology, it should behave as a measure of technology, i.e., one might ask for the determinants of product variety from a growth perspective. This latter point has so far been only taken up in Addison (2003), however, without an explicit base in a growth model: according to his study, the introduction of new export categories in countries with already very high levels of export variety appears to be driven by R&D. In contrast, countries that are furthest away from the frontier of export variety tend to experience the highest variety growth rates, which lends support to the existence of a diffusion process, where a combined effect of educational attainment and the original variety gap increases the growth rates of export variety in developing countries.

Our contribution is to structurally test a model of capital goods variety growth, i.e., to explicitly derive a testable hypothesis on the rate of capital goods variety growth and taking it to the data. The rest of the paper is organised as follows: the first part of section 3 presents the theoretical framework (Jones, 2002, ch.6, based on Jones, 2003), where a view of technical change as learning how to deal with newly innovated varieties of intermediate capital goods is embedded into a simple growth model. In the second part of section 3, we derive a testable "conditional

technological convergence" hypothesis within this framework. Section 4 introduces our unique panel database of highly disaggregated trade-based product variety measures, allowing for product differentiation by country of origin. In section 5, we test the conditional technological convergence hypothesis using tools from the income convergence literature. In sections 6 and 7, we test the robustness and plausibility of our results. Section 8 concludes.

3 A testable hypothesis on the variety of available capital goods as a measure of technology

3.1. Theoretical framework: Jones (2002, ch. 6)

This framework of our analysis is Jones' (2002, ch. 6) "simple model of growth and development," where the change of a country's state of technology is modelled as a process of learning to deal with new varieties of intermediate capital goods, exogenously innovated anywhere in the world. Final output *Y* is produced by labour, *L*, and a range or variety, *h*, of available intermediate capital goods, x_j, according to

$$Y = L^{1-\alpha} \int_0^h x_j^{\alpha} dj \qquad (1)$$

neglecting the time dimension. Newly innovated designs of intermediate capital good varieties are available everywhere without technology transfer cost such that intermediate capital goods can be produced at the place of use. The variety of capital goods used in production, *h*, represents the state of technology of production in the Smithian sense of the division of labour. This becomes especially clear, when one unit of an intermediate capital good is produced without further input from one unit of raw capital, *K*, and when all intermediate capital goods are priced equally: then, $x_j = x$ for all *j*, $h \cdot x = K$, and the aggregate production function takes the familiar Solow-form,

$$Y = K^{\alpha}(h \cdot L)^{1-\alpha} \qquad (2)$$

illustrating the labour-augmenting character of technology *h*. Introducing the time dimension, physical capital accumulation follows the standard form, $\dot{K}(t) = s_k Y(t) - d \cdot K(t)$, where s_k is the rate of investment and *d* denotes the rate of depreciation of capital. Labour *L* grows exogenously at rate *n*. Technical change reflects a process of labour's learning to adopt and use new intermediate capital good varieties, invented where ever.[17] Specifically,

[17] This is in the spirit of theoretical approaches such as Keller's (1996) formalisation of "absorptive capacity", going back to Nelson and Phelps (1966), or Basu and Weil's (1998) concept of an "appropriate technology." Both stress the idea that the labour force of a firm or

$$\dot{h}(t) = \mu e^{\psi u} A(t)^{\gamma} h(t)^{1-\gamma}, \ \mu > 0 \text{ and } 0 < \gamma \leq 1 \qquad (3)$$

Apart from the initial technology gap vis-à-vis the world technology frontier *A,* learning success depends on time dedicated to formal education, i.e. length of schooling, *u*, the effectiveness of formal education (*ψ*/γ, to which we will return below), and on other influences on the productivity of the learning process, summarised by *μ*. Individual countries take *A* as given, which expands at a constant rate, *g*.[18] Re-writing (3) in terms of the growth rate of *h*, and defining *B*(*t*) = *h*(*t*)/*A*(*t*) as the variety of capital goods available in a country relative to what is available at the world technology frontier,

$$\frac{\dot{h}(t)}{h(t)} = \mu e^{\psi u} B(t)^{-\gamma} \qquad (4)$$

Moving towards the technology frontier slows down the speed of technological catch-up. Technology gap concepts such as (4), based on Gerschenkron's (1952) notion of the advantage of backwardness, are highly popular in empirical approaches dealing with diffusion and adoption. In particular, a number of studies take (4) as the direct point of departure for econometric specification, often hypothesising combined effects between education parameters and a measure of initial relative technology on the speed of diffusion (*inter alia* Nelson and Phelps, 1966, Griffith et al. 2000, and in our variety context also Addison, 2003). We deem the underlying assumption that both components have a significant effect on the dependent variable if the coefficient of the combined effect is statistically significant, as problematic. Accordingly, rather than following the combined effects avenue, we derive an empirically testable hypothesis from (4) that has the advantage that it clearly separates the various influences on our proposed direct measure of technology, i.e. the variety of capital goods available for production.

The steady-state properties of the model can be used to motivate the particular, exponential form of the learning process (3). As the choice of length of schooling, *u*, is a private investment decision, we should have (3) be consistent with what we know about returns to this investment decision. Formally, the model is an augmented Solow-model, in which s_k, *u*, the growth rate of the labour force, *n*, and the rate of expansion of the technology frontier, *g,* are all exogenous and constant. As the growth rate of *h* is constant in the steady state, (4) then requires *B* to be constant such that *A* and *h* must grow at the same rate. Therefore, along the steady-state growth path,

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a country, in order to be able to successfully adopt new technologies, needs to have certain skills.

[18] This is in line with the evidence that *A* increases over time due to innovations in only a very few advanced economies. While their share in world GDP was 64 per cent in 1995, the seven largest industrialised countries accounted for 84 per cent of the world's R&D spending (Keller, 2004, p. 752).

$$B^* = \left(\frac{\mu}{g} e^{\psi u} \right)^{\frac{1}{\gamma}}, \qquad (5)$$

where μ must be sufficiently small to ensure that $B^* < 1$. Note that capital accumulation and the learning process (3) are independent from each other, such that the model preserves the neoclassical property of a constant steady-state capital-output ratio, K^*/Y^*. h is labour augmenting so that the growth rate of h determines the growth rates of capital per worker and output per worker. The steady-state level of output per worker can then easily be shown (Jones, 2002, p. 128) to be

$$y(t)^* = \left(\frac{s}{n+g+d} \right)^{\frac{\alpha}{1-\alpha}} h(t)^* = \left(\frac{s}{n+g+d} \right)^{\frac{\alpha}{1-\alpha}} \left(\frac{\mu}{g} e^{\psi u} \right)^{\frac{1}{\gamma}} A(t)$$

With perfect competition on the labour market, the Cobb-Douglas production function (2) establishes a steady-state real wage $w(t)^* = \partial Y(t)^* / \partial L_t = (1-\alpha) y(t)^*$, and

$$\frac{\partial \ln w(t)^*}{\partial u} = \frac{\psi}{\gamma},$$

i.e., additional time of schooling increases the wage rate by a constant percentage, ψ/γ. The particular functional form of the learning process (3), chosen in Jones (2002), thus provides for consistency of the model with Mincer's (1974) approach to wage formation, supported by subsequent empirical work (see Pritchett, 2006). We will make use of this property in discussing the plausibility of our empirical results in section 7.

3.2. Conditional technological convergence

In order to study the convergence properties of h,[19] we employ the usual instrument of growth theory for this purpose, i.e. we linearise (4) in ln $B(t)$ around the steady state ln B^* by using a first-order Taylor-expansion, to arrive at,

$$\begin{aligned} \delta_{h(t)} \equiv \frac{\dot{h}(t)}{h(t)} &\approx \mu e^{\psi u} \left[e^{-\gamma \ln B^*} - \gamma e^{-\gamma \ln B^*} \left(\ln B(t) - \ln B^* \right) \right] \\ &= \mu e^{\psi u} e^{-\gamma \ln B^*} \left[1 + \gamma \left(\ln B^* - \ln B(t) \right) \right] \\ &= \mu e^{\psi u} \left(B^* \right)^{-\gamma} \left[1 + \gamma \left(\ln B^* - \ln B(t) \right) \right]. \end{aligned}$$

From the definition of the steady state in (5), this implies

[19] For the closed-form solution of $h(t)$, see Appendix 1.

$$\begin{aligned}\delta_{h(t)} &\approx g\left(B^*\right)^{\gamma}\left(B^*\right)^{-\gamma}\left[1+\gamma\left(\ln B^* - \ln B(t)\right)\right] \\ &= g\left[1+\gamma\left(\ln B^* - \ln B(t)\right)\right] \\ &= g + \gamma g \ln B^* - \gamma g \ln B(t)\end{aligned} \tag{6}$$

As $B(t) = h(t) / A(t)$,

$$\delta_{B(t)} = \delta_{h(t)} - \delta_{A(t)} = \delta_{h(t)} - g$$

and, with (6),

$$\delta_{B(t)} = \frac{d \ln B(t)}{dt} \approx \gamma g \ln B^* - \gamma g \ln B(t) \tag{7}$$

Denoting $\ln B(t) = z(t)$, and assuming the equality holds, equation (7) is a simple linear differential equation of the type

$$\dot{z}(t) = \gamma g z^* - \gamma g z(t),$$

with the straightforward explicit solution

$$z(t) = z_0 e^{-\gamma g t} + z^*\left(1 - e^{-\gamma g t}\right).$$

Accordingly,

$$\ln B(t) = e^{-\gamma g t} \ln B_0 + \left(1 - e^{-\gamma g t}\right)\ln B^*$$

and

$$\ln B(t) - \ln B_0 = \left(1 - e^{-\gamma g t}\right)\left(\ln B^* - \ln B_0\right)$$

Substituting back for $\ln B(t) = \ln h(t) - \ln A(t),$

$$\ln h(t) - \ln h_0 - \ln A(t) + \ln A_0 = \left(1 - e^{-\gamma g t}\right)\left(\ln B^* - \ln B_0\right)$$

and

$$\ln h(t) - \ln h_0 = \left(\ln A(t) - \ln A_0\right) + \left(1 - e^{-\gamma g t}\right)\left(\ln B^* - \ln B_0\right)$$

The world technology frontier is assumed to expand at a constant rate, $g,$ according to $A(t) = A_0 e^{gt}$ such that $\ln A(t) = \ln A_0 + gt$ and

$$\ln h(t) - \ln h_0 = gt + \left(1 - e^{-\gamma g t}\right)\left(\ln B^* - \ln B_0\right) \tag{8}$$

where $0 < \gamma \leq 1$ and g, the rate of innovation, is small. As the time horizon of our empirical assessment will be comparatively short (see section 5.2), we already at this stage approximate $e^{-\gamma gt}$ in (8) by $1-\gamma gt$, such that $1-e^{-\gamma gt} = \gamma gt.$ Consequently,

$$\ln h(t) - \ln h_0 = gt + \gamma gt(\ln B^* - \ln B_0)$$

and

$$(\ln h(t) - \ln h_0)/t = g + \gamma g \ln B^* - \gamma g \ln B_0. \qquad (8')$$

From the definition of the steady-state in (5),

$$\ln B^* = 1/\gamma(\ln \mu - \ln g + \psi u),$$

and

$$(\ln h(t) - \ln h_0)/t = (g - g\ln g + \gamma g \ln A_0) - \gamma g \ln h_0 + g\psi u + g \ln \mu \qquad (9)$$

Interpreting (9) in discrete time, $(\ln h_t - \ln h_0)/t$ is an average yearly rate of change of the variety of available capital goods, as a measure of technology, which depends negatively on initial variety and positively on formal education parameters, and on other influences on the productivity of the learning process, μ.[20]

4 Measuring available product variety and some stylised facts

Variety measures are commonly derived from detailed data on merchandise trade, where export variety is taken to proxy the variety of domestic production. As goods may be available in a country due to production at home or from imports, simple trade-based count measures of produced, imported, or available variety then record the number of different categories exported, imported, or traded, where data detail obviously depends on the level of aggregation of the trade classification used.

