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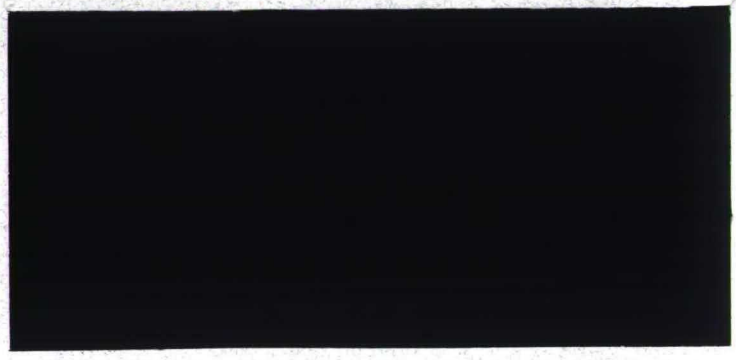

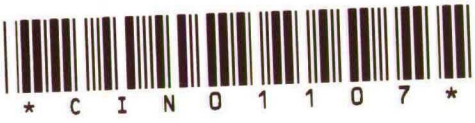

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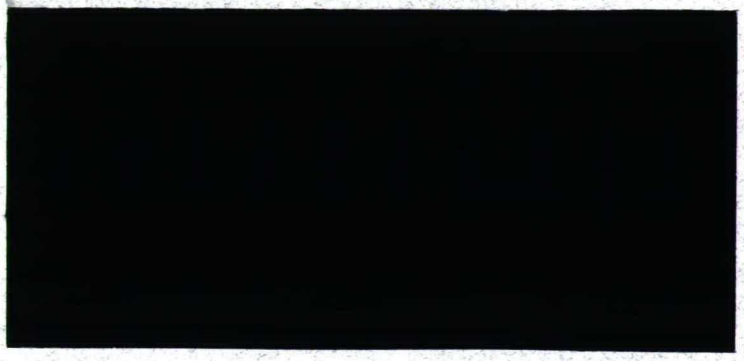

RECONSIDERING THE FUTURE OF EASTERN EUROPE: THE CASE OF CZECHO-SLOVAKIA

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Reconsidering the Future of Eastern Europe: The Case of Czecho-Slovakia

by Hans J. Gremmen and Eva van Deurzen-Mankova[1]

1. Introduction

One of the fundamental questions for Eastern European policy makers today regards the direction in which their economies should develop in order to have the highest possible future welfare. The answer to this question should form the basis of many of their policies (industrial, commercial, etcetera). Recently, Hughes and Hare (1991, 1992) have made several noteworthy attempts to answer the question "which of their sectors are most viable?" for several Eastern European countries. Their research is very appealing, and therefore widely cited, because it yields immediately applicable results. Amongst other things, they concluded that one of the few things that the countries they investigated have in common, is that the labour and possibly education intensive sectors would be the advantageous ones.[2] In Section 2, we will firstly argue, however, that the measure they have used is not fit to determine the comparatively advantageous sectors of an economy, as a comparison with the yardstick developed by Webster (1991) shows. Moreover, we will argue there that all, what we will call "output oriented measures"[3] to establish comparative advantages, although perhaps appropriate for well established market economies, are not adequate for the Eastern European economies of today. In this case one has to go back to the possible sources of comparative advantage and use, what we will label "input oriented measures".
In this article we will concentrate on relative factor endowments as one of those input oriented measures. Since Eastern Europe cannot be regarded as one entity, the present article focuses on only one of its regions: Czecho-Slovakia. Although split into two formally independent states now, we will assume that their economies are so closely linked that they can be regarded as one economic entity. This is also justified by the fact that their commercial policies are still to a large extent unified. Moreover, data problems prevented us from treating them separately.[4]

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[2] See Hughes and Hare, 1992, pp 673-676.

[3] Like the one developed by Webster, the one applied by Hughes and Hare and all "Revealed Comparative Advantage"-measures.

[4] Recently, however, the values of the Czech and the Slovak currencies have developed differently. It is an open question to what extent this different development blurs our results.

The data are presented in Section 3. They relate to Czecho-Slovakia and to the Rest of the World[5] on the one hand, and, as a check, to the EC as a major trading block and the Rest of the World, on the other.[6] In Section 4 we will draw our conclusions and compare them to the findings reported above.

2. The Proper Yardstick for Comparative Advantage

In this section, we will answer two questions. Firstly, is it possible to correctly determine the sectors in which a country has a comparative advantage by application of the yardstick used by Hughes and Hare (*op.cit.*)?[7] Like many other yardsticks, the measure they used was based on the outcomes of the economy. The second question we will address is: is this kind of approach adequate to determine the sectors in which Eastern Europe should concentrate in the long run in order to have a maximal future national income?
We will argue that the answers to both questions are negative and that in the case of Eastern European countries, we have to go back to the roots of possible comparative advantages.

To answer the first point, let us briefly summarize the contribution by Webster (1991). He investigated the quality of RCA (Revealed Comparative Advantage) measures. RCA measures focus on the actual volumes of international trade in order to determine the comparative advantage of various sectors of the economy. He wondered what could be the main cause of the phenomenon that different RCA yardsticks yield different results and, moreover, that one yardstick may lead to certain results in a two country, many good analysis that are not in compliance with the results of the same yardstick when applied to a many country, single commodity analysis. One of the possible causes could be measurement problems (like the correction needed in case there are major macro-economic disturbances such as severely imbalanced international trade). In his test of UK trade in 1979, however, this appeared not to be the case. Another possibility is that RCA measures are too remote from the theory. At this point we need to recall some of the major achievements of comparative advantage theory. Ethier (1984) has shown that in a two country, many goods framework, the weak form of the comparative advantage theorem still holds. Deardorf (1979) has shown that this weak form only holds as long as trade is "natural". Factors that render international trade unnatural are subsidies and trade distortions on intermediate products. Moreover, he showed that current domestic prices are positively related to autarkic prices.
Hence, Webster concludes that under natural trade the weak form of comparative

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5 As Vollrath (1991) indicates, a proper analysis cannot be restricted to the country under investigation, only, but should also confront it with its trading partners.

6 A priori, we would expect the EC to have an advantage in capital intensive and education intensive production processes, and to have a disadvantage in labour intensive sectors. The present research confirms this expectation. See Section 4.

7 Although qualified to a certain extent, their conclusion is, e.g., a starting point in a recent well documented official advise by the SER ("Sociaal Economische Raad", Social Economic Council) to the Dutch government. See SER (1993), pages 23-25 and page 134.

advantage holds, i.e., (denoting the world price level by Pw and the domestic price level by Pd) if in a sector (Pw - Pd) is relatively high, that sector is relatively advantageous and its net exports should be higher.[8] As a consequence, Webster suggests a preferable yardstick, namely a price measure that is more closely related to the theory, that essentially boils down to:

if after correction for non-natural trade[9]
$Pj = (Pw - Pd)/ (\overline{Pw} - \overline{Pd}) > 1$,
sector j is a comparatively advantageous sector, (A)

where a 'barred' symbol relates to the value of the average sector.

Let us now turn to the analyses by Hughes and Hare (1991, 1992) on the comparative advantage of some Eastern European states. They try "... to rank enterprises ... in terms of their long-run viability and competitiveness - that is, after removing the effects of present distortions.." (1992, p.671). To this end, they estimate the differences in competitiveness of various sectors by calculating at world market prices their respective values added. "The most competitive sectors are those with a high level of value added at world prices relative to their value added at domestic prices which means that they have relatively low domestic resource costs ...(DRC)... , ...provided value added at world prices is positive....." (1992, p.673).
The yardstick they apply is related to the one suggested by Webster, which can be seen as follows. If we assume the following notation: VA = value added, an asterisk indicates a world (as opposed to domestic) price level, Py = output price level and Pi = price level of inputs needed per product of output, Hughes and Hare derive their ranking of sectors by degree of competitiveness by the use of a measure that may in essence be summarized as follows:

competitiveness is higher if Q is higher, where
$Q = VA^*/VA = (Py^* - Pi^*) / (Py - Pi)$, provided $VA^* > 0$ (B)[10]

The intuitive explanation is obvious: if trade is opened up, the sector with the highest Q will have the largest increase in reward for its factors of production (VA), or, put the other way around, in the sector with the highest Q, the current costs of the factors of production (needed to produce one unit of output) is very low if compared to its counter-

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8 Note that in a distortion-free situation Pw equals Pd, factor price equalization holds and a ranking of sectors in terms of their comparative advantage is no longer possible.

9 Curiously enough, however, Webster does not allow for an adjustment in the input-output coefficients following this correction.

10 Note that Hughes and Hare actually define DRC (= "Domestic Resource Costs") as 1/Q. If DRC is low, implying that the costs of the factors of production needed to produce one unit of output is lower here than on the world market, they claim the sector concerned to have a high degree of competitiveness. A drawback of their notation, however, is an unnecessary kind of discontinuity: a very uncompetitive sector has a DRC < 0, a barely competitive sector has a very high value of DRC, and a more competitive sector has a lower DRC.

part on the world market. Consequently, the higher the Q, the more competitive is the sector concerned.

Yardsticks (A) and (B) may be partly reconciled if one explicitly assumes that for each sector, the local price of inputs is the same as on the world market. Measure (A) then becomes:

if after correction for non-natural trade
$Pj = \{(Pw - Piw) - (Pd - Pi)\}/\{(\overline{Pw} - \overline{Piw}) - (\overline{Pd} - \overline{Pi})\} > 1$,
sector j is a comparatively advantageous sector (A')

or, since the difference between the output price level and the price level of the inputs required equals value added (VA), measure (A') can be rewritten as:

if after correction for non-natural trade
$Pj = (VA^* - VA) / (\overline{VA}^* - \overline{VA}) > 1$,
sector j is a comparatively advantageous sector. (A'')

This reformulation may clarify the differences between the yardstick of Hughes and Hare on the one hand (measure B) and the Webster yardstick (measure A) on the other:

1. Hughes and Hare have mistakenly not corrected their measure for elements of non-natural trade. As Deardorf indicated, the presence of such factors leaves the relationship between autarkic prices and the trade pattern undetermined. And especially in the Eastern European case one would expect these non-natural factors to be important.
2. Hughes and Hare do not divide by the average value of VA*-VA. This implies that their measure may (if the other objections were lifted) result in a ranking of competitiveness, but cannot discriminate between comparatively advantageous and comparatively disadvantageous sectors.
3. In order to partly reconcile measures (A) and (B), one has to assume that for each sector, the local price of inputs is the same as on the world market.

To sum up, if one compares Hughes and Hare's yardstick to the theory of comparative advantage, the answer to question 1 above must be negative: their analysis does not determine the sectors in which Eastern Europe currently has a comparative advantage, where a major factor is the likely existence of non-natural trade.
In addition, Hughes and Hare do not allow for the impact of major macro-economic disturbances. Since these disturbances formed a major reason why the planning system collapsed in the first place, they can reasonably be argued to have a distorting impact on the picture that was detected by Hughes and Hare.

A long run approach

Suppose that we were to take a measure like measure (A) above, and we could detect the sectors that are *currently* competitive relative to world market competitors, could we then expect to get an answer to question 2 above namely: on which sectors should Eastern European countries concentrate *in the long run* in order to have a maximal future national income? The answer is no. The reason is simple. The economies concerned are in transition. This implies that when applied to these economies, all "output oriented measures", i.e., measures that look to current outcomes of the underlying, fundamental

forces in the economy, run the risk of making serious mistakes. In the case of measure (A) for instance, we may trace product groups in which the economies concerned are currently relatively cheap, but without knowing why they are cheap, and as a result without knowing if they will still be cheap it the longer run. It is dangerous to advise policy makers on the basis of output oriented measures that cannot be applied to economies that do not yet function as well established market economies that are more or less in equilibrium. In economies in transition, prices and volumes of production and trade are not yet in equilibrium. As a consequence, neither RCA measures (focusing on volumes of trade), nor Webster's IRCA measure (concentrating on prices), nor Hughes and Hare's DRC measure are appropriate in this kind of economies. So, although possibly yielding very interesting and immediately applicable results regarding the question: "which sectors of this economy are the presently (and in the immediate future) competitive?", output oriented measures should not be used to address questions as the one under consideration ("what is the most beneficial future structure of this economy?") in the case of countries in Eastern Europe.
Moreover and put differently, output oriented measures are not applicable to the economies under consideration, whose structures are still to a large extent inherited from a non-market oriented system like the previously planned economies of Eastern-Europe (see Hare and Hughes, 1992, p.671). To give an example, Holzman (1972) explains that under the previous planning system, the price elasticity of exports was negative; i.e., if world market export prices rose, exports would tend to fall, reducing the balance of exports over imports.[11] In other words, an RCA measure would make us believe that the country concerned would have a weaker comparative advantage in the sector concerned (as opposed to the stronger advantage that could be expected under a market oriented system).

In conclusion, instead of using what is to be regarded as a black box method here, in the case of Eastern European economies we should go back to the possible fundamental origins of comparative advantage and determine their comparative advantages on the basis of what we will call "input oriented measures" (measures that look at the ingredients of an economy). From literature, several of such "input" factors are known, e.g., relative factor endowments[12], the opportunities for economies of scale[13], the possibilities for product differentiation[14] and others[15].
We will limit ourselves here to just one of them - the relative factor endowments. Whilst applying this yardstick we not only explicitly assume that markets will work efficiently *in*

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11 The explanation is that under central planning, the reason to export was just to be able to pay for the imports that were needed according to the Plan. Consequently, at a given value of imports, a rise in the export price level reduced the necessary volume of exports.

12 For the relevance of this factor, see Leamer (1993).

13 For the relevance of this factor, see Tybout (1993).

14 For the (ir)relevance of this factor, see Hummels and Levinsohn (1993).

15 Like the ones mentioned by Porter (1990).

the longer run, but also that the other assumptions of the Heckscher-Ohlin theory apply (like no international factor mobility) and that knowledge embodied in the production functions is perfectly mobile internationally. Since we leave out the other "input" factors mentioned, the conclusions that we will draw about the respective comparative advantages will have to be handled with the necessary care.
One disadvantage of the approach we have to choose if compared to the output oriented ones referred to above, is brought about by the complicating factor that in reality more than just 2 production factors are relevant. As a consequence, the straightforward Heckscher-Ohlin Theorem (that a country has a comparative advantage and should export the product that makes intensive use of the production factor it is relatively well endowed with) no longer holds. More precisely, we are no longer able to point directly to well defined productive sectors as being the relatively advantageous ones. Nevertheless, along the lines set out by Vanek (1968), in Section 4 we will still be able to draw conclusions directly relevant to policy decisions.

3. The data

In the current paper we try to establish the comparative advantages of Czecho-Slovakia (test 1) and the EC (test 2). To this end, we estimate the availability of labour, capital, education and Research and Development (R&D) in Czecho-Slovakia (CZ) relative to the Rest of the World (test 1), and in the EC relative to the Rest of the World (RoW) (test 2).[16]
How do we measure the availability of the respective production factors?

Labour is measured straightforwardly by the available labour force in a country.

The amount of *capital* can be estimated in several ways.[17] A relatively direct (but still rough) measure is to add gross investment over a (by assumption fixed) number of years (the life span of machines) per country using Purchasing Power Parity (PPP) figures (and not exchange rates) to get an international comparison. Although these data are available for both the EC and Czecho-Slovakia, we did not find them for RoW.
To get around this problem, in principle one could take the alternative measure of commercial energy consumption in killogrammes of coal equivalent, for which data are available for all countries in the tests. Gremmen (1985) found that in a "world-"sample, this yardstick showed a very strong (positive) correlation with the first measure (sum of investments). However, oil was known to be relatively cheap in Eastern Europe, as imports (including oil imports) from the former USSR were to be paid for with "transferable rubles"[18], which typically led to a wastage of energy. As a result, the above mentioned relationship between "summed investments" on the one hand, and energy consumption on the other, can be shown not to hold in the case of Czecho-Slovakia, e.g. So, the use of "energy consumption" as a measure for the availability of capital must be

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16 Note that the definition of "The Rest of the World" differs in the two tests.

17 See Hofman (1992), and Lin-Yeok Tan (1992), e.g.

18 See Ellman (1989).

abandoned, since it would imply an overestimation in the Czecho-Slovakian case.[19]
To derive an estimation of the world capital stock on the basis of summed investments, we multiplied world commercial energy consumption with the ratio found in the EC between summed investments on the one hand, and commercial energy consumption on the other.[20] Obviously, the implied assumption that the EC ratio also (more or less) applies to the Rest of the World[21], makes the estimate rather rough.[22]

To estimate *education*, we use the Harbison Meyers index[23] for educational enrolment (as the educational attainment data are not available for all countries under consideration[24]). The Harbison Meyers index, to be abbreviated as HMENR, is defined as: enrolment in primary and secondary education + 5 x enrolment in post-secondary education[25].

Finally, *Research and Development (R&D)*. Once again, there are several possible measures here. The measure "R&D expenditures" was not chosen since the relevant PPP figures, also necessary to get comparable data for RoW, were lacking. A second approach is to measure R&D on the basis of the number of people working in R&D. Ideally, it could be measured then (analogous to HMENR) as: number of technicians working in

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19 In principle, one could estimate the "proper" (commercial) energy consumption (and with it this measure for the amount of capital) in Eastern Europe, by adjusting its energy consumption for the difference between Eastern European and world market prices, using the (western) long run elasticity for the demand for energy. This approach would have two drawbacks, however: one would assume that this elasticity would also apply to Eastern Europe, and, moreover, the estimate derived would refer to capital used as opposed to (the intended) capital available, where the gap between the two might be considerable especially in Eastern Europe.

20 A drawback of this measure is that prices (in this case of capital) show up again in the analysis and with it the danger, signaled in Section 2, that a badly working price mechanism may distort the picture. Taking PPP figures, as we did, may have alleviated the problem again.

21 Note, that in test 1 (2) the amount of capital in RoW is found by subtracting the capital in CZ (EC) from the world figure found this way.

22 For one thing, "RoW" