Technological Development and a “New Economy” in Eastern Europe*[*]

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Abstract

This paper examines the evolution of revealed comparative advantage in the Visegrad countries of Central and Eastern Europe (CEECs) from 1994-1999. In particular, we investigate whether the increasing integration with Western Europe might lead the CEECs to specialize in labor and resource-intensive “low-tech” products while production of “high-tech” goods remains in Western Europe and elsewhere. Using the revealed comparative advantage approach as an indirect measure of technological competencies, we find that the CEECs are not increasingly specializing in the “low-tech” sectors but in some cases gaining growing comparative advantages in more technologically advanced sectors. We explore the implications of these findings for the emergence of a “new economy” in the region based on technological development and affirm the importance of evolving networks and institutions in providing the conditions necessary for innovation and future development.

Keywords: technological growth, revealed comparative advantage, transition economies

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I. Introduction

As the countries of Central and Eastern Europe (CEECs) enter their second decade as free and independent states, their move towards integration with the rest of Europe is unmistakable. Trade has been redirected from Eastern to Western Europe and many CEECs are attracting record amounts of foreign direct investment. Three CEECs—the Czech Republic, Poland, and Hungary—have obtained NATO membership, while most CEECs are on paths with the ultimate aim of formal EU membership in the next decade.

As the CEECs become increasingly part of a Europe "whole and free," their influence upon the economic landscape of Europe is increasingly become subject for debate. One particularly important issue deals with the relationship of the CEECs to technological growth in Europe. In light of the widely acclaimed "New Economy," economists and commentators have voiced concern over Europe's diminishing position in innovation and technological development relative to other parts of the world. Fears of an inability to keep up with advances in information technology and projected productivity effects have led the EU to launch the 1996 Innovation Action Plan as well as highlight the importance of innovation policies through various initiatives announced at the European Council of Lisbon in March 2000.

As the CEECs become further integrated with Europe, two important sets of ideas have emerged postulating adjustments of comparative advantages in technological distribution with important implications for structures of both the EU economy and the economies of the CEECs. One idea, forwarded by Thurow (2000) among others, asserts that the inclusion of the CEECs into the EU will enable the capital-intensive, "high-tech" sectors to concentrate in the Western Europe countries with appropriate innovation infrastructures, while labor-intensive, "low-tech" sectors will flow to the former Communist states. Others, such as Trabold and Berke (1996), Jansen and Landesmann (1998), and Grabbe et al (1998), present evidence that lends credence to the possibility that the CEECs may eventually become attractive areas for investment in "high-tech" industries due to the region's advantages in highly-skilled workers and comparatively low wages.

This paper seeks to shed light on these issues by examining the development of high and low tech sectors in the Visegrad countries—the Czech Republic, Hungary, Poland, and Slovakia—which arguably stand out among the most advanced countries in Eastern Europe. By examining the variation in trade behavior of these countries through analyses of revealed comparative advantage and the export shares of specific sectors, conclusions will be drawn regarding the evolving distribution of technological capabilities. With a focus on the years from 1994 to 1999, this study extends the works of others (see Trabold and Berke 1996, Wolfmayr-Schnitzer 1999), and seeks to explain trading patterns in the period after the initial transition shocks have been weathered and political and economic consolidation have been largely achieved. By looking at technological development through trading patterns, we hope to understand whether the Visegrad countries are on a possible course to a technologically advanced "new economy," or instead locked within the economy of old.

This paper is organized as follows: Section II identifies the issues and theoretical background for investigating technological development and trade patterns in the CEECs. Section III explains the empirical methodology employed while Section IV provides results and analysis. Section V explores the prospects of a "new economy" in the region while Section VI presents conclusions.

II. Theory

The high interest in the technological capabilities of nations is in large part due to the linkage between technology and productivity. From the earliest growth models with two factors and exogenous savings rates (cf. Solow 2000) to recent developments in endogenous growth theory (Barro and Sala-i-Martin 1995), focus has generally been placed on the ability of nations to more productively utilize their resources to increase production and hence national income. Indeed, much of the excitement over the "new economy" is directly related to the premise that information technology will change the world due to unprecedented productivity effects, though such effects remain difficult to ascertain (cf. IMF 2000, Pohjola 2000).

This linkage between productivity growth and technological development was famously addressed by Posner (1961) in his work discussing the importance of both innovation and diffusion in achieving economic growth. Posner notes that countries facing a technological gap may benefit from technology developed in leading countries through imitation, which would enable the lesser developed countries to achieve such technology at lower development costs. Others, such as Pavitt (1984), empirically tested this proposition and determined that technological catching-up is a long-term endeavor, which depends primarily on a path-dependent process of sequential accumulation of technological knowledge.[1]

Later research, particularly that of Barro and Sala-I-Martin (1995) developed models concluding that in the steady state, technologically leader and follower countries can grow at the same rate despite differences in R&D costs, levels of productivity, and the willingness to save. In such cases, it is the diffusion of technology that can equalize growth rates over time. A pattern of convergence among leader and follower countries can be attained from a cost structure, which implies a form of diminishing returns to imitation. In addition to possible cost benefits from foreign involvement, the authors conclude that the honoring of intellectual property rights across international borders helps provide the proper incentive for discoveries of new goods and techniques in the leader countries. The process of convergence in technology gaps, however, is in large part dependent upon government policies and other variables that influence the rate of return to imitation in the follower economy.

While these studies have focused on the prospects for technological imitation, others have addressed technological development through domestic innovation. Hanson and Pavitt's (1987) study provides a useful survey of national innovation systems with a focus on the differences between innovation in centrally planned economies and those in Schumpeterian markets. Highlighting the technological follower status of the Soviet Union since 1975 and widespread misallocation of R&D resources, the authors conclude that centralized systems of innovation, despite the advantages that may be attained through planning, are ultimately embedded in an institutional structure that is more restrictive than conducive the innovation. Instead, elements such as pluralism, decentralization, the locus of R&D activity in specific enterprises, participation in the international market, as well as micro and macro incentive structures make the structure of Schumpetarian markets more favorable to technological innovation than that in a centrally planned economy.

[1] In addition, much of the "New Growth" literature has empirically demonstrated that the negative association between long run growth rates and income per capita depends on the addition of factors such as education rates and R&D expenditures (Godinho and Pais Mamede 1999).

As the CEECs undergo the process of post-Communist transition and industrial restructuring, the character of technological development and specialization will depend to a large extent on the countries' abilities to imitate and innovate. The process of transition, however, creates complications on both accounts. In the early stages of transition, the ability of the CEECs to imitate was restricted by the collapse of the CMEA trade structure towards which CEEC goods were previously oriented, thereby forcing the CEECs to focus on exporting heavy industry and agricultural goods within which they held strong comparative advantages (EIU country profiles). In addition, the institutional legacies of the centralized innovation structure, in which innovation was planned by the state and distributed to enterprises, impeded the development of innovation systems embedded in the private sector.

Widmaier (1999) points out that while empirical evidence clearly reveals the potential for extensive trade and supply relationships with developed economies, such links are at times hindered by insufficient social and institutional links needed to mobilize existing knowledge complementary to the accumulation of technology. Accordingly, she suggests that a long-range strategy for knowledge-based development is needed, which requires increased interaction between private, intermediary and public institutions. Instead of focusing merely R&D funding, it is important to develop an adequate interaction of the science system with enterprises and the overall market, which will ultimately foster the generation and application of new knowledge in the production of competitive products. Widmaier also asserts the importance of external in addition to internal influences, such as the competitive effects resulting from EU accession, as further contributing to the establishment of dynamic innovation systems in the CEECs.

Studies of technological development have often been conducted through investigating the character of a country's export structure. Detailed export statistics provide both direct and indirect measures of structural change. Changes in a country's export structure provide a reflection of the distribution of technological competencies of those industries with the greatest outward orientation. In addition, export performance has a direct impact on productivity: higher exports permit higher imports of scarce Western capital goods, on which productivity growth - at least in the medium term - will crucially depend. Although this paper does not focus on the quality of imports, the results enable one to infer this effect as well since the developments in the CEEC export structure from heavy industrial specialization to specialization in high and medium tech goods, for instance, can reflect the degree to which western technology has been assimilated.

A common tool for analyzing trade patterns are the *revealed comparative advantage indices* (RCA) computed in accordance with the methodology of Balassa (1965). These indices allow us to trace and quantify the change in specialization of the CEECs in their exports over the period 1994 - 1999 relative to that of the rest of the world. Accordingly, revealed comparative advantage is defined as:

$$(1) \qquad RCA = \frac{X(ij)/X(j)}{X(iw)/X(w)}$$

where X(ij) is exports of commodity i by country j, X(j) is total exports by country j, X(iw) is world exports of commodity i, and X(w) is total world exports.

The comparative advantage is “revealed” in the sense that the specialization of a country in exports (the numerator) is compared to the world’s specialization in that particular good. A country enjoys a revealed comparative advantage when its degree of export specialization is greater than that of the rest of the world (i.e., RCA>1). The country demonstrates a disadvantage when its degree of specialization is less than the corresponding ratio for the rest of the world (i.e., RCA<1). It is standard practice to take the natural log of this ratio such that revealed comparative advantages are reflected by positive numbers and disadvantages by negative numbers.

This index is not a perfect measure, however. To the extent that trade flows reflect political preferences or price and other market distortions, the index may however not be a good indicator of comparative advantage at a particular point in time. For the CEECs in particular, the legacy of previous trade and industrial policies means that revealed comparative advantage may provide misleading indications at times as to the underlying long run comparative advantage of their economies.

Nevertheless this method of analysis still provides valuable information on the pattern of transition and RCA values are likely to reflect short run comparative advantages as determined by existing production structures. Furthermore, the evolution of RCA over time is likely to be indicative of changes in export structures, which, given greater openness, global trade integration and domestic market liberalization, should reveal a country's true comparative advantage with increasing accuracy.

Numerous studies have investigated the trade performance of the CEECs using the revealed comparative advantage method. After documenting the relative abundance of skilled labor in the CEECs, Halpern (1995) shows that recent trends in the commodity pattern of CEEC trade with the EU reflect this fact only to a limited extent. Besides continuing exports in sectors where the individual countries enjoy a comparative advantage for historical and/or natural endowment reasons, such as for glass industry and cars in the Czech and Slovak Republics, food processing in Hungary, and textiles and furniture in Poland, the CEECs should seek to exploit their comparative advantage in skill-intensive sectors more fully by attracting sufficient complementary capital in the form of foreign direct investment. Also, by achieving a more similar pattern of factor endowment with respect to industrial countries, the CEECs may be able to expand differentiated product intra-industry trade with Western countries, instead of having to rely on relatively low labor costs. While low labor costs are probably attractive for setting up outward processing operations in some sectors, the benefits of this form of foreign activity are quite limited, especially since low labor costs may only represent a transitory phenomenon.

The main finding of a study by Trabold and Berke (1996) is that comparative advantages in resource- and capital-intensive goods will decline as the comparative advantage artificially created during planning through heavy subsidization and low interest rates should be increasingly eroded. Furthermore, the comparative disadvantage in research intensive goods should be considerably reduced as the human capital base of the CEEC offers great potential for speedy learning. Nevertheless, the speed at which this will occur depends on the availability of complementary technology. Regarding the long run sustainability of economic consolidation in the CEECs, the authors note that a specialization in resource and labor-intensive products will only lead to competition with other low-wage economies (e.g. Southeast Asia) over prices with simple, low-quality goods. A greater specialization on R&D and skill-intensive products instead would be conducive to expanding intra-industry trade with the rest of the world and notably the EU. This should not only lower adjustment costs in terms of transitory unemployment, but also be of greater long-run benefit.

Kubielas (1998) uses RCA indices to identify the underlying determinants of observed trends in the transformation of technology patterns of trade in a number of CEE countries. Using two different taxonomies for the classification of traded goods at the three-digit aggregation level following Pavitt (1984), he finds that the most expected growth candidates, traditional labor-intensive and resource-intensive industries, did in fact exhibit decreasing improvement or even a tendency to stagnate or a decline in their RCA values over time. While Kubielas observes selective improvements in the production of certain medium technology goods, the initial comparative disadvantage in high technology sectors (very high human-capital-intensive, but also scale-intensive sectors) continues to be particularly pronounced. With relatively low efficiency wages coupled with skill- and human capital abundance as a general source of comparative advantage in high-tech and human capital-intensive industries and R&D expenditures seeming to be significant in providing skills to second-ranking high-tech industries, he reasons that further skill improvement both directly and through R&D activity may become crucial for future trade performance of CEECs.

The 1998 study by Wolfmayr-Schnitzer confirms many of these conclusions. Concluding that specialization patterns in the CEECs are strongly biased towards labor-intensive and resource-intensive industries, Wolfmayr-Schnitzer notes that the comparative disadvantages in human capital-intensive products widely differ among countries with the gaps with OECD country levels being smallest in the Czech Republic and Hungary. In addition to the RCA measure, which provides information about the relative importance of an industry on a national level, Wolfmayr-Schnitzer also considers market shares of imports in seeking to understand the importance of an industry on the international level. In this regard, Wolfmayr-Schnitzer finds that countries such as Poland, which demonstrate lower ranking in RCA values, actually perform better with respect to market shares. Though Wolfmayr-Schnitzer concludes that a general pattern of trade specialization exist in all CEECs biased towards labor and resource-intensive goods, different countries appear to display different potentials for increased specialization in human capital-intensive goods.

Thus, these surveys do indicate that the CEECs need not be stuck in a trade pattern that specializes in resource-intensive and labor-intensive goods. Instead, some countries have apparently demonstrated progress in developing potential for production in more human capital-intensive sectors. The major shortcomings of these studies, however, is that their results are based upon data from 1989 to 1995. Updating the analysis of these issues is in order and embarked upon in the following section.

III. Methodology

This study considers developments in trade patterns as a means of inferring technological competencies and development in the four Visegrad countries - the Czech Republic, Hungary, Poland, and Slovakia. The method of empirical analysis employed in this study is twofold: first, revealed comparative advantage calculations, in accordance with equation (1), are collected. Data is obtained from the PCTAS database from UNCTAD for the years 1994 through 1999. Two hundred and forty-nine goods are considered from the three to five digit level according to SITC classification.[2]

After these RCA calculations have been made, we proceed to evaluate the results by grouping the goods in accordance with technology classes and observing the grouping's RCA movement over time. We adopt the method of technology classification employed by Wolfmayr-Schnitzer (1998) who uses a combination of earlier methods by Legler (1982), Schulmeister (1990), and Schulmeister and Boesch (1987). The primary advantage of the Wolfmayr-Schnitzer approach is the ability to discriminate between high-tech and low-tech sectors as well as between different sophistication of goods. In this approach, factor intensities are first calculated which results in the classification of a good in the categories of human capital-intensive, R&D intensive, capital-intensive, labor-intensive, scale-intensive, resource-intensive, energy-intensive, and environment-intensive.[3] These groupings are then further subdivided into four main hierarchies of technology, which are then subdivided into further subgroups.[4]

Accordingly, the four main groupings are:

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[2] The authors are very grateful to Daniel Piazolo for contributing data and calculations for this analysis.
[3] To be assigned to a product group, the input of the factor had to exceed the average value by ten percent. Expert opinion was used to distinguish between high-tech and medium tech production processes that appeared within the human capital-intensive groups. (Wolfmayr-Schnitzer 1998).
[4] A complete listing of the groups and subgroups can be found in Table 1.

1. “Human capital-intensive industries”: This group is defined by those production processes in which the input of qualified labor exceeded the average intensity by ten percent. Expert opinion, as determined by Wolfmayr-Schnitzer, further divides this grouping into high technology and medium technology goods. Examples of high technology goods include optical instruments, power generating machinery, specific organic chemicals, and special plastic materials. Examples of medium-tech product groups include printing and bookbinding machinery, sound recording equipment, electrical machinery, pigments and paints, organic and inorganic chemicals, and paper mill and pulp mill machinery. Further divisions are made within the medium technology group between labor-intensive industries (as in machines and medical apparatus) and capital-intensive products (motors, or specific chemicals).

2. “Physical capital-intensive industries”: This grouping includes products such as iron or steel wire, floor coverings, and cotton fabrics which are capital-intensive but at the same time neither human capital nor resource-intensive.

3. “Labor-intensive industries”: This grouping consists of products that are neither human capital-intensive nor resource-intensive. Products of this variety include textiles, footwear, furniture, and leather manufactures.

4. “Resource-intensive industries”: This category, consisting of goods with high inputs of agrarian and mineral resources (such as construction materials, glass, cement, leather) is subdivided into strong and weak resource-intensive groups. Those products considered strong resource-intensive are mostly resource-intensive but also possess a high degree of human capital input. Examples of weak resource intensive products include leathers, glass, and pottery while strong resource intensive goods include fertilizer, railroad track, and paper.

After categorization, the RCA calculations are averaged for each category and then compared across the years. The results of these calculations are presented by country in Tables 2-7. Calculations of export share (i.e., the numerator of the RCA calculation) were also considered as an admittedly redundant explanatory tool. Though references to changes in export share are occasionally made in the analysis, these calculations are excluded for purposes of space, but are available from the authors upon request.

By using the categorized RCA calculations, we hope to gain a better grasp of the nature and development of technological competencies in the Visegrad countries. Instead of analyzing technological development through investigating R&D input and output,[5] this method allows us to infer technological competency through looking at the economic performance of goods of different technological sophistication. Though this analysis, as described above, provides insight into evolving technological development as these countries increasingly compete in those sectors with which they consider themselves most comparatively advantaged, we are aware of the limitations of this approach. It is difficult to infer a great deal regarding the distribution of technology from RCA calculations for five years since as numerous empirical studies have shown, radical changes in specialization, in particular that with regard in the technology pattern of trade, usually occur over the course of one to two decades.[6] Nevertheless, this method of analysis can provide us with some clues regarding patterns of movement among these categories in the 1994-1999 period of transition.

IV. Results

The results for the RCA calculations for each year, averaged by category, are found in Tables 2-5. In addition, Table 6 provides a summary of the results by displaying the difference in RCA values between 1999 and 1994, with an "A" or "D" signifying a comparative advantage or disadvantage, respectively, for the category at the end of 1999.

Though the Czech Republic displays revealed comparative advantages for only two categories through the entire time period (the general labor intensive category and the others subcategory under the resource intensive grouping), several other important trends can be observed. First, the Czech Republic gains cumulative RCA gains in the labor intensive subcategories in both the high and medium technology sectors. Relatively large gains are seen in the general "others" category with smaller gains in the general physical capital and general labor categories. Those categories

[5] Indeed, reliable R&D data required for this form of analysis (R&D expenditure, qualification of workers, patents or citations in economic journals), is exceeding difficult to attain for the transition countries.
[6] See for instance Patel and Pavitt (1994) and Kubielas (1998)

experiencing declines in RCA averages over this period are the capital intensive subcategories for high and medium technology, as well as all subcategories under the resource intensive category.

Hungary displays comparative disadvantages for all sectors except the weak resource intensive sector.[7] Gains in RCA averages could be observed in the labor intensive and resource intensive subcategories for medium technology, the human capital and "others" subcategories in the resource intensive category, as well as in the general physical and labor intensive categories. Notable declines in RCA averages were found in the labor intensive subcategory of the high technology grouping as well as in the general "others" category.

Like the Czech Republic and Hungary, Poland saw rises in RCA averages in the labor intensive subcategory for medium technology, the general labor intensive category, and the "others" subcategory under the human capital grouping. Poland also demonstrated a rather strong RCA advantage in the "weak" subcategory of the resource intensive grouping as well as in the "others" subcategory in the same grouping. Poland's strongest disadvantages appear to be developing in both the labor intensive and capital intensive subcategories of the high technology grouping, though the magnitude appears to be stable in the former.

Finally, Slovakia exhibits consistent comparative advantages in the "weak" and "others" subcategories of the resource intensive grouping. However, Slovakia demonstrated RCA gains in only the general physical capital intensive and general labor intensive groupings. Otherwise, the RCA averages dropped in each of the groups, most significantly in the capital intensive subcategory of the high technology grouping.

These results have their shortcomings. In addition to the limitations of the RCA approach described in the previous section, the averaging of RCA values places limitations on the explanatory power of the results. However, despite the caution necessary in interpreting the actual RCA average values, we can evaluate the general patterns that might be observed from the data in the hopes of understanding how patterns of specialization are evolving.

[7] In this respect, Table 3 is a bit misleading, since Hungary held RCA advantages in this category except for 1999, the value for which Table 3 displays.

A general pattern of diminishing comparative advantage in the resource-intensive categories can be seen, with the exception of Hungary in the “strong” resource intensive subcategories. The hardening of budget constraints and the initiation of privatization programs resulted in large declines in exports of those goods largely dependent on state support and/or those that were revealed to be non-profitable. The fact that resource-intensive branches were heavily subsidized under planning explains well that CEECs' exports in 1989 were strongly biased against skill-intensive branches and in the direction of energy and resource-intensive branches. With the removal of price distortions and the elimination of state subsidies, the RCA for resource-intensive branches shows a continued decline in the second five years of transformation. This trend is particularly marked in the case of Slovakia, reflecting that country's delayed restructuring.

A general pattern of increases in the RCA averages for the physical capital intensive category can also be observed across countries, with the exception of Poland. Due to the previous specialization of these countries in these goods during the Communist era, this result might not be surprising and in fact indicate progress in the restructuring necessary to enhance competitiveness on world markets.

More surprising, however, are the patterns observed in the general labor intensive category. While each country experiences an increase in RCA averages over the period, the magnitude of these changes appear negligible. Indeed, a closer look at the RCA averages shows no consistent patterns through the years; instead, the RCA average values fluctuate substantially. Such results again point to the limitations of the RCA approach but also show that no consistent pattern of specialization in the labor intensive sector seems to have occurred in this period.

Aside from these general patterns, however, no other broad trends are observable. More concrete explanations, therefore, can perhaps be found by analyzing the performance of the technology groupings on the country level. The growing comparative advantage of the Czech Republic in high technology is coupled with a rising RCA in labor-intensive medium technology products and an increase in the general labor-intensive category as well. A rising trend in export shares of these categories, though relatively small, indicates that the Czech Republic is increasingly specializing in these areas in which it seems to be gaining advantages. Coupled with the increasing access to higher education, which at 28% of those in the 18-22 age group approaches west European levels, these results indicate that the Czech Republic stands a good chance to gain from an increasingly educated workforce (EIU report 1997). In addition, the historical weakness of trade unions, a relatively low initial wage level and small rate of wage growth in recent years all contribute to patterns observed in those sectors drawing heavily on the human capital base.

In the case of Hungary, results are more ambiguous. While specialization in the labor-intensive subcategory of medium technology increased along with a slight increase in RCA, export shares in the labor-intensive subcategory of high technology and in the general labor-intensive category remained flat with diminishing revealed comparative advantages. However, performance in these and other categories has remained relatively stable over this time period. This may reflect the fact that in comparison with the other Visegrad countries, Hungary had opened itself up to western trade earlier than the others and therefore may have had more opportunity to already orient its industries to the west. However, this possibility must be tempered by the fact that Hungary's process of industrial restructuring through privatization proceeded at a relatively slower rate; hence, the country's export structure is still very much in transition (EIU 1997). Growth in Hungary since 1994 depended very much on the investment of foreign-owned firms. At the same time, there seems to have been little spillover from these firms to the rest of the economy. Like in Poland, there are still a number of large industrial loss-makers, kept alive by creditor inactivity and state rescue packages. This lack of spillovers and comprehensive restructuring may serve as other reasons, which explain the comparative disadvantages and stagnant export shares. [8]

Like the Czech Republic, Poland demonstrates an increase in export shares of all three categories of labor-intensive goods described above, but enjoys increasing comparative advantages in only two: the labor-intensive subcategory of medium technology and the general labor-intensive category. Moreover, the slight improvement in the comparative advantage of the weak resource-intensive category may be attributed to the effect proposed by Halpern (1995) that the relatively good performance of these sectors appears to lie in a country-specific tradition and/or natural endowments.[9]

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[8] See also Carlin and Landesmann (1997)
[9] cf. Halpern (1995)

Slovakia's much heralded export-led growth spurt in 1994 and 1995 was not reflected in the groupings under consideration. All categories in Slovakia underwent a deterioration in RCA during this time period in addition to a general decline in the shares of exports (excepting increases in the general physical capital intensive and labor intensive categories). Such trends are perhaps reflective of Slovakia's precarious domestic position during this time period. The process of privatization stagnated during this period and industrial restructuring was therefore impeded. With a weakening of foreign demand and falling export prices in 1996, Slovakia's trade position deteriorated sharply. Furthermore, Slovakia suffered from low levels of foreign investment and high levels of enterprise debt, contributing to a fall in R&D expenditures coupled with an inadequate competitive environment necessary for firm development (EIU report 1997). The weakening of Slovakia's external position as well as the absence of foreign investment and know-how probably explain the reason for Slovakia's decline or steady RCA measures in both its traditional and medium/high-tech groupings. The only groupings for which we can observe a comparative advantage, though declining over time, are the "weak" and "others" resource-intensive categories and should be seen to stem from the communist legacy of favoring capital and resource-intensive industries.

V. A "New Economy" in Eastern Europe?

The results of the RCA analysis, of course, must be considered with caution with a recognition of the limitations of the approach. Indeed, it would be very premature to use these results for the five year period to herald a move toward the "new economy," of which academics and commentators speak in the United States and Western Europe. The economic legacy of forty years of centralized planning which yielded distorted prices, misallocated resources, and depressed innovation continues to be reflected in the challenges continuing to face the transition economies today. "Catching-up" to the West remains a pertinent and formidable goal.

Nevertheless, the results do provide a piece of evidence to suggest that in some countries of Central and Eastern Europe, potential exists for further technological development in the medium and high tech sectors. Most notably in the Czech Republic, where comparative disadvantages have been moving steadily toward comparative advantages particularly in the high and medium tech labor intensive goods, the countries under consideration in this study, with the possible exception of Slovakia, have provided indications of a shift in advantage away from the traditional resource intensive sectors to greater advantages in the human capital intensive sectors. While it is true that these countries continued to accrue advantages in the general labor intensive and physical capital intensive sectors, it is noteworthy that the gains in advantage in the general labor intensive sector have not been substantial. Should the countries under consideration have been increasingly specializing in non-human capital intensive goods, we would have expected the advantages in these categories to be growing consistently; however, such trends clearly do not exist in our data.

Despite the apparent potential for technological development in the high and medium tech sectors, important caveats must be asserted. The Visegrad countries do not possess any revealed comparative advantages in human capital intensive goods over this period, and specialization patterns remain biased toward the general labor intensive and resource intensive goods. Studies investigating the Grossman-Helpman notion of the "quality ladder" of goods, whereby technological follower countries imitate production of leader countries (see Grossman and Helpman 1991), find that the CEECs still tend to produce goods on the lower quality end of the ladder, therefore posing little threat to Western European production, particularly in human capital intensive goods (Jansen and Landesmann 1999). The absence of high-income markets in the CEECs demanding new high technology products and the absence of institutional and social links necessary for industrial innovation systems also pose challenges to development in the high and medium technological sectors (Wolfmayr-Schnitzer 1998. Widmaier 1999).

The apparent potential extrapolated from the movements of our RCA calculations and the impediments toward technological development facing the transition countries indicate the need for technology policies aimed at fostering innovation in these countries. The need for "innovation strategies" has been recognized early in the transition period as an indispensable aspect of completing the transition process and ensuring long run competitiveness (Radosevic 1994, Fritsch and Werker 1999). While alliances between CEEC and western firms have at times been suggested as a means by which technical learning and the production of knowledge can be developed in the CEECs, foreign technology imports have been considered insufficient for developing technical change in the CEECs (Radosevic 1999). Instead, numerous authors have highlighted the need for domestic technological efforts in generating the linkages between firms and R&D as well as institutions necessary for spurring endogenous technical change and innovation (Fritsch and Werker 1999, Goglio 1999).

It is the development of these linkages and institutions that will ultimately determine the degree of success of the CEECs in catching-up to the technological levels of western Europe and achieving a "new economy" based on more than the heavy, resource intensive industry that characterized the Communist era. Government measures aimed at replacing the vertical network linkages between firms and research institutions, as characterized by the era of central planning, with horizontal "networking activities" can serve to advance the generation of new technologies, skills, and knowledge as well as facilitate the diffusion of these technologies. Reforming research institutions themselves and expanding contacts with industry as well as academia can further serve enhance both the production of new knowledge but provide education as well. However, factors limiting the role of the public sector—particularly funding constraints, opposition to reform by vested interests, and a general nebulousness surrounding the overall goals of innovation policy—has meant that the burden of innovation and diffusion must rest with firms themselves. The legacy of centralized planning has rendered this a substantial challenge, since the central steering of production of distribution of new products eliminated the need for firms to be innovative and thus never prepared firms to develop and market products on their own. Empirical evidence is limited on the question of whether the privatization processes have led to new types of enterprises conducive toward innovative activities (Havas 1999, Widmaier 1999). Yet, it is the evolving structure of enterprise in the CEECs, as well as the possibilities of regional or sectoral clustering of innovation, that will play a decisive role in both the abilities of firms to develop new knowledge and technology and that of governments to facilitate such advances.

VI. Conclusions

This paper examined patterns of technological specialization in the Visegrad countries of the Czech Republic, Hungary, Poland, and Slovakia during the period of 1994 through 1999. Seeking to understand if evidence indicates that these countries might be expected to increasingly specialize in those products which require low technology inputs while western Europe specializes in medium and higher technology, our results indicate that this hypothesis is not necessarily correct.

Using the Balassa's measure of revealed comparative advantage combined with the technological classifications proposed by Wolfmayr-Schnitzer (1998), we find a general decline in comparative advantages in resource intensive goods and evidence of increases in advantages in human capital intensive goods. Though the four countries experience increases in advantages in the general physical capital intensive goods category, similar gains in the general labor intensive category (i.e., those labor intensive products that are not human capital intensive) are relatively meager and not indicative strong positive movements in advantage for such sectors. The movements in revealed comparative advantage tend to differ by country with the Czech Republic exhibiting gains in labor intensive products for both the high and medium tech sectors while others, particularly Hungary and Slovakia, saw increasing advantages in more traditional sectors. Despite our awareness that using revealed comparative advantage calculations in this manner does possess limitations, our results appear to confirm earlier research suggesting that the Visegrad countries, by virtue of their skilled labor force and low comparatively low wages, may ultimately possess advantages in industries other than the traditional heavy, resource intensive industries of the Communist period.

This paper also outlined several of the important issues related to the impediments to technological development in the former Communist countries, as well as needed institutional reforms to foster innovation in the transition economies. We suggest indispensable roles for both the public and private sectors in fostering innovation, viewing the creation of linkages and institutions as crucial for future technological development. We leave to future research explanations of divergence in the human capital bases in the high and medium technology sectors of the countries considered as well as the question of what specific actions the public and private sectors should take to foster appropriate development in these areas.

In sum, we find that the experience of the Visegrad countries in the second half of the 1990s indicates that potential exists for the development of high or medium technologies instead of mere specialization in the low-skilled, resource intensive industries of the past. At present, therefore, a glimmer of possibility exists for at least several CEECs to align themselves with the "new economy" of the future provided that the appropriate networks and institutional frameworks emerge in these countries to facilitate technological development. Accordingly, studying the development of these networks and institutions on both the public and private levels remains an important and crucial endeavor at this stage of economic transition.

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Table 1: Technology Classifications according to Legler/Schulmeister

HUMAN CAPITAL INTENSIVE

High technology		Medium technology			Others
Labor intensive	Capital Intensive	Labor Intensive	Capital Intensive		
			Resource Intensive	Others	
714 Engines, motors, non-el.	516 Other organic chemicals	691 Structures of iron, steel, alum	515 Organo-inorganic compnds.	533 Pigments, paints, etc.	553 Perfumery, cosmetics, etc.
718 Other power gen. mach.	525 Radio-active assoc. mat.	695 Tools	522 Inorganic chem. elements	551 Essntl. oil, perfume, flavor	554 Soap, cleaners, polish, etc.
776 Transistors, valves, etc.	541 Medicines	723 Civil engineering equipment	523 Metal salts, inorgan. acid	7811 Snow-travelling vehicles	592 Starches, inulin, etc.
778 Electric.mach.appart.nes	542 Medicaments	725 Paper, Pulp mill machines	524 Other chemical compounds	7812 Motor vhe. transp. or pers	593 Explosives, pyrotechnics
792 Aircraft, assoctd. equip.	57594 Alginic acid	726 Printing, bookbinding mach.	531 Synth. colors, lakes, etc.	782 Goods, spcl. transport veh.	711 Steam gener. boilers, etc.
871 Optical instruments, app.	57595 Natural, modified polymeres	727 Food-p[rocessing machines	57 Plastics in primary forms	882 Photo, cinematograph suppl.	712 Steam turbines
874 Measure, control instr.	58219 Other film, strip of plastic	728 Other spec. machinery	58 Plastics in non-primary forms		713 Intrnl. combus pstn. engin
	591 Insecticides, etc.	741 Heating, cooling equipm.	5972 Anti-knock preparations		716 Rotating electric plant
	752 Automatc. data proc., equip.	744 Mechanical handling equipm.	5973 Prepared liquids		742 Pumps for liquids, parts
		745 Other non-electr. mach.	5977 Lubricating preparations		743 Pumps nes, centrifugs etc.
		746 Ball or roller bearings	598 Other chemical products		762 Radio-broadcast receiver
		747 Taps, cocks, valves, etc.	679 Tubes, pipes, etc. iron, steel		773 Electr. distribt. eqpt. nes
		748 Transmissions shafts etc.			793 Ship, boat, float. structrs.
		749 Non-elect. mach.parts etc.			831 Travel goods
		751 Office machines			898 Musical instruments, etc.
		759 Parts for offices machines			
		761 Television receivers etc.			
		763 Sound recorder, phonograph			
		764 Telecomm. equip. parts nes			
		772 Elec. switch.realy.circuit			
		774 Electro-medcl. XRAY equip			
		775 Dom. elec. non-elec. equipm.			
		811 Prefabricated buildings			
		872 Medical instruments			
		873 Meters, counters			
		881 Photograph appar. etc. nes			
		884 Optical goods			

Table 1: Technology classes according to Legler/Schulmeister (continued)

PHYSICAL CAPITAL INTENSIVE	LABOR INTENSIVE		RESOURCE INTENSIVE	
		Weak	Strong	
			Human Capital Intensive	Others
652 Cotton fabrics, woven	612 Manufact. leather etc. nes	611 Leather	511 Hydrocarbons, nes, drivts	6345 Fibreboard of wood
653 Fabrics, man-made fibres	62 Rubber manufactures	613 Furskins, tanned, dressed	512 Alcohol, phenol, etc. derivts	641 Paper and paperboard
654 Oth. textile fabric, woven	633 Cork Manufactures	634 Veneers, plywood, etc.	513 Carboxylic, acids, derivts	68 Non-ferrous metals
6574 Quilted textile products	642 Paper, paperboard, cut etc.	635 Wood manufactures, nes	514 Nitrogen-funct. compounds	69962 Cast articles
65793 Tyre cord fabric	655 Knit. crochet, fabric nes	651 Textile yarn	562 Fertilizer	69965 Articles of iron and s
659 Floor coverings, etc.	656 Tulle, lace, embroidry, etc.	661 Lime, cement, constr. material	671 Pig iron, Spiegeleisen, etc.	
67319 Flat-roll prod (FRP) iron	657 Special yarn, txtl. fabric	662 Clay, refrct. constr. material	672 Ingots etc. iron or steel	
67327 FRP 4.75mm	658 Textile articles nes	663 Mineral manufactures, nes	673 Flat-rolled iron etc.	
67329 FRP -600mm	667 Pearls, precious stones	664 Glass	67411 Flat-rolled products (FRP) other plated	
67349 FRP, cold, -600mm	692 Containers, storage, trnsp.	665 Glassware	67421 FRP plated 600mm	
67412 FRP, -600mm	696 Cutlery	666 Pottery	67431 FRP painted 600mm	
67414 FRP, plated, -600mm	697 Household equipment, nes	694 Nails, screws, nuts, etc.	6744 FRP clad	
67422 FRP, plated, +600mm	699 Manufacts. base metal, nes		67511 FRP of silicon	
67432 FRP, painted, -600mm	721 Agic. machines, ex. tractr		67521 FRP of high speed steel	
6745 FRP, clad	722 Tractors		67531 FRP in coils, 4.75mm	
67512 FRP, alloy	724 Textile, leather machines		67532 FRP in coils, 3mm	
67522 FRP, high speed steel	771 Elect power machny. parts		67533 FRP on coils -3mm	
67537 FRP, stainless +4.75mm	784 Parts, tractors, motor veh.		67534 FRP stainl. steel, 4.75mm	
67538 FRP, stainless -4.75mm	785 Cycles, motorcycles etc.		67535 FRP stainl. steel 3mm	
67556 FRP, cold rolled, -600mm	786 Trailers, semi-trailer, etc.		67536 FRP stainl. steel -3mm	
67562 FRP, cold rolled, 600mm	791 Railway vechiles, equipmt.		67541 FRP alloy steel 4.75mm	
67572 FRP, stainless -600mm	812 Plumbing, sanitry, equpt etc.		67542 FRP alloy steel 3mm	
67574 FRP, alloy -600mm	813 Lighting fixtures etc., nes		67543 FRP alloy steel -3mm	
678 Wire of iron and steel	821 Furniture, cushions, etc.		6755 FRP stainless cold rolled	
783 Rad motos vechiles nes	831 Trunk, suitcases bag etc.		67561 FRP alloy steel cold roll.	
89973 Plaits	84 Apparel and clothing		67571 FRP prod. stainless 600mm	
	851 Footwear		67573 FRP alloy steel 600mm	
	8724 Medical, dental furniture		676 Iron, steel, bar, shapes, etc.	
	883 Cine. film exposd. develpd.		677 Railway track iron, steel	
	885 Watches and clocks			
	891 Arms and ammunition			
	892 Printed matter			
	893 Articles, nes, of plastics			
	894 Baby carriage, toys, games			
	895 Office, stationary suppls.			
	897 Gold, silverware, jewl nes			
	899 Misc. manufactrd. goods nes			
	961 Coin nongold noncurrent			

Source: Wolfmayr-Schnitzer (1998)

Table 2: Czech Republic: Revealed Comparative Advantage

	1994	1995	1996	1997	1998	1999
HUMAN CAPITAL INTENSIVE						
High technology						
Labor intensive	-1.4474	-1.24097	-0.60567	-0.49342	-0.31202	-0.70037
Capital intensive	-1.2103	-1.89456	-1.70241	-1.48154	-1.357	-1.63719
Medium technology						
Labor intensive	-0.505	-0.39262	-0.38064	-0.24938	-0.15197	-0.21486
Capital intensive						
--Resource intensive	-0.36804	-0.45373	-0.43637	-0.4984	-0.67648	-0.79206
--Others	-1.17902	-1.21488	-1.49388	-1.25751	-1.07997	-1.42781
Others	-0.32727	-0.38853	-0.06996	-0.12866	-0.1922	-0.08156
PHYSICAL CAPITAL INTENSIVE	-0.7939	0.33246	-0.23042	-0.41748	-0.49093	-0.58942
LABOR INTENSIVE	0.109313	0.162139	0.217633	0.137867	0.15149	0.119272
RESOURCE INTENSIVE						
Weak	0.826727	0.92411	0.830188	0.761107	0.673301	0.689409
Strong						
--HK intensive	-0.64905	-0.29744	-0.64717	-1.02988	-0.99134	-1.3578
--Others	1.076305	1.028498	0.870564	0.859875	0.682633	0.700081
OTHERS	-0.24031	-0.33508	-0.12508	-0.07937	-0.15114	0.299011

Source: UNCTAD (1998, 1999), own calculations

Table 3: Hungary: Revealed Comparative Advantage

	1994	1995	1996	1997	1998	1999
HUMAN CAPITAL INTENSIVE						
High technology						
Labor intensive	-1.85325	-1.67189	-1.31147	-2.00934	-2.0754	-2.35498
Capital intensive	-1.11743	-1.29619	-1.24489	-0.78386	-0.92694	-1.40184
Medium technology						
Labor intensive	-0.55803	-0.33445	-0.42394	-0.39648	-0.42147	-0.42206
Capital intensive						
--Resource intensive	-1.66712	-1.03801	-1.23514	-1.14228	-1.3221	-1.43631
--Others	-1.16555	-1.20387	-1.39201	-1.56283	-1.8196	-1.59128
Others	-0.89323	-0.89167	-0.61817	-0.32928	-0.0068	-0.45188
PHYSICAL CAPITAL INTENSIVE	-1.49924	-0.9611	-0.65743	-1.16704	-0.97023	-0.84464
LABOR INTENSIVE	-0.46236	-0.6843	-0.3498	-0.59279	-0.55376	-0.4982
RESOURCE INTENSIVE						
Weak	0.16686	0.149982	0.291811	0.037307	0.067583	-0.07896
Strong						
--HK intensive	-1.86109	-2.2597	-1.35695	-1.31196	-1.36207	-1.68654
--Others	-0.08914	-0.06348	0.112964	-0.22884	-0.478	-0.59828
OTHERS	-0.69211	-0.53613	-0.94634	-1.2364	-0.99049	-1.13998

Source: UNCTAD (1998, 1999), own calculations

Table 4: Poland: Revealed Comparative Advantage

	1994	1995	1996	1997	1998	1999
HUMAN CAPITAL INTENSIVE						
High technology						
Labor intensive	-1.46221	-1.25455	-1.08358	-1.37329	-1.43363	-1.6418
Capital intensive	-1.50751	-1.70154	-1.49995	-1.50623	-1.67197	-1.93258
Medium technology						
Labor intensive	-1.12961	-1.04124	-1.01417	-0.89459	-0.79742	-0.89135
Capital intensive						
--Resource intensive	-0.82307	-0.81365	-0.75906	-0.85323	-1.03621	-1.12721
--Others	-1.90725	-1.60792	-1.23833	-0.87825	-0.97343	-1.35489
Others	-0.35226	-0.15921	-0.05719	-0.25427	-0.11809	-0.14722
PHYSICAL CAPITAL INTENSIVE	-0.73992	-0.95524	-0.74818	-0.70432	-0.84624	-1.10217
LABOR INTENSIVE	-0.54305	-0.45735	-0.10226	-0.15703	-0.11837	-0.21363
RESOURCE INTENSIVE						
Weak	0.654193	0.725712	0.714339	0.732189	0.755276	0.712165
Strong						
--HK intensive	-0.65074	-0.81469	-0.90881	-0.62325	-0.93048	-0.72969
--Others	1.892646	1.872499	1.707999	1.632138	1.611258	1.588761
OTHERS	-0.47876	-0.45095	-0.14632	-0.23596	-0.4656	-1.01174

Source: UNCTAD (1998, 1999), own calculations

Table 5: Slovakia: Revealed Comparative Advantage

	1994	1995	1996	1997	1998	1999
HUMAN CAPITAL INTENSIVE						
High technology						
Labor intensive	-1.52591	-2.23933	-2.47179	-1.83649	-2.2718	-2.19949
Capital intensive	-0.38593	-0.82211	-1.54386	-1.23892	-1.12066	-1.56165
Medium technology						
Labor intensive	-0.74452	-0.81102	-1.16478	-0.63665	-0.78372	-0.76145
Capital intensive						
--Resource intensive	0.006755	-0.19468	-0.12924	-0.22547	-0.47463	-0.66273
--Others	-1.57503	-1.93698	-2.44052	-1.34577	-1.63482	-2.0801
Others	-0.53641	-0.72121	-0.63877	-0.50676	-0.54444	-0.87937
PHYSICAL CAPITAL INTENSIVE	-1.00582	0.023594	-0.78388	-0.21153	-0.33267	-0.19255
LABOR INTENSIVE	-0.3359	-0.43971	-0.308	-0.46391	-0.57945	-0.28244
RESOURCE INTENSIVE						
Weak	0.602062	0.599121	0.449918	0.447574	0.322592	0.215154
Strong						
--HK intensive	-0.04341	-0.23794	-1.18497	0.481605	0.288548	-0.51278
--Others	0.76411	0.709159	0.579819	0.674224	0.40898	0.11456
OTHERS	-0.64356	-0.68781	-0.64157	-0.77769	-0.72712	-1.37664

Source: UNCTAD (1998, 1999), own calculations

Table 6: Change in RCA (1999-1994); 1999 advantage (A) or disadvantage (D)

Category	Czech Rep.	Hungary	Poland	Slovakia
HUMAN CAPITAL INTENSIVE				
High technology				
Labor intensive	+ 0.747 (D)	- 0.501 (D)	- 0.180 (D)	- 0.673 (D)
Capital intensive	- 0.427 (D)	- 0.284 (D)	- 0.425 (D)	- 1.180 (D)
Medium technology				
Labor intensive	+ 0.29 (D)	+ 0.136 (D)	+ 0.238 (D)	- 0.017 (D)
Capital intensive				
--Resource intensive	- 0.424 (D)	+ 0.231 (D)	- 0.304 (D)	- 0.669 (D)
--Others	- 0.249 (D)	- 0.426 (D)	+ 0.552 (D)	- 0.505 (D)
Others	+ 0.247 (D)	+ 0.440 (D)	+ 0.205 (D)	- 0.343 (D)
PHYSICAL CAPITAL INTENSIVE	+ 0.204 (D)	+ 0.654 (D)	- 0.362 (D)	+ 0.813 (D)
LABOR INTENSIVE	+ 0.009 (A)	+ 0.036 (D)	+ 0.329 (D)	+ 0.053 (D)
RESOURCE INTENSIVE				
Weak	- 0.137 (A)	- 0.246 (D)	+ 0.058 (A)	- 0.387 (A)
Strong				
--HK intensive	- 0.709 (D)	+ 0.175 (D)	- 0.078 (D)	- 0.469 (D)
--Others	- 0.376 (A)	+ 0.509 (D)	- 0.304 (A)	- 0.650 (A)
OTHERS	+ 0.539 (A)	- 0.448 (D)	- 0.533 (D)	- 0.733 (D)

Source: Own calculations