Our data set covers exports of 46 countries-reporters, among them transition economies from eastern Europe and the CIS, and OECD economies from Europe and North America, between 1992 and 2004 to the rest of the world, and these countries' imports from 55 selected partner countries, which account for the bulk of their total imports. We derive variety measures from these data according to the lowest aggregation level of the SITC, Rev. 3 (5- and 4-digit basic headings) in the UN COMTRADE database. This level of aggregation covers 3,114 basic

[20] We are enormously indebted to an anonymous referee for pointing out a small mistake in our original derivation of (9). Only correcting this mistake enabled the formulation of section 7 below.

headings, or SITC categories, while the United Nations Statistics Division's *Classification by BEC* (*Broad Economic Categories*) allows for almost all of these SITC categories to be grouped into basic SNA activities, namely 272 primary good categories, 1,627 intermediate good categories, 471 capital good categories, and 704 consumer good categories.[21]

As we will be testing for convergence, we would want to avoid finding convergence by data construction, which is highly likely when using simple count measures based on the SITC 5 digit level; there are more than 3,000 categories but fewer than 500 of them cover capital goods according to BEC, which is not many, and most OECD countries indeed trade (i.e., either export or import) almost all of them. However, variety measurement may go beyond counting. More sophisticated measures include especially Feenstra's (1994) exact measure of product variety constructed from a CES function when products enter non-symmetrically. In line with Feenstra and Kee (2007), we construct such exact variety measures, which are comparable both across years and across countries, by defining a consistent benchmark that does not itself vary over time and at the same time encompasses as many of our sample countries as possible. Given our data limitations (not all countries report in each year), this benchmark set is defined as I^a, the total set of categories traded by the "aggregate country" of all original OECD economies, as defined in Table A2 of the paper, over all years between 1992 and 2004; then, $p_i^a q_i^a$ is the average value of trade for category i, summed over all OECD economies and averaged across years 1992 and 2004. Only "by aggregating across countries and over time, we obtain a consistent comparison set ... I^a, that does not itself vary over time" (Feenstra and Kee, 2007, p. 10).[22]

Accordingly, the appropriate Feenstra-measure for assessing product variety of country c in period t for our purposes of comparing variety both across years and across countries, is given by equation (4) in Feenstra and Kee (2007),

$$Variety_t^c = \frac{\sum_{i \in I_t^c} p_i^a q_i^a}{\sum_{i \in I^a} p_i^a q_i^a}, \qquad (10)$$

which depends on the set of categories traded by country c at time t, I_t^c, but not on the value of this trade. $Variety_t^c$ can be interpreted as the share of OECD-traded goods during 1992–2004 also traded by country c in year t. Clearly, for non-OECD economies, this share is a virtual share.

Inspection of the distributions of these measures, based on the SITC 5 digit commodity level of our data, demonstrates that it alleviates but does not eliminate the convergence bias problem: the share of OECD-traded goods during 1992–2004 also traded by country c in year t is very close to 1 for OECD countries in each year, as most OECD countries indeed trade almost all of the categories on the SITC 5 digit level.

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21 For a comprehensive description of our trade-based variety measurement, see Appendix 2.

22 Also, see their fn. 1, criticizing their earlier approach in this respect, e.g., as in Feenstra and Kee (2004).

The way to escape the convergence bias problem is therefore not by weighting count data, but to increase data detail by expanding the product space. When using the SITC 5 digit level, this can be achieved by differentiating categories by their country of origin, such that a German car is differentiated from a Japanese car, etc. Using the country of origin enables us to introduce an additional dimension of variety, one which is absent in other data sources. The number of SITC categories produced at home (proxied by the number of exported categories) plus the number of imported SITC categories times the respective number of origin countries then corresponds to a count measure, which we term the product variety available within a country, i.e. *available product variety*. In this paper, we will deal exclusively with this definition of variety, for which we can identify a maximum count of 174,384, since a country-reporter plus all 55 partner countries can each supply all 3,114 SITC categories to the country-reporter. With an average of 40.2 countries reporting per year between 1992 and 2004, computing our product variety measures thus requires the manipulation of some 90 million data points.

While theoretically less robust than the Feenstra measure, this simple count measure over an expanded product space defined by product differentiation by country of origin, deals with the convergence bias problem a lot better by spreading the variance in the data far more evenly. The most preferable solution would thus be defining a Feenstra-measure over our expanded product space, allowing for product differentiation by country of origin. Again, in order to then consistently measure variety across countries and over time, we would have to define a benchmark "aggregate country." In the expanded product space, this would have to be the aggregate of all our economies, as any subset of countries would tend to introduce a new bias into the data: allowing for country of origin in product differentiation introduces the geographical specialisation of imports into the product space, which differs from country to country. However, as not all of our countries report trade for all years, we cannot define a consistent variety measure à la Feenstra and Kee (2007) by aggregating across all countries and over time. As any subset of countries, such as the OECD, when chosen as the benchmark, would introduce the geographic specialisation bias, the size of which we cannot really assess, we stick with our count measure over the expanded product space.

In Figure 1 we present available product variety count measures by BEC groups for the year 2000, where primary and intermediate goods are aggregated for ease of exposition. Countries are ranked in descending order of available variety for capital goods but sorting countries by each measure of variety reveals more or less the same rough groupings: the highest degrees of variety occur in west European and North American economies, followed by east European EU member countries, then by southeastern Europe, and finally the CIS. There are a few notable exceptions to the general pattern, however, the most striking being Iceland, Cyprus, and Malta among the western economies and Russia among the transition countries. The three very small islands, that specialise in producing and exporting a narrow range of goods and services, are also in the lowest ranks with respect to available variety,

while Russia displays degrees of variety similar to that of high-income economies.

– Figure 1 about here –

The fact that Russia, and also Ukraine, stand out from the other CIS countries in variety terms in part reflects the legacy of the Soviet Union's central planning system, which determined who produced what and did not reflect comparative advantages across the Union. Hence, while many ex-Soviet republics produced too little variety, Russian and Ukrainian enterprises were subsidised to produce too much of it, albeit of low quality.[23]

During our period of observation, product variety increases in western Europe and North America were almost entirely due to the "geographic spread of trade," i.e. to trading with more partners than before, and only marginally to more categories being exported or imported at our level of aggregation.[24] For the reforming east European and CIS economies, however, both factors played an important role. A rapid liberalisation of their trade led to a geographical diversification that went well beyond the substitution of new western for old eastern trading partners. However, during the 1990s, there were also many more SITC categories being imported or produced at home and exported than before, which allow for an important increase in variety available domestically in most east European and CIS economies. This applies especially to capital and intermediate goods, the relative variety of which used to lag behind that of consumer goods in many of these economies prior to reforms. This corresponds to Kehoe and Ruhl's (2002) result that trade liberalisation generally implies that goods traded the least prior to liberalisation account for much higher shares afterwards.

5 Empirical assessment

5.1. Assessing technical change through product variety

Testing whether trade-based measures of available product variety indeed contain information on technology requires making use of the data within an econometric framework that matches the conditional technological convergence hypothesis (9) as closely as possible. Any such attempt is deeply entrenched in the interdependence between technology, trade, and income. Resolving this interdependence might call for a simultaneous equations approach: variety should depend on trade, trade on income,

[23] Russia remains a major supplier of industrial goods to most of its CIS neighbours and to other, mainly developing, economies. In our previous work in UNECE (2004), we report a notable discrepancy between Russia's high rank (and also Ukraine's, to some extent) for variety and its low rank for quality, which to a certain degree reflects a delay in industrial restructuring.

[24] For data on 1992–2001, see Table 6.22 in UNECE (2004, p. 150). On the export side, this particular feature has been noticed and termed "geographic spread of trade" (Evenett and Venables, 2002). Klenow and Rodríguez-Clare (1997) show that the 1986–92 trade liberalisation in Costa Rica led to a large increase in the average number of countries from which product categories are drawn, supporting the notion of "geographic spread of trade" also on the import side.

and income on variety via a technology channel. Modelling this would probably be very demanding, especially when considering the hitherto unclarified nature of the trade-income relationship (cf. Rodríguez, 2006).

Rather, given the BEC grouping into primary, intermediate, capital, and consumption goods, we formulate a short-cut through this web of endogeneity. At the core of capital-goods-variety-based models of growth is the formulation that the variety of capital goods available for production constitutes a technology parameter. This implies that the variety of consumption goods available in a country does not constitute technology but is a pure trade measure, i.e., consumer goods variety depends on income via trade but does not influence income via a technology channel. Accordingly, we define the available variety of capital goods relative to the available variety of consumer goods, i.e. $CGV_{jt} = VarCap_{jt}/VarCon_{jt}$, as a technology-relevant variety measure, where $VarCap_{jt}$ and $VarCon_{jt}$ are the available variety count measures of country j at time t of capital and consumer goods, respectively, as defined in section 4, i.e., measured as the number of exported categories plus the number of imported categories times their places of origin. CGV_{jt} potentially influences income via a technology channel but does not depend on trade – and thus on income – unless there are asymmetrical effects on capital and consumption variety via trade, for which we will have to control.[25]

Also, in order to test for potential technology-related information in goods used in production other than capital goods, we define two additional variety measures, the available variety of primary goods relative to the available variety of consumer goods, i.e. $PGV_{jt} = VarCap_{jt}/VarPrim_{jt}$, and the available variety of intermediate goods relative to the available variety of consumer goods, i.e. $IGV_{jt} = VarInt_{jt}/VarCon_{jt}$, where $VarPrim_{jt}$ and $VarInt_{jt}$ and are defined analogously to $VarCap_{jt}$ and $VarCon_{jt}$.

5.2. Data and specification

Dependant variables

We test the conditional technological convergence hypothesis (9) on average yearly growth rates of our thee variety measures defined above, i.e. on $(\log CGV_{j,t+T} - \log CGV_{jt})/T$, $(\log IGV_{j,t+T} - \log IGV_{jt})/T$, and $(\log PGV_{j,t+T} - \log PGV_{jt})/T$, with T as the length of the period under consideration.

[25] While previous studies have established links between increases in the variety of all products *exported* out of a country and productivity increases in this country, potentially motivated by Acemoglu and Ventura (2002), there is no theoretical reason and no indication that the same would hold for increases in the variety of *traded* consumer products. However, to make sure this undesirable effect is not hidden in our identification strategy, we also conduct conditional convergence tests with defining the *import* – rather than the traded – variety of capital goods relative to the *import* variety of consumer goods as the potential technology-relevant variety measure. As our tests indicate that this does not qualitatively change the results presented below, we prefer the definition given here, which is closer to our theoretical model.

Explanatory variables derived from the hypothesis (9)

In the framework of conditional technological convergence, initial states are given by log CGV_{jt}, log PGV_{jt}, or log IGV_{jt}, respectively. On the right hand side of equation (9), u refers to the length of schooling, and ψ/γ to returns to schooling, which are presumably interdependent: the individual choice of length of schooling responds to the returns to schooling. Here, however, we abstract from these interdependencies and retreat to the usual assumptions prevailing in the empirical literature on skill acquisition and assume especially that ψ/γ is constant.

From the steady state in (5), we know that μ is restricted in order to support $h^* \leq A$. We might leave it at this, and see μ just as a scaling parameter. However, also compatible with the functional form (3), one might interpret μ as collecting additional influences on the productivity of the learning process. As we know from Keller (2004) and Comin and Hobijn (2004) that empirically the most important influences on the adoption of technology – other than education variables – are a country's own innovative activities, we try to collect indicators related to this. A data mining exercise with the World Bank's *World Development Indicators* produced variables described in Table A4, on population density, the share of urban population, and the sum of residents' and non-residents' patent applications. However, as data availability on all these variables is restricted, we start testing hypothesis (9) without these variables. Rather, we test for their potential influence as part of our sensitivity tests in section 6.

This leaves us with one steady state variable, i.e. the length of schooling, which we measure in average years per person aged between 25 and 65, $u25_{j,tT}$, for the period tT between t and $t+T$. We use data from the updated Barro-Lee set (Barro and Lee, 2000) with the *caveat* that for our purposes this data set, while representing the best available, has shortcomings: a principal problem "is the comparability over time of match between the educational categories in the survey data" (Pritchett, 2006, p. 656). In addition, they measure education of labour force aged population not labour force, i.e., there is no correction for participation rates, which differs across countries and by gender; also, there is no correction for school quality. Furthermore, we know that individuals also acquire skills outside of formal education, and experience is about as important as formal education. Finally, the Barro-Lee data set contains only limited information on transition economies (for more detail, see Table A4 in the appendix).

Control variables

Initial variety, educational parameters, and additional potential influences on the productivity of the learning process, μ, are all explanatory variables we can identify strictly from the hypothesis (9). In order to test the hypothesis, however, we need to control for influences on changes in h other than from (9).

Most importantly, (9) is a hypothesis on technical change in a model without explicit trade, while we measure h as trade-based variety. In

order to test (9) with trade-based variety measures, we have to isolate the potential technology information in trade-based variety data and control for the trade information in these data. This we achieve by normalising potential technology variables by a pure trade variety variable, the available variety of consumer goods. This normalisation then requires controlling for different overall demand effects on different types of goods, which we do by including $inv\_con_{j,t+T} - inv\_con_{jt}$, i.e. the change in the investment-consumption ratio.

Second, there are potential size effects to be controlled for: empirical work on trade-based variety data suggests that there are fixed costs of trading varieties (Hummels and Klenow, 2005). As mentioned, however, our empirical tests control for the trade aspect of our data, leaving the potential technology information. This is to say, we need not control for fixed costs of trading varieties. However, our hypothesis (9) assumes costless technology transfer, i.e. the design of newly innovated capital good varieties is available everywhere without further cost. This is most probably too simple a picture: designs have to be adapted to specific markets, licenses have to be traded. All this implies that there are costs of new technology adoption – in the sense of design transfer before capital good varieties can be used in a new market. Whether these costs are variable with market or labour force size (as suggested by Easterly et al., 1994) or fixed, much as fixed costs of innovation (as suggested in Romer, 1994), is actually an empirical question. If there are fixed costs of technology adoption, we should be able to still find country size effects in our data, even after controlling for trade influences.

How can we form prior expectations on how to enter country size effects into the testing equation? Although our theoretical model assumes no such costs, we can argue in the spirit of the model. Fixed costs of new technology adoption would alter the steady state effects of length of schooling on technology, in equation (5). Although the specific form of this alteration is unclear, we do not think that it would make much sense to model market size as a perfect substitute for education. Empirically, such an approach would assume that market size is a limiting factor for technology adoption and use for Germany, as compared to the larger US, as much as for Cyprus, as compared to the larger Czech Republic. This is very unlikely to be the case. Rather, both the spirit of our model and the expected size of fixed costs of new technology adoption and use suggest that lack of size might limit the steady state effects of length of schooling on technology in equation (5) only until a certain threshold size. This suggests adding a combined effect of length of schooling and a small country dummy. We develop various small country dummies with the help of the cumulative distribution of GDP in constant international dollars in the year 2000. We divide countries according to the five quantiles of this distribution, enabling us to define four different size dummies, according to the thresholds. We start out using the smallest threshold, i.e. we add a size dummy that is positive for those countries in the lowest quantile of the cumulative distribution of GDP in constant international dollars in the year 2000, and interact it with the schooling variable, $GDP1 \times u25_{j,tT}$.[26] We

[26] We already documented some reservation concerning the use of interaction dummies. e therefore also tested for size dummies without interaction with schooling. As this did not

take this issue up again in the sensitivity test in section 6, where we also explore the consequences of controlling for country size directly in terms of GDP in constant international dollars.

Finally, transition may exert an influence on the behaviour of our potential technology variables beyond hypothesis (9).[27] By the definition of transition, this is rather likely to affect the speed of convergence rather than the steady state. Accordingly, in a first specification we control for transition effects in our testing equation by adding a combined effect of transition status and initial variety, *Trans* × log CGV_{jt}, *Trans* × log PGV_{jt}, or *Trans* × log IGV_{jt}. Table A4 in the appendix summarises the description of all variables used in the regression analysis.

Specification

Our steady state variable, i.e., length of schooling, is available only at five-year intervals (1995, 2000). This fact alone makes clear that we cannot exploit the full yearly 1992–2004 panel of annual variety data.

In choosing an estimation approach we rely on the experience with estimating conditional per capita income convergence. There has been a long-running debate in per capita income growth empirics on how to exploit the variation available in panel data. If per capita income growth depends on the initial level of countries' technology, omitting this variable causes heterogeneity bias: in the absence of measurement error using only within-country variation dominates any estimators using also between country variation. Without omitted variable bias but in the presence of measurement error, and when explanatory variables are more time persistent than measurement error, the opposite is true.[28]

Hauk and Wacziarg (2004) perform a Monte Carlo study to assess the effects of both sources of bias on various estimators used in per capita income growth regressions and find that within estimators greatly overstate the speed of convergence and bias steady state variable estimates towards zero. Estimators that use at least some between variation tend to overestimate steady state variable influence and are probably closer to the true speed of convergence. Especially, the SUR estimator used in Barro and Sala-i-Martin (2004) performs best in terms of estimating speed of convergence. The between estimator (OLS applied to a single cross-section averaged over time) performs best in terms of overall bias.

With potential mismeasurement in our trade-based variety data, the above argument points towards employing a traditional between estimator in our context of conditional technological convergence estimation. Our main

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qualitatively change our results, we prefer $GDP1 \times u25_{jtr}$., which is more in the spirit of our theoretical framework.

[27] See Frensch (2004) for a theoretical justification that improvements in public governance, which are connected to a successful political transformation, facilitate variety gains during transition.

[28] Provided all our countries are "small" relative to the technology frontier, our approach should not suffer from heterogeneity bias (cf. (9) in section 3.2). To make sure, we will in our sensitivity analysis construct a smaller sample excluding those countries where this assumptions seems in doubt due to their prominence in innovation activity.

limitation here is data availability: after data cleaning (see Appendix 2), the maximum number of observations over a period somewhat longer than five years is around 40. We can increase this by about two thirds by using data from two five-year periods (1993–98 and 1999–2004). Accordingly, we compromise between data availability and measurement bias by using data from two five-year periods and estimating this small panel with 3SLS (as in Barro and Sala-i-Martin, 2004, chapter 12, in the context of per capita income convergence), i.e., the two-stage least squares version of the SUR method, an estimation technique less prone to measurement bias than other panel estimators, and appropriate when there may be both heteroskedasticity and contemporaneous correlation in the residuals.[29]

5.3. Estimation and discussion of the results

We accordingly estimate

$$(\log CGV_{j,t+T} - \log CGV_{jt})/T = \beta_0 + \beta_1 \log CGV_{jt} + \beta_2 u25_{j,tT} + \beta_3 (inv\_con_{j,t+T} - inv\_con_{jt}) + \beta_4 GDP1 \times u25_{j,tT} + \beta_5 Trans \times \log CGV_{jt} + \varepsilon_{jt}, \quad (11)$$

with available capital goods variety data, and corresponding equations with available primary goods variety data, and with available intermediate goods variety data, respectively. *A priori* expectations from (9) and the discussion of control variables in the previous section are that β_1, β_4, $\beta_5 < 0$ and β_2, $\beta_3 > 0$ for the available capital goods estimation.

Instruments are the one-period lagged initial state variables. (11) is tested over an unbalanced panel of countries over two intervals of equal length $T = 5$, 1993–98 and 1999–2004, i.e. as a system of two equations. Estimation is by three-state-least squares allowing the error terms to have different variances in the two intervals and to be correlated across intervals.

Estimation results are given in Table 1. Coefficients of control variables have the expected signs and are significant in the CGV estimation (capital goods, Table 1, column 1), with the exception of the size variable. This is different in the PGV and IGV estimations (primary goods, Table 1, column 2, and intermediate goods, Table 1, column 3, respectively). Especially, transition does not have a significant effect on PGV or IGV growth.

– Table 1 about here –

More importantly in the sense of our conditional technological convergence hypothesis, estimations also reveal important differences with respect to the significance of schooling and the estimated speed of convergence. For

[29] In the per capita income convergence literature close to our approach measurement bias of initial states is also dealt with by using lagged initial state variables as instruments, usually lagged for the length of one period, i.e. five years in our context. Our data, however, start only with 1992 and thus allow only for a one year lag. Using this lagged state variable as instrument results in our system being just identified, so we cannot properly test for the validity of these instruments, e.g. with a Sargan test.

their full sample of countries, Barro and Sala-i-Martin (2004, Table 12.3, p. 522), report a conditional convergence speed of real per capita GDP of 2.5 per cent. In addition, Wong's (2007) recent findings indicate that *tfp* growth, rather than capital accumulation, is what empirically accounts for conditional income convergence both for richer and poorer countries. Thus, conditional technological convergence speeds much different from Barro and Sala-i-Martin's 2.5 per cent would appear counterfactual. Indicating estimated speeds of convergence of 2.1 and 2.9 per cent, respectively, CGV and PGV results in Table 1 match Barro and Sala-i-Martin's. The speed of convergence from the intermediate goods variety regressions of 4.4 per cent seems too high to be consistent with conditional technological convergence in the context outlined above.

Average length of schooling of the labour-force-aged population exerts a significant effect only on the growth of available variety of capital goods, but not so on the growth of available variety of primary or intermediate goods. As is to be expected from the hypothesis (9), the effect of schooling on variety growth is rather small: increasing length of schooling by one year increases the yearly average growth rate of the variety of available capital goods by about 0.0014, i.e. when expressing growth rates in percentages, this amounts to slightly less than one seventh of a percentage point. Equivalently, *ceteris paribus* it takes an increase of about three and a half years in the average length of schooling to bring about a half a percentage point increase in the yearly average growth rate of the variety of available capital goods.

The first evidence thus seems to point towards the direction that a trade-based count measure of the variety of available capital goods in our expanded product space, allowing for product differentiation by country of origin, indeed behaves "as if" it represented technology in the sense of hypothesis (9), while measures of the variety of primary or intermediate goods do not. This is perfectly in line with the spirit of capital-goods-variety-based growth models: the division of labour can be expected to be embedded in the variety of available capital goods, much more so than in the variety of primary or intermediate goods.

Policy reforms in transition

So far, we have not specified how exactly transition exerts an influence on the speed of technological convergence. Within our approach, studying this in more detail means searching for a policy reform area that has a positive impact on technology over and above that on trade. The variables most in use for such a purpose are the EBRD transition indicators, measured on a scale between levels 1 and 4+ (= 4.33). I.e., these variables are ordered qualitative rather than cardinal measures and should perhaps best not be used directly in linear regression analysis. Rather, we construct dummy variables from these EBRD indicators in the general form of $ReformMeasure\_Level_{j,tT}$, indicating whether or not a country has within a certain policy field made the step towards a certain level on the EBRD scale within a given period. We define seven reform fields (price liberalisation, foreign trade and payments liberalisation, *de jure* large scale privatisation, governance and enterprise restructuring, banking reform and interest rate liberalisation, securities markets and non-bank financial

institutions reform, and progress with competition policy), in each of which four steps can possibly be taken on the EBRD scale. This makes for twenty eight potential indicators of the general form of $ReformMeasure\_Level_{j,tT}$ (Table A4).[30]

From Aghion et al. (2005) one might expect that banking reform has a positive impact on technical change over and above that on trade, while there is no clear cut *a priori* expectation on the direction of influence of other policy reforms. We therefore substitute in (11) our preliminary transition control variable $Trans \times \log CGV_{jt}$ with $Bank\_2_{j,tT} \times \log CGV_{jt}$, and do correspondingly in IGV and PGV estimation equations, where $Bank\_2_{j,tT}$ indicates whether or not a country has made the step towards level 2 on the EBRD scale in the area of banking reform and interest rate liberalisation within a given period.

Policy reforms may not be exogenous because of potential reverse causality from technology via per capita income growth on reforms, or because of common effects of omitted variables on both technical change and reforms (e.g., the often quoted "distance to Brussels"). However, Godoy and Stiglitz (2006) show in a simultaneous equations approach that there is no significant endogeneity problem in the per capita growth and policy reforms context. As income growth appears to be the only potential channel between technology and reforms, we thus take policy reforms to be exogenous for our purposes.

Results in Table 2 confirm our expectations, in as much as banking reforms exert a significant and positive effect on the speed of CGV convergence (column 4, Table 2).

– Table 2 about here –

Substituting the transition dummy in the CGV estimation by a specific banking reform variable only slightly changes the point estimates of other explanatory variables, with the exception of the investment-consumption ratio change, which is substantially reduced. The significance of estimated coefficients (again, with the exception of the investment-consumption ratio change) and the overall fit of the CGV estimation is substantially improved (column 4, Table 2 versus column 1, Table 1).

Surprisingly, the impact of banking reforms during transition is negative on the speed of IGV convergence (column 6, Table 2), while the relatively high speed of convergence estimate is only slightly reduced, and the effect of schooling remains insignificant. The latter also holds for the PGV estimation (column 8, Table 2).

To test for potential misspecification, we applied a systems version of Ramsey's Reset-test in form of a Wald-test on polynomials of second, second and third, and second, third and fourth order, respectively, of the fitted values from column 4, 6 and 8 regressions in Table 2 in augmented

[30] In fact, there are fewer than that. With different reform progress in different fields, we can only consider levels on the EBRD scale, which create sufficient variability in the data. E.g., in the period under consideration, no transition country has reached "level 4" on the EBRD scale in terms of banking reform. Attempts to study the corresponding impact on variety change thus make little sense.

regressions. In none of these tests could we reject the null of zero coefficients of these polynomials for the CGV and PGV regressions. However, we had to reject the hypothesis of zero coefficients for the second and third order fitted value polynomials at 10 percent level of significance for the IGV regression.

Summing up this evidence, we take Table 2 results as substantiating our first impression that our trade-based count measure of the available variety of capital goods indeed behaves as if it represented technology, while measures of the available variety of primary or intermediate goods do not. But how robust and how plausible are these results?

6 Sensitivity

Sample composition

The motivation for the learning process (3) was the existence of technology transfer, but this concept is in principle relevant also within, not only across countries: the important difference between countries is thus not the absence of technology transfer but whether or not countries are small relative to the technology frontier, which is what we assumed in deriving our conditional technological convergence hypothesis. We construct a "small country" sample excluding countries where this assumption seems in doubt due to their prominence in innovation activity (see fn. 6 in section 3.1), thus reducing potential heterogeneity bias if the small country assumption were wrong. Repeating the above discussion of results for columns (5), (7), and (9) in Table 2 confirms the conclusion that our trade-based count measure of the available variety of capital goods behaves as if it represented technology, while measures of the available variety of primary or intermediate goods do not. Specifically, excluding countries with substantial innovation activity from the CGV estimation (column 5, Table 2) results in a slight reduction of the point estimate of the speed of convergence and an increase in that of the schooling variable, while results in general are quite robust to sample composition.

Definition of intermediate goods

The so far negative outcome for testing for technological content in intermediate goods variety in the sense of our hypothesis (9) may perhaps be due to our too strictly following the definition of intermediate goods as outlined in Appendix 2. Accordingly, we experimented with alternative definitions of intermediate goods in testing the IGV estimations in columns (6) and (7) of Table 2. Specifically, we alternatively defined intermediate goods (i) not to contain BEC heading 121, (ii) not to contain BEC heading 42, (iii) not to contain BEC headings 42 and 53, (iv) to consist only of BEC heading 22, (v) to consist only of BEC headings 42 and 53. For none of these alternative specifications was there a qualitative change to the results in columns (6) and (7) of Table 2. Specifically, for none of these specifications did schooling significantly explain IGV growth, or did transitional banking reform significantly increase IGV speed of convergence (results are available upon request).

Alternative size variables

In section 4.2, we argued that both the spirit of our model and the expected moderate size of fixed costs of new technology adoption suggest reflecting country size effects by adding a combined effect of length of schooling and a small country dummy. So far, we have used a size dummy that is positive for those countries in the lowest of five quantiles of the cumulative distribution of GDP in constant international dollars in the year 2000, $GDP1 \times u25_{j,tT}$. Table 3 indicates estimation results for our benchmark CGV estimation (column 4, Table 2), when widening the definition of the size dummies to include an increasing number of the five quantiles of the cumulative distribution of GDP in constant international dollars in the year 2000, i.e., for $GDP2 \times u25_{j,tT}$, $GDP3 \times u25_{j,tT}$, and $GDP4 \times u25_{j,tT}$. We also explore the consequences of controlling for country size directly in terms of GDP in comparable international dollars, in (column 13) or without (column 14) combination with the schooling variable $u25_{j,tT}$. CGV results are presented in Table 3 and indicate that none of the alternative size variables exerts a significant influence on CGV growth. Hence we conclude that fixed costs of technology transfer indeed seem to be a problem only for countries of comparatively small size (PGV and IGV results are available upon request).

– Table 3 about here –

Alternative schooling variables

As hypothesis (9) is in accordance with Mincerian wage formation, our preferred schooling measure is $u25_{j,tT}$, the average length of schooling of the labour-force-aged population. We test the robustness of our benchmark results in column 4 of Table 2, both for the full sample and for the small country sample, to alternative measures of schooling, where $u25{,}2_{j,tT}$ indicates the percentage share of the labour-force-aged population with secondary education; *f* indicates schooling measures for the female part of the population. As Table 4 indicates, all alternative schooling measures are significant in CGV estimations across both samples, without substantially altering point estimates and significance levels of other coefficients. As none of our alternative schooling measures turns out significant in our PGV and IGV regressions (available upon request), we conclude that our results are robust to the measurement of educational attainment.

– Table 4 about here –

In addition, Table 4 reveals two interesting patterns: (1) secondary schooling measures are *cet. par.* more significant in CGV estimations than length of schooling measures. (2) Schooling measures for the female part of the population are *cet. par.* more significant in CGV estimations than for the total population. As an suggested answer to the second regularity, provided that females have so far been disadvantaged in education in most countries, their change signals change in both mean and variance of total population educational attainment, both of which are conducive to improving a learning processes such as (3). I.e., female schooling

measures are in fact preferable to total population measures. All these results are also robust to substituting education parameters for age 25 to 65 by education parameters for age 15 to 65 (available upon request).

Alternative policy reforms in transition in CGV estimations

We have already indicated that – except for banking reform – we constructed a number of additional transition reform measures in the general form of $ReformMeasure\_Level_{j,tT}$, indicating whether or not a country has within a certain policy field made the step towards a certain level on the EBRD scale within a given period (for details see Table A4). Only four of these turned out significant when being substituted for $Bank\_2_{j,tT}$, i.e. for whether or not a country has made the step towards level 2 on the EBRD scale in the area of banking reform and interest rate liberalisation within a given period, in the CGV benchmark estimation (column 4, Table 2). These reform indicators are presented in Table 5, they are $PL\_4_{j,tT}$ (for the step towards level 4 price liberalisation in the EBRD scale); $FT\_4_{j,tT}$ (level 4 in foreign trade and payments liberalisation), $LSP\_2_{j,tT}$ (level 2 in *de jure* large scale privatisation); and $CP\_2_{j,tT}$ (level 2 in competition policy).

– Table 5 about here –

Of these, only the price liberalisation dummy is uncorrelated with the banking reform dummy for the benchmark estimation sample, with a correlation coefficient of less than 0.1. However, estimation with the price liberalisation dummy in Column 21a, Table 5, produces non-normal second subperiod residuals; once we remove the responsible data point, price liberalisation does no longer significantly influence speed of convergence in the CGV estimation (Column 21b, Table 5). Both the foreign trade and payments liberalisation and the large scale privatisation dummies are highly correlated with the banking reform dummy for the benchmark estimation sample, with correlation coefficients of 0.8. I.e. these reforms tend to be taken at the same time with banking reform. However, as in Aghion et al. (2005) we do have a theoretical basis for including the banking reform dummy, but do not have such a basis for including the foreign trade and payments liberalisation and the large scale privatisation dummies, and as respective CGV estimations in columns 22 and 23 typically deteriorate the overall fit of the CGV estimation, we prefer not to substitute any of these two reform measures for the banking reform measure in the CGV benchmark estimation. With respect to these criteria, the preference for the banking reform dummy versus a competition reform dummy also holds, albeit less clearly so: the correlation between banking reform and competition policy improvement is moderate, with a simple correlation coefficient of 0.47; column 24 shows that including a however theoretically so far unbacked competition reform dummy does not deteriorate the overall fit of the CGV estimation, as compared to including banking reform.

Additional regressors

A strong case can be made that the Reset test on our benchmark specification tests only for functional form misspecification, rather than for omitted variables. We therefore also test the influence of additional variables, summed up in μ, potentially influencing the learning process (3), namely the mid-period levels of *population density* and the share of *urban population*, and the mid-period logs of the sum of residents' and non-residents' *patent applications* and the sum of residents' and non-residents' *patent applications per employee*, respectively, all drawn from the World Bank's *World Development Indicators 2006*. None of these additional regressors turned out significant in the CGV benchmark estimation (column 4, Table 2). Again, results are available upon request.

7 Plausibility of the results

Our results are structural test results, i.e., they are based on a clearly spelled-out hypothesis. As indicated in section 3.1, Jones' (2002) learning process (3), and thus our hypothesis (9), are in full consistence with Mincerian wage formation. This indeed gives us a chance to check the plausibility of our estimations against other, independent results. Comparing our CGV equation (11) to the hypothesis (9) reveals our estimated coefficients in the CGV estimations to be restricted as $\beta_1 = -\gamma g$, and $\beta_2 = \psi g$. Thus, the ratio of our $-\beta_2/\beta_1$ estimates is an imputed macro-based estimate of a Mincer coefficient of average returns to schooling in our sample, indicating the percentage real wage rise, ψ/γ, implied by each year of additional schooling. In addition, we may check the plausibility of our β_1 estimate against what we know about g, the rate of change of the world technology frontier, given our parameter restriction, $0 < \gamma \leq 1$ in (3).

Pritchett (2006, p. 657) informs about Mincer coefficients based on estimates of wage regressions: "The central tendency of the coefficient on schooling in a log wage/earnings regression is between 7 percent (the average for the OECD countries) and 10 percent (the average for the non-OECD countries) ... The median in the whole sample is 8.5 percent and the standard deviation is 3.4 percentage points." Also, Bils and Klenow (2000) report returns to schooling of 10 percent on average for a 52 country sample. However, for the only 17 countries, for which our and the Bils and Klenow (2000) samples overlap, we compute a considerably lower average figure around 6 per cent, as our sample excludes very poor developing countries with above-average returns to schooling. As, also according to Pritchett (2006), there is little substance for or against significant differences between social and private rates of return to education, our imputed macro-based Mincer coefficients, as the ratio of $-\beta_2/\beta_1$ estimates, should indeed be consistent with the figures quoted.

With the ratio of $-\beta_2/\beta_1$ estimates between 0.06 (in our CGV benchmark estimation (column 4, Table 2) and 0.07 (column 15, Table 4a), the order of magnitude of our point estimates seems plausible. Also, consistent with results reported in Bils and Klenow (2000) and Pritchett (2006), our imputed macro-based Mincer coefficient goes up to between 0.08 (column

5, Table 2) and 0.09 (column 18, Table 4b), when banning the most innovative – and richest – economies from the sample.

The parameter restriction $0 < \gamma \leq 1$ in (3) implies our estimated β_1 as $0 < -\beta_1 \leq g$, where g is the rate of change of the world technology frontier. On this, we have little independent information. However, a rough first approximation might be technical progress in the U.S. economy, arguably one of the world's technological leaders. As over the long-run, the U.S. economy can be assumed to be on its steady-state growth path, technical progress here should equal the growth rate of labour productivity. In per capita terms, this has been around 2 per cent over the 20th century (Kehoe and Prescott, 2002), where, however, one might well argue in favour of a higher figure, given that our data cover 1992–2004, i.e., a period when the productivity growth slump of the post 1973 era had been overcome.[31] If this is correct, this independent source of information, together with the parameter restriction on γ, implies an estimated $-\beta_1$ between 0 and about 2.5–3 to be plausible. Our benchmark point estimates, –0.023 and – 0.021 for the full sample and the small country sample, respectively (columns 4, 5, Table 2), meet this requirement well, and in turn indicate that γ may be closer to 1 than to 0, underlining the importance of the original technology gap in the learning process (3): the elasticity of the transitory growth rate of h with respect to the original technology gap is certainly closer to one than to zero.

Thus, with appropriate caution, our results indicate that not only the estimated speed of technological convergence matches that of income convergence, but also that our estimates are plausible when checked against independent information from Mincerian wage regressions and what we know about the rate of change of the world technology frontier.

8 Conclusions

The results of this paper constitute evidence on the issue of direct measurement of the state of technology by trade-based measures of product variety. A trade-based count measure of the variety of available capital goods, defined over an expanded product space allowing for product differentiation by country of origin, indeed behaves "as if" it represented technology when change of technology is understood as Jones' (2002) learning process. Variety measures of available primary and intermediate inputs do not behave this way. Based on available capital goods variety estimations, there is conditional technological convergence among a panel of mostly OECD and transition countries, where the speed of convergence corresponds to that of real per capita income arrived at with comparable estimation techniques. Extending the analysis to allow for transitional reforms to influence technological convergence shows that banking reforms exert a positive an significant effect on the speed of technological convergence.

Against the background of the recent use of various trade-based variety measures as if implicitly representing states of technology, our results

[31] Bureau of Labor Statistics data, as reproduced in Jones (2002, p. 46) indicate a trend growth rate of output per hour worked between 2.5 per cent for 1949–98, and 3.3 per cent for 1949–73.

imply that caution is needed when constructing such measures: measures that include information on the variety of consumption, primary, or intermediate goods and/or only on export variety rather than available variety seem unwarranted when testing variety-productivity links rooted in capital-goods-variety-based models of growth..

There is much scope for further research. Both theoretically as well as empirically, an integration of trade-based variety and quality measures to better proxy the extent and the quality of the division of labour as a measure of technology is called for. Finally, if available intermediate goods variety is not a technology variable, what then is it? Increases in the variety of intermediate goods available for production may have productivity effects, while the results of this paper would imply that these effects are not based on technology characteristics in the sense of the theoretical basis of the paper. What exactly then would be the channel for productivity effects of an increased variety of intermediate goods available for production remains unclear.

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Appendix 1: A closed-form solution for *h*(*t*)

Technical change is as described in (4). Define the technology of a country relative to the frontier as $B(t) = h(t)/A(t),$ and the respective growth rate as $\delta_{B(t)} = \delta_{h(t)} - \delta_{A(t)}.$ Assume the technological frontier grows according to $A(t) = A_0 e^{gt}$, and g is given to any single country in the world such that $\delta_{B(t)} = \delta_{h(t)} - g.$ Then, (4) can be rewritten as

$$\delta_{B(t)} + g = \mu e^{\psi u} B(t)^{-\gamma}$$

or equivalently as

$$\frac{\dot{B}(t)}{B(t)} = \mu e^{\psi u} B(t)^{-\gamma} - g$$

and

$$\dot{B}(t) = \mu e^{\psi u} B(t)^{1-\gamma} - gB(t) \qquad \text{(A1)}$$

(A1) is a Bernoulli-equation, which can be transformed into an ordinary linear differential equation by setting $Z(t) = B(t)^{\gamma}$, and accordingly $\dot{Z}(t) = \gamma B(t)^{\gamma-1}\dot{B}(t).$ Then, (A1) becomes

$$\frac{\dot{Z}(t)}{\gamma} = \mu e^{\psi u} - gZ(t)$$

and thus

$$\dot{Z}(t) = \gamma\mu e^{\psi u} - \gamma g Z(t). \qquad \text{(A2)}$$

(A2) has the explicit solution

$$Z(t) = Z_0 e^{-\gamma gt} + \frac{\mu}{g} e^{\psi u}(1 - e^{-\gamma gt})$$

such that

$$B(t)^{\gamma} = B_0^{\gamma} e^{-\gamma gt} + \frac{\mu}{g} e^{\psi u}(1 - e^{-\gamma gt}) = B_0^{\gamma} e^{-\gamma gt} + (B^*)^{\gamma}(1 - e^{-\gamma gt}) \qquad \text{(A3)}$$

The resemblance so far to the derivation of the closed-form solution for per capita income in the Solow model (Jones, mimeo) is evident. From (A3), we can straightforwardly derive,

$$h(t) = \left[\left(\frac{h_0}{A_0}\right)^{\gamma} e^{-\gamma gt} + \frac{\mu}{g} e^{\psi u}(1 - e^{-\gamma gt})\right]^{1/\gamma} A_0 e^{gt} \qquad \text{(A4)}$$

Appendix 2: Trade-based measurement of variety

For this paper, data were extracted from COMTRADE in November 2005, complemented and corrected in a few cases by using COMTRADE-on-line in January 2006.

Commodity classifications

SITC

The Standard International Trade Classification, Revision 3 (SITC, Rev.3) was used at all aggregation levels (1-, 2- and 3-digit levels for checking totals, 4- and 5-digit levels for counting SITC categories).

There are 3,121 basic headings in the SITC, Rev.3, 2,824 at the 5-digit level and 297 at 4-digits, that are not disaggregated any further. The 3-digit group 334 (petroleum products), which is divided into eight final headings in SITC, Rev.3, is in fact not subdivided by many reporting countries, so we treat it as a single heading. Thus, there are 3,114 basic headings, which are referred to as SITC categories.

BEC

The United Nations Statistics Division's *Classification by BEC* (*Broad Economic Categories*, available online at: http://unstats.un.org/unsd/cr/family2.asp?Cl=10) allows for headings of the SITC, Rev.3 to be grouped into 19 activities covering primary and processed foods and beverages, industrial supplies, fuels and lubricants, capital goods and transport equipment, and consumer goods according to their durability. The BEC also provides for the rearrangement of these 19 activities (on the basis of SITC categories' *main* end-use) to approximate the basic System of National Accounts (SNA) activities, namely, primary goods, intermediate goods, capital goods, and consumer goods.

– Table A1 about here –

Primary goods (BEC headings 111, 21) consist of 272 SITC, Rev.3 categories and include primary food and beverages designated mainly for industrial use and primary industrial supplies (raw materials).

Intermediate goods (BEC headings 121, 22, 42, 53) consist of 1,627 SITC, Rev.3 categories and include: processed food and beverages designated mainly for industry; processed industrial supplies, parts and accessories of capital goods, and transport equipment.

Capital goods (BEC headings 41, 521) comprise 471 categories at the 4- and 5-digit levels of the SITC, Rev.3 and include: machinery such as electric generators and computers; indus-

trial transport equipment such as finished ships, road vehicles, aircraft, railway and tramway rolling stock; and other manufactured goods such as medical furniture, which are used by industry, government and non-profit private institutions.

Consumer goods (BEC headings 112, 122, 522, 6) cover 704 categories at 4- and 5-digits of the SITC and include primary and processed food and beverages designated mainly for household consumption, non-industrial transport equipment, such as motorcycles and bicycles, and other consumer goods.

SITC categories falling under BEC headings 51, 3, and 7 are excluded from our rearrangement of SITC categories into primary goods, intermediate goods, capital goods, and consumer goods for various reasons. "Motor vehicles for the transport of passengers", SITC, Rev.3, heading 7812 (equivalent to BEC heading 51) cannot be divided into capital or consumer goods. Similar reasoning holds for motor spirits. By definition, intermediate goods should also include primary and processed fuels and lubricants (other than motor spirit), but in this data set "fuels and lubricants", which include 32 4- and 5-digit headings of the SITC, Rev.3, are not used, in part due to countries' incomparable reporting practices (see above). BEC 7, "goods not elsewhere classified", comprises 14 basic headings of the SITC, namely, military equipment, including arms and ammunitions, special transactions, postal packages, etc., which are excluded.

Country and period coverage

Reporting countries' data were extracted for 46 UNECE countries, i.e. most of Europe, Central Asia and North America. Belgium and Luxemburg are counted as one country throughout as reported until 1998. The data cover 1992–2004 but not all countries report in each year (average: 40.15 countries per year).

– Table A2 about here –

Partner countries comprise the rest of the world (for total exports and imports), and 55 individual countries (the 46 reporter countries plus: Bosnia and Herzegovina, Tajikistan, Uzbekistan, China, Hong Kong, Japan, South Korea, Taiwan and Thailand) for imports and thus for the product variety count. These partner countries generally account for 80–95 per cent of reported imports (on average above 90 per cent for the data points actually used in regressions (1–24), although Canada and the United States trade extensively with south American countries that are not included among the 55 partners). Also, the Czech Republic, Slovakia and Macedonia are partner countries only from 1993 on, thus slightly weakening the strength of our 1992 product variety data, which are used as instruments in first subperiod regressions (1) – (24) in Tables 1–5.

Data cleaning

The most important source of measurement bias in our variety data is potential fluctuation in data coverage on the fairly disaggregate level of SITC we are using, i.e. fluctuations in the ratio of reported exports (or imports) of all the individual SITC categories and total exports (or imports). Even by eyeballing the data (Table A3), Turkmen, Kazakh and Kyrgyz data disqualify in this respect right away. If we were to normalise the distributions of these coverage fluctuations for the rest of the data over our five-year periods of interest, we would have to forego about ten per cent of the data. Rather than doing this, we dismiss the most obvious remaining outliers, which are the coverage fluctuations in the Croatian data between 1993–98. Consistency checks with the remaining data reveal that all Polish product variety measures double between 2003 and 2004, unaccounted for by any comparable coverage fluctuation but probably due to changes in the methodology since the EU accession. As the emerging distrust comes on top of an often substantial mismatch between Polish customs and balance of payments foreign trade data during the 1990s, we also have to dismiss Polish data. Given the above procedure, checking for normality of residuals in our estimations is a clear must.

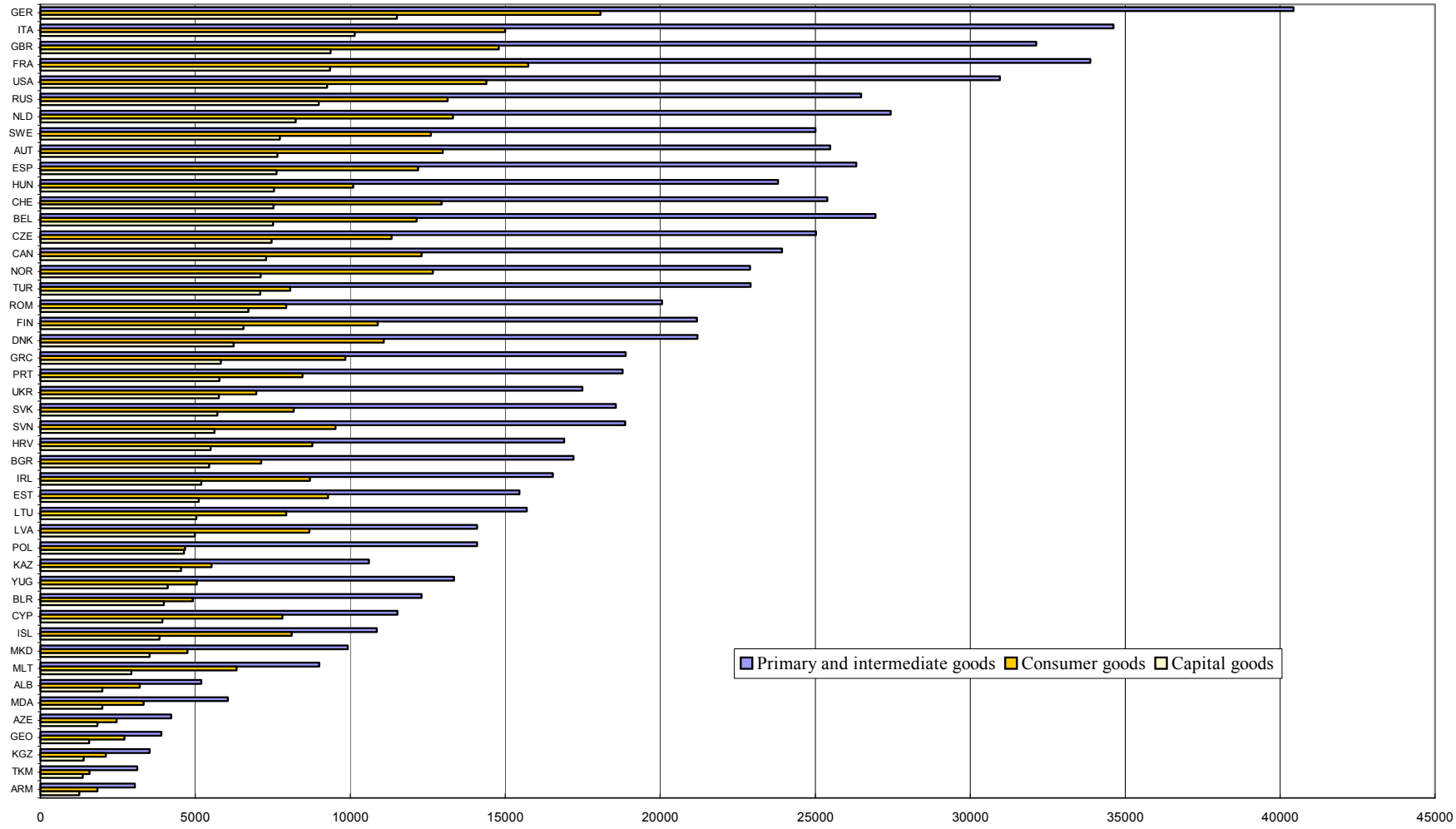
– Table A3 about here –

– Table A4 about here –

– Table A5 about here –

Appendix 3: Text tables and figures

Figure 1: Available variety by BEC groups in Western Europe, North America and the CIS, 2000



Sources: United Nations COMTRADE database and own calculations.
Notes: The maximum attainable variety counts are 39,424 for consumer goods, 26,376 for capital goods, and 106,344 for primary and intermediate goods together.

Table 1: Available product variety growth regressions (3SLS)

	(1) Capital goods	(2) Intermedia-te goods	(3) Primary goods
Dependent variables:	(log $CGV_{j,t+T}$ – log CGV_{jt})/T	(log $IGV_{j,t+T}$ – log IGV_{jt})/T	(log $PGV_{j,t+T}$ – log PGV_{jt})/T
Explanatory variables:			
Initial variety relative to consumer goods, log CGV_{jt}	–0.021**		
	(–2.00)		
log IGV_{jt}		–0.044***	
		(–3.14)	
log PGV_{jt}			–0.029***
			(–3.29)
Average years of schooling, $u25_{j,tT}$	0.0014*	–0.0001	–0.0006
	(1.77)	(–0.10)	(–0.55)
Size, $GDP1 \times u25_{j,tT}$	–0.0007	–0.0019***	–0.0023**
	(–1.50)	(–2.87)	(–2.56)
Investment-consumption ratio change, $inv\_con_{j,t+T} - inv\_con_{jt}$	0.090***	0.069***	0.036
	(4.73)	(3.17)	(1.18)
Transition, *Trans*× log $CGV_{j,t}$	–0.018**		
	(–2.46)		
Trans× log IGV_{jt}		0.004	
		(0.74)	
Trans× log IGV_{jt}			0.005
			(1.29)
Observations (1993–98, 1999–2004)	64 (25, 39)	64 (25, 39)	64 (25, 39)
Correlation between subperiod residuals	0.06	0.23	–0.24
Adj. R-squared (1993–98, 1999–2004)	0.36, 0.39	0.22, 0.37	–0.15, 0.11

Notes: t-statistics in parentheses. * (**, ***): significance at 10, (5, 1) per cent. Instruments: one year lagged initial relative product varieties. Interval dummies not reported. We cannot reject non-normality of second subperiod residuals in (2) and (3) on a Jarque-Bera test at 5 per cent level; qualitative results in (2) and (3) are robust to removal of an outlier (YUG) normalising residuals, except for an almost 50 per cent decline in the point estimates of the speed of convergence and the size coefficient in (2).

Table 2: Available product variety growth regressions with banking reform in transition (3SLS)

	(4)	(5)	(6)	(7)	(8)	(9)
	Capital goods		Intermediate goods		Primary goods	
Dependent variables:	(log $CGV_{j,t+T}$ – log CGV_{jt})/T		(log $IGV_{j,t+T}$ – log IGV_{jt})/T		(log $PGV_{j,t+T}$ – log PGV_{jt})/T	
Explanatory variables:	Full sample	Small country sample	Full sample	Small country sample	Full sample	Small country sample
Initial variety relative to consumer goods, log CGV_{jt}	−0.023**	−0.021**				
	(−2.59)	(−2.27)				
log IGV_{jt}			−0.041***	−0.042***		
			(−3.83)	(−3.96)		
log PGV_{jt}					−0.025***	−0.032***
					(−3.26)	(−3.28)
Average years of schooling, $u25_{j,tT}$	0.0013*	0.0016*	−0.0001	−0.0004	−0.0004	−0.0011
	(1.99)	(2.01)	(−0.12)	(−0.48)	(−0.38)	(−0.90)
Size, $GDP1 \times u25_{j,tT}$	−0.0009**	−0.0009**	−0.0020***	−0.0020***	−0.0024***	−0.0027***
	(−2.31)	(−2.05)	(−3.71)	(−3.42)	(−2.85)	(−2.91)
Investment-consumption ratio change, $inv\_con_{j,t+T}$ – inv_con_{jt}	0.075***	0.075***	0.057***	0.060***	−0.006	−0.004*
	(4.64)	(4.44)	(3.18)	(3.15)	(−0.217)	(−0.14)
Banking reform in transition, $Bank\_2_{j,tT} \times$ log CGV_{jt}	−0.070***	−0.070***				
	(−5.70)	(−5.54)				
$Bank\_2_{j,tT} \times$ log IGV_{jt}			0.050***	0.042***		
			(4.77)	(4.84)		
$Bank\_2_{j,tT} \times$ log PGV_{jt}					−0.008**	−0.008*
					(−2.05)	(−1.93)
Observations (1993–98, 1999–2004)	64 (25, 39)	52 (19, 33)	64 (25, 39)	52 (19, 33)	64 (25, 39)	52 (19, 33)
Correlation between subperiod residuals	−0.19	−0.21	0.07	0.08	−0.27	−0.18
Adj. R-squared (1993–98, 1999–2004)	0.54, 0.56	0.57, 0.57	0.52, 0.47	0.56, 0.47	−0.43, 0.27	−0.75, 0.29

Notes: t-statistics in parentheses. * (**, ***): significance at 10, (5, 1) per cent. Instruments: one year lagged initial relative product varieties. Interval dummies not reported. The small country sample excludes observations from the six G-7 economies in our sample, i.e. the US, the UK, France, Germany, Italy and Canada (cf. fn. 6 in the text). We cannot reject non-normality of second subperiod residuals in (6–9) on a Jarque-Bera test at 5 per cent level; qualitative results in (6–9) are robust to removal of an outlier (YUG) normalising residuals, except for an almost 50 per cent decline in the point estimates of the speed of convergence and the size coefficient in (6 and 7).

Table 3: Available capital goods variety growth regressions with banking reform in transition (3SLS): alternative size variables

	(4)	(10)	(11)	(12)	(13)	(14)
Dependent variable:	(log $CGV_{j,t+T}$ – log CGV_{jt})/T					
Explanatory variables:						
Initial variety relative to consumer goods, log CGV_{jt}	–0.023**	–0.012	–0.015*	–0.014*	–0.011	–0.014
	(–2.59)	(–1.38)	(–1.80)	(–1.68)	(–1.30)	(–1.59)
Average years of schooling, $u25_{j,tT}$	0.0013*	0.0016**	0.0018***	0.0017**	–0.0006	0.0012*
	(1.99)	(2.36)	(2.68)	(2.53)	(–0.29)	(1.84)
Size, $GDP1 \times u25_{j,tT}$	–0.0009**					
	(–2.31)					
$GDP2 \times u25_{j,tT}$		–0.00002				
		(–0.08)				
$GDP3 \times u25_{j,tT}$			–0.0004			
			(–1.58)			
$GDP4 \times u25_{j,tT}$				–0.0002		
				(–0.72)		
$GDP \times u25_{j,tT}$					0.0000	
					(1.02)	
GDP						0.0010
						(1.49)
Investment-consumption ratio change, $inv\_con_{j,t+T} - inv\_con_{jt}$	0.075***	0.078***	0.085***	0.079***	0.082***	0.084***
	(4.64)	(4.56)	(5.10)	(4.84)	(5.13)	(5.27)
Banking reform in transition, $Bank\_2_{j,tT} \times \log CGV_{jt}$	–0.070***	–0.064***	–0.066***	–0.065***	–0.065***	–0.066***
	(–5.70)	(–5.27)	(–5.39)	(–5.31)	(–5.50)	(–5.56)
Observations (1993–98, 1999–2004)	64 (25, 39)	64 (25, 39)	64 (25, 39)	64 (25, 39)	63 (25, 38)	63 (25, 38)
Correlation between subperiod residuals	–0.19	–0.16	–0.27	–0.16	–0.22	–0.27
Adj. R-squared (1993–98, 1999–2004)	0.54, 0.56	0.39, 0.59	0.53, 0.54	0.43, 0.58	0.42, 0.61	0.48, 0.59

Notes: t-statistics in parentheses. * (**, ***): significance at 10, (5, 1) per cent. Instruments: one year lagged initial relative product varieties. Interval dummies not reported

Table 4: Available capital goods variety growth regressions with banking reform in transition (3SLS): alternative schooling measures

	(4)	(15)	(16)	(17)	(5)	(18)	(19)	(20)
Dependent variable:	(log $CGV_{j,t+T}$ – log CGV_{jt})/T							
	Full sample				Small country sample			
Explanatory variables:								
Initial variety relative to consumer goods, log CGV_{jt}	–0.023**	–0.021**	–0.020**	–0.018**	–0.021**	–0.019**	–0.019**	–0.016*
	(–2.59)	(–2.46)	(–2.37)	(–2.22)	(–2.27)	(–2.11)	(–2.08)	(–1.90)
Schooling, $u25_{j,tT}$	0.0013*				0.0016*			
	(1.99)				(2.01)			
$u25f_{j,tT}$		0.0014**				0.0017**		
		(2.37)				(2.43)		
$u25{,}2_{j,tT}$			0.00022**				0.00024**	
			(2.41)				(2.39)	
$u25{,}2f_{j,tT}$				0.00026** *				0.00028** *
				(3.14)				(3.03)
Size, $GDP1 \times u25_{j,tT}$	–0.0009**				–0.0009**			
	(–2.31)				(–2.05)			
$GDP1 \times u25f_{j,tT}$		–0.0010**				–0.0009**		
		(–2.30)				(–2.05)		
$GDP1 \times u25{,}2_{j,tT}$			–0.00016**				–0.00015*	
			(–2.04)				(–1.73)	
$GDP1 \times u25{,}2f_{j,tT}$				–0.00017**				–0.00015*
				(–2.10)				(–1.81)

Table 4 contd

	(4)	(15)	(16)	(17)	(5)	(18)	(19)	(20)
Dependent variable:	(log $CGV_{j,t+T}$ – log CGV_{jt})/T							
	Full sample				Small country sample			
Explanatory variables:								
Investment-consumption ratio change, $inv\_con_{j,t+T} - inv\_con_{jt}$	0.075*** (4.64)	0.072*** (4.50)	0.076*** (4.79)	0.070*** (4.50)	0.075*** (4.44)	0.071*** (4.23)	0.078*** (4.69)	0.071*** (4.34)
Banking reform in transition, $Bank\_2_{j,tT}$ × log CGV_{jt}	–0.070*** (–5.70)	–0.070*** (–5.82)	–0.067*** (–5.57)	–0.067*** (–5.80)	–0.070*** (–5.54)	–0.070*** (–5.70)	–0.067*** (–5.40)	–0.067*** (–5.64)
Observations (1993–98, 1999–2004)	64 (25, 39)	64 (25, 39)	64 (25, 39)	64 (25, 39)	52 (19, 33)	52 (19, 33)	52 (19, 33)	52 (19, 33)
Correlation between subperiod residuals	–0.19	–0.20	–0.16	–0.20	–0.21	–0.23	–0.21	–0.26
Adj. R-squared (1993–98, 1999–2004)	0.54, 0.56	0.55, 0.56	0.46, 0.60	0.48, 0.63	0.57, 0.57	0.58, 0.59	0.53, 0.60	0.53, 0.63

Notes: t-statistics in parentheses. * (**, ***): significance at 10, (5, 1) per cent. Instruments: one year lagged initial relative product varieties. Interval dummies not reported. The small country sample excludes observations from the six G-7 economies in our sample, i.e. the US, the UK, France, Germany, Italy and Canada (cf. fn. 6 in the text).

Table 5: Available capital goods variety growth regressions (3SLS): alternative transitional reforms

	(4)	(21a)	(21b)	(22a)	(22b)	(23)	(24)
Dependent variable:	(log $CGV_{j,t+T}$ – log CGV_{jt})/T						
Explanatory variables:							
Initial variety relative to consumer goods, log CGV_{jt}	–0.023**	–0.018*	–0.015	–0.023**	–0.020**	–0.016	–0.024***
	(–2.59)	(–1.71)	(–1.63)	(–2.25)	(–2.24)	(–1.64)	(–2.69)
Average years of schooling, $u25_{j,tT}$	0.0013*	0.0014*	0.0016**	0.0012	0.0014**	0.0014*	0.0014**
	(1.99)	(1.79)	(2.19)	(1.52)	(2.03)	(1.92)	(2.12)
Size, $GDP1 \times u25_{j,tT}$	–0.0009**	–0.0006	–0.0008*	–0.0006	–0.0009**	–0.0005*	–0.0012***
	(–2.31)	(–1.23)	(–1.96)	(–1.31)	(–2.19)	(–1.22)	(–2.77)
Investment-consumption ratio change, $inv\_con_{j,t+T} - inv\_con_{jt}$	0.075***	0.094***	0.097***	0.112***	0.109***	0.107***	0.107***
	(4.64)	(4.94)	(5.83)	(6.26)	(7.04)	(6.55)	(6.95)
Banking reform in transition, $Bank\_2_{j,tT} \times$ log CGV_{jt}	–0.070***						
	(–5.70)						
Price liberalisation, $PL\_4_{j,tT} \times$ log CGV_{jt}		–0.017**	–0.009				
		(–2.08)	(–1.24)				
Foreign trade and payments lib. $FT\_4_{j,tT} \times$ log CGV_{jt}				–0.080***	–0.076***		
				(–2.70)	(–2.73)		
Large scale privatisation, $LSP\_2_{j,tT} \times$ log CGV_{jt}						–0.046***	
						(–3.86)	
Competition policy, $CP\_2_{j,tT} \times$ log CGV_{jt}							–0.066***
							(–5.13)
Observations (1993–98, 1999–2004)	64 (25, 39)	64 (25, 39)	63 (25, 38)	64 (25, 39)	63 (25, 38)	64 (25, 39)	64 (25, 39)
Correlation between subperiod residuals	–0.19	0.01	–0.05	–0.08	–0.13	–0.19	–0.08
Adj. R-squared (1993–98, 1999–2004)	0.54, 0.56	0.36, 0.38	0.38, 0.46	0.51, 0.31	0.55, 0.42	0.21, 0.53	0.57, 0.50

Notes: t-statistics in parentheses. * (**, ***): significance at 10, (5, 1) per cent. Instruments: one year lagged initial relative product varieties. Interval dummies not reported. We cannot reject non-normality of second subperiod residuals in (21a, 22a) on a Jarque-Bera test at 5 per cent level. Removal of an outlier (YUG) normalises residuals, resulting in (21b, 22b).

Appendix 4: Appendix tables

Table A1: The structure of BEC

1 Food and beverages
- 11 Primary
  - 111 Mainly for industry
  - 112 Mainly for household consumption
- 12 Processed
  - 121 Mainly for industry
  - 122 Mainly for household consumption

2 Industrial supplies not elsewhere specified
- 21 Primary
- 22 Processed

3 Fuels and lubricants
- 31 Primary
- 32 Processed
  - 321 Motor spirit
  - 322 Other

4 Capital goods (except transport equipment), and parts and accessories thereof
- 41 Capital goods (except transport equipment)
- 42 Parts and accessories

5 Transport equipment and parts and accessories thereof
- 51 Passenger motor cars
- 52 Other
  - 521 Industrial
  - 522 Non-industrial
- 53 Parts and accessories

6 Consumer goods not elsewhere specified
- 61 Durable
- 62 Semi-durable
- 63 Non-durable

7 Goods not elsewhere specified

Source: Available online at : http://unstats.un.org/unsd/cr/family2.asp?Cl=10

Table A2: Reporter countries and country codes

1	*ALB*	*Albania*	17	GBR	United Kingdom	33	NLD	Netherlands
2	*ARM*	*Armenia*	18	*GEO*	*Georgia*	34	NOR	Norway
3	AUT	Austria	19	GER	Germany	35	*POL*	*Poland*
4	*AZE*	*Azerbaijan*	20	GRC	Greece	36	PRT	Portugal
5	BEL	Belgium and Luxemburg	21	*HRV*	*Croatia*	37	*ROM*	*Romania*
6	*BGR*	*Bulgaria*	22	*HUN*	*Hungary*	38	*RUS*	*Russia*
7	*BLR*	*Belarus*	23	IRL	Ireland	39	*SVK*	*Slovakia*
8	CAN	Canada	24	ISL	Iceland	40	*SVN*	*Slovenia*
9	CHE	Switzerland	25	ITA	Italy	41	SWE	Sweden
10	CYP	Cyprus	26	*KAZ*	*Kazakhstan*	42	*TKM*	*Turkmenistan*
11	*CZE*	*Czech Republic*	27	*KGZ*	*Kyrgyzstan*	43	TUR	Turkey
12	DNK	Denmark	28	*LTU*	*Lithuania*	44	*UKR*	*Ukraine*
13	ESP	Spain	29	*LVA*	*Latvia*	45	USA	United States
14	*EST*	*Estonia*	30	*MDA*	*Moldova*	46	*YUG*	*Serbia and Montenegro*
15	FIN	Finland	31	*MKD*	*Macedonia*			
16	FRA	France	32	MLT	Malta			

Notes: Belgium and Luxembourg are treated as one country. OECD countries as of 1992 underlined. Transition countries in *italics*.

Table A3: Ratio of reported exports (imports) of 3,121 basic headings to total exports (imports)

	Exports													Imports										
	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
ALB					**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**0.999**	**1.000**					**0.998**	**0.992**	**0.990**	**0.994**	**0.996**	**0.996**	**0.997**	**0.994**	**0.994**
ARM						**1.000**		**1.000**	0.970		**1.000**	**1.000**	**1.000**						**0.999**		**0.996**	**0.999**		**0.998**	**0.996**	**0.998**
AUT	**0.990**	**0.991**	**1.000**	0.935	0.954	0.932	0.937	0.949	0.951	0.953	0.950	0.957	0.958	0.975	0.975	**1.000**	**0.999**	**0.997**	**0.996**	**0.992**	**0.996**	**0.996**	**0.996**	**0.993**	**0.993**	**0.991**
AZE					**0.999**	**1.000**	**1.000**	**0.992**	**0.998**	**0.998**	**1.000**	**0.998**	**1.000**					**0.997**	**0.999**	**1.000**	**0.999**	**0.998**	**0.999**	**0.998**	**0.999**	**0.999**
BEL	0.980	0.979	0.979	**1.000**	**0.996**	**0.996**	0.954	0.961	0.965	0.969	0.967	0.973	0.975	**0.997**	**0.998**	**0.997**	**1.000**	**0.997**	**0.997**	**0.992**	**0.991**	0.988	**0.994**	0.986	0.984	0.982
BGR					**0.995**	**0.996**	0.969	**0.998**	**0.998**	**0.998**	**0.999**	**0.999**	**0.999**					**0.996**	**0.997**	0.977	**0.996**	**0.996**	**0.996**	**0.994**	**0.994**	**0.990**
BLR							**0.992**	**0.995**	**0.996**	**0.994**	0.966	0.967	0.971							**0.995**	**0.997**	**0.997**	**0.997**	0.935	0.945	0.951
CAN	**1.000**	**1.000**	**1.000**	**1.000**	**0.996**	**0.997**	**0.997**	**0.997**	**0.997**	**0.998**	0.988	0.990	0.989	**1.000**	**1.000**	**1.000**	**1.000**	**0.999**	**0.998**	**0.999**	**0.999**	**0.999**	**0.999**	**0.996**	**0.996**	**0.996**
CHE	**1.000**	**1.000**	**1.000**	**1.000**	**0.999**	**0.999**	**0.999**	**0.999**	**0.999**	**0.999**	0.981	0.987	0.986	**1.000**	**1.000**	**1.000**	**1.000**	**0.998**	**0.997**	**0.997**	**0.998**	**0.997**	**0.998**	0.988	0.988	**0.992**
CYP	**1.000**	**1.000**	**1.000**	**1.000**	**0.999**	**0.999**	**0.999**	**0.999**	**0.999**	**0.999**	**0.999**	**0.999**	**0.999**	**1.000**	**1.000**	**1.000**	**1.000**	**0.998**	**0.998**	**0.998**	**0.999**	**0.998**	**0.999**	**0.996**	**0.996**	**0.996**
CZE		**1.000**	**1.000**	**1.000**	0.985	0.988	**0.990**	**0.991**	**0.992**	**0.992**	**0.991**	**0.991**	0.990		**1.000**	**1.000**	**1.000**	**0.997**	**0.997**	**0.996**	**0.997**	**0.997**	**0.997**	**0.994**	**0.994**	**0.993**
DNK	**1.000**	**1.000**	**1.000**	**1.000**	**0.999**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**0.998**	**0.998**	**0.998**	**1.000**	**1.000**	**1.000**	**1.000**	**0.998**	**0.998**	**0.998**	**0.998**	**0.998**	**0.999**	**0.995**	**0.995**	**0.995**
ESP	**1.000**	**1.000**	**1.000**	**1.000**	**0.997**	**0.997**	**0.997**	**0.997**	**0.997**	**0.998**	**0.994**	**0.994**	**0.993**	**1.000**	**1.000**	**1.000**	**1.000**	**0.998**	**0.998**	**0.998**	**0.998**	**0.998**	**0.998**	**0.995**	**0.995**	**0.995**
EST				0.968	**1.000**	**1.000**	**0.999**	**0.998**	**1.000**	**1.000**	**0.998**	**0.997**	**0.999**				**0.991**	**0.999**	**0.999**	**0.997**	**0.994**	**0.998**	**0.999**	**0.996**	**0.996**	**0.996**
FIN	**1.000**	**1.000**	**1.000**	**1.000**	**0.998**	**0.998**	**0.998**	**0.997**	**0.998**	**0.998**	0.944	0.946	0.944	**1.000**	**1.000**	**1.000**	**1.000**	**0.998**	**0.999**	**0.998**	**0.999**	**0.999**	**0.999**	**0.997**	**0.997**	**0.997**

Table A3 contd.:

Exports

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
FRA	0.982	**0.999**	0.974	0.973	**0.993**	0.973	0.974	0.977	0.977	0.978	0.974	0.974	0.974
GBR	0.953	0.974	0.979	**0.999**	**0.998**	0.979	0.979	**0.998**	0.941	0.929	0.949	0.944	**0.996**
GEO					**1.000**	**1.000**	**0.999**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
GER	**0.991**	**0.991**	0.989	0.989	0.988	0.988	0.989	**0.992**	**0.994**	**0.994**	0.988	0.989	0.990
GRC	**1.000**	**1.000**	**1.000**	**0.995**	**0.995**	**0.997**	**0.998**	**0.996**	**0.997**	**0.998**	**0.998**	**0.997**	**0.997**
HRV	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**0.997**	**0.997**	**0.998**
HUN	**1.000**	**1.000**	**1.000**	**1.000**	**0.999**	**1.000**	**0.999**	**1.000**	**0.999**	**0.999**	**0.998**	**0.999**	**0.996**
IRL	**0.996**	**0.993**	**0.994**	**0.990**	**0.997**	**0.998**	**0.996**	**0.997**	**0.997**	**0.997**	**0.991**	0.989	**0.996**
ISL	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
ITA	**1.000**	**1.000**	**1.000**	**1.000**	**0.998**	**0.998**	**0.998**	**0.998**	**0.998**	**0.998**	**0.996**	**0.996**	0.981
KAZ				0.647	0.677	0.688	0.708	0.739	**1.000**	**1.000**		**0.999**	0.786
KGZ				**1.000**	**1.000**		0.349	0.793	**1.000**	**1.000**	**1.000**	**0.999**	**0.999**
LTU			**1.000**	**1.000**	**1.000**	**0.999**	**0.999**	**0.998**	**0.996**	**0.999**	**0.997**	**0.998**	**0.993**

Imports

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
FRA	**1.000**	**1.000**	**0.999**	**0.999**	**0.997**	**0.997**	**0.996**	**0.997**	**0.997**	**0.998**	**0.992**	**0.993**	**0.993**
GBR	0.978	**0.997**	**0.997**	**0.999**	**0.998**	**0.994**	**0.994**	**0.999**	0.961	0.936	0.953	0.957	**0.994**
GEO					**1.000**	**1.000**	**0.998**	**0.998**	**0.999**	**0.999**	**0.999**	**0.997**	**0.998**
GER	**1.000**	**1.000**	**1.000**	**1.000**	**0.997**	**0.998**	**0.997**	**0.998**	**0.998**	**0.998**	**0.994**	**0.995**	**0.995**
GRC	**1.000**	**1.000**	**1.000**	**0.995**	**0.996**	**0.995**	**0.992**	**0.990**	**0.990**	**0.994**	0.985	**0.990**	**0.994**
HRV	0.937	0.930	0.918	**1.000**	**1.000**	**0.997**	**0.996**	**0.997**	**0.996**	**0.997**	**0.994**	**0.994**	**0.993**
HUN	**1.000**	**1.000**	**1.000**	**1.000**	**0.998**	**0.998**	**0.998**	**0.998**	**0.998**	**0.998**	**0.994**	**0.994**	0.989
IRL	**0.994**	**1.000**	**1.000**	**0.999**	**0.999**	**0.998**	**0.998**	**0.998**	**0.999**	**0.999**	**0.998**	**0.997**	**0.995**
ISL	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**0.999**	**0.999**	**1.000**	**0.999**	**0.999**	**0.996**	**0.996**	**0.997**
ITA	**1.000**	**1.000**	**1.000**	**1.000**	**0.997**	**0.996**	**0.996**	**0.997**	**0.997**	**0.997**	**0.994**	**0.994**	0.975
KAZ				0.426	0.423	0.435	0.440	0.401	**0.998**	**0.998**		**0.995**	0.399
KGZ				**1.000**	**1.000**		0.399	0.403	**0.997**	**0.996**	**0.996**	**0.993**	**0.993**
LTU			**1.000**	**1.000**	**1.000**	**0.997**	**0.997**	**0.997**	**0.995**	**0.998**	**0.994**	**0.994**	0.989

Table A3 contd.:

Exports

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
LVA			**1.000**	**1.000**	**1.000**	**0.997**	**0.995**	**0.998**	**0.999**	**0.998**	**0.997**	**0.997**	**0.994**
MDA				**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**0.993**	**0.993**
MKD			**1.000**	**1.000**	**1.000**	**0.999**	**0.999**	**1.000**	**1.000**	**1.000**	**1.000**	**0.999**	**0.998**
MLT	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**0.999**	**0.999**	**0.999**	**1.000**	**0.999**	**1.000**
NLD	**0.999**	**0.999**	**0.999**	**0.999**	**0.999**	**0.998**	**0.998**	**0.999**	**0.999**	**0.999**	**0.995**	**0.996**	**0.996**
NOR	0.977	**1.000**	**1.000**	**1.000**	**0.999**	**0.999**	**0.999**	**0.999**	**1.000**	**1.000**	**0.994**	**0.994**	**0.995**
POL	0.978	0.983	**1.000**	**1.000**	**0.993**	**0.994**	**0.997**	**0.996**	**0.996**	**0.997**	**0.997**	**0.997**	**0.996**
PRT	**1.000**	**1.000**	**1.000**	**1.000**	**0.999**	**0.998**	**0.998**	**0.998**	**0.998**	**0.998**	**0.998**	**0.996**	**0.994**
ROM	**0.996**	**1.000**	**1.000**	**1.000**	**1.000**	0.981	0.988	**0.995**	**0.997**	**0.998**	**0.998**	**0.998**	**0.996**
RUS					**1.000**	**0.993**	**0.995**	**0.996**	**0.996**	**0.997**	**0.996**	**0.996**	**0.995**
SVK			**1.000**	**1.000**	**1.000**	**0.996**	**0.996**	**0.997**	**0.997**	**0.997**	**0.997**	**0.997**	**0.996**
SVN	**1.000**	**1.000**		**1.000**	**0.999**	**0.999**	**0.999**	**0.999**	**0.999**	**0.999**	0.989	0.990	0.989
SWE	**0.999**	**0.999**	**0.999**	**0.999**	**0.997**	**0.997**	**0.997**	**0.997**	**0.997**	**0.998**	0.984	0.986	0.987
TKM						0.981	0.983	**1.000**	**1.000**				
TUR	**1.000**	**1.000**	0.978	0.982	0.983	**0.992**	0.981	0.986	0.982	0.981	0.982	**1.000**	**1.000**
UKR					**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	0.977	0.976		

Imports

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
LVA			**0.999**	**0.999**	**0.999**	**0.997**	**0.995**	**0.998**	**0.999**	**0.997**	**0.994**	**0.995**	**0.994**
MDA				**1.000**	**1.000**	**1.000**	**1.000**	**0.999**	**0.999**	**0.999**	**0.998**	**0.995**	**0.995**
MKD			**1.000**	**1.000**	**0.993**	**0.994**	**0.994**	**0.995**	**0.996**	**0.996**	**0.994**	**0.993**	**0.991**
MLT	**1.000**	**1.000**	**1.000**	**1.000**	**0.997**	**0.997**	**0.996**	**0.997**	**0.998**	**0.997**	**0.995**	**0.991**	0.986
NLD	**0.999**	**0.999**	**0.999**	**0.999**	**0.997**	**0.997**	**0.997**	**0.998**	**0.998**	**0.998**	**0.995**	**0.995**	**0.995**
NOR	**0.998**	**1.000**	**1.000**	**1.000**	**0.999**	**0.999**	**0.999**	**0.999**	**0.999**	**0.999**	**0.996**	**0.997**	**0.997**
POL	0.978	0.985	**1.000**	**1.000**	**0.995**	**0.999**	**0.998**	**0.998**	**0.998**	**0.998**	**0.992**	**0.992**	**0.991**
PRT	**1.000**	**1.000**	**1.000**	**1.000**	**0.997**	**0.997**	**0.997**	**0.997**	**0.997**	**0.997**	**0.994**	**0.994**	**0.992**
ROM	**0.999**	**1.000**	**1.000**	**1.000**	**1.000**	**0.999**	**0.999**	**0.999**	**0.999**	**0.999**	**0.995**	**0.995**	**0.995**
RUS					**1.000**	**0.999**	**0.998**	**0.999**	**0.999**	**0.999**	**0.997**	**0.997**	**0.997**
SVK			**1.000**	**1.000**	**1.000**	**0.995**	**0.995**	**0.996**	**0.997**	**0.997**	**0.992**	**0.992**	**0.991**
SVN	**1.000**	**1.000**		**1.000**	**0.993**	**0.994**	**0.993**	**0.994**	**0.994**	**0.994**	0.990	0.990	0.990
SWE	**1.000**	**1.000**	**1.000**	**0.999**	**0.997**	**0.997**	**0.997**	**0.997**	**0.997**	**0.998**	**0.996**	**0.995**	**0.995**
TKM						**0.405**	**0.376**	0.989	0.981				
TUR	**1.000**	**1.000**	0.989	0.973	0.976	0.997	0.961	0.943	0.957	0.950	0.959		
UKR					**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**0.998**	**0.999**		

Table A3 contd.:

	Exports													**Imports**											
	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
USA	**1.000**	**1.000**	**1.000**	**1.000**	**0.999**	**0.999**	**0.999**	**0.999**	**0.999**	**0.999**	**0.995**	**0.994**	**0.995**	**1.000**	**1.000**	**1.000**	**1.000**	**0.998**	**0.998**	**0.998**	**0.998**	**0.998**	**0.999**	**0.995**	**0.995**	**0.995**
YUG	**1.000**				**1.000**	**1.000**	**1.000**	0.971	0.979	0.973	0.976		**0.995**	**1.000**				**1.000**	**1.000**	**1.000**	**0.992**	0.932	0.929	0.939		0.987
Reporters	**28**	**31**	**36**	**43**	**44**	**45**	**46**	**46**	**44**	**44**	**43**	**44**	**28**	**28**	**31**	**36**	**43**	**44**	**45**	**46**	**46**	**44**	**44**	**42**	**43**

Notes: above 0.99, **bold;** below 0.90, grey; no data, .

Table A4: Variables used in regressions (1) – (24), Tables 1–5

Variable	Definition	Source	Description and availability
Dependent variables			
(log $CGV_{j,t+T}$ – log CGV_{jt})/T, (log $IGV_{j,t+T}$ – log IGV_{jt})/T, and (log $PGV_{j,t+T}$ – log PGV_{jt})/T	Average yearly growth rates of available variety in capital, intermediate, and primary goods; relative to available consumer goods variety, respectively	see Text and Appendix 2	
Explanatory variables derived from hypothesis (9)			
log CGV_{jt}, log IGV_{jt}, and log PGV_{jt}	Initial available variety in capital, intermediate, and primary goods; relative to available consumer goods variety, respectively	see Text and Appendix 2	
$u25$, $u25f$ $u25{,}2$, $u25{,}2f$	Average years of school of total and female population aged between 25 and 65, respectively Percentage shares of total and female population aged between 25 and 65 with secondary education, respectively	Barro and Lee (2000)	Data for ARM, AZE, BLR, GEO, RUS and UKR are still for Soviet Union. MKD data are proxied by YUG. For EST, MKD, LAT, LIT, MDA, YUG, 1990 data must be used to proxy year 2000 observations. Due to other data limitations, all of these countries, however, enter regressions only with observations on the second five-year period (1998–2004). I.e., each educational attainment observation is indeed used only once for each country.

Table A4 contd.

Variable	**Definition**	**Source**	**Description and availability**
popdens, urban, patent applications, patent applications per employee	Mid-period levels of population density and share of urban population; mid-period logs of the sum of residents' and non-residents' patent applications (per employee)	*WDI 2006*	Additional steady state regressors for sensitivity tests
Control variables			
$inv\_con_{j,t+T} - inv\_con_{jt}$	Change in investment-consumption ratio	Calculated from *WDI 2006* data	Controls for specific demand effects on different BEC groups
GDP	GDP in constant international dollars	*WDI 2006*	
*GDP*1,*GDP*2,*GDP*3, *GDP*4	Country size dummies	Own definition, calculated from *WDI 2006* data	*GDP*1 is 1 for the lowest quantile of the cumulative distribution of GDP in constant international dollars in the year 2000, *GDP*2 is 1 for the two lowest quantiles of that distribution, etc.

Table A4 contd.

Control variables			
Trans	Country dummy to control for transition effects	See Table A2	
*PL*_4, *T_FT*_4, *LSP*_2, *CP*_2, and *Bank*_2	Policy reform dummies in transition economies, where *PL*: price liberalisation, *FT*: foreign trade and payments liberalisation, *CP*: competition policy, and *Bank*: Banking reform and interest rate liberalisation	EBRD	EBRD transition indicators are measured on a scale between 1 and 4+ (=4.33). According to the EBRD, 1 represents no or little progress; 2 indicates important progress; 3 is substantial progress; 4 indicates comprehensive progress, while 4+ indicates countries have reached the standards and performance norms of advanced industrial countries. Accordingly, the competition policy of all non-transition countries in the sample is evaluated at 4+. Dummy variables from the EBRD measures indicate whether or not a country has made the step towards a certain level in the EBRD scale on the respective policy area within a given period.

Table A5: List of countries in regression samples in Tables 1–5

Full sample		Small country sample	
1993–97	1998–2004	1993–97	1998–2004
	ALB		ALB
AUT	AUT	AUT	AUT
	AZE		AZE
BEL	BEL	BEL	BEL
	BGR		BGR
	BLR		BLR
CAN	CAN	CAN	CAN
CHE	CHE	CHE	CHE
CYP		CYP	
	CZE		CZE
DNK	DNK	DNK	DNK
ESP	ESP	ESP	ESP
	EST		EST
FIN	FIN	FIN	FIN
FRA	FRA		
GBR	GBR		
	GEO		GEO
GER	GER		
GRC	GRC	GRC	GRC
	HRV		HRV
HUN	HUN	HUN	HUN
IRL	IRL	IRL	IRL
ISL	ISL	ISL	ISL
ITA	ITA	ITA	ITA
	LTU		LTU
	LVA		LVA
	MDA		MDA
	MKD		MKD
MLT	MLT	MLT	MLT
NLD	NLD	NLD	NLD
NOR	NOR	NOR	NOR
PRT	PRT	PRT	PRT
ROM	ROM	ROM	ROM
	RUS		RUS
	SVK		SVK
SVN	SVN	SVN	SVN
SWE	SWE	SWE	SWE
TUR	TUR	TUR	TUR
USA	USA		
	YUG		YUG

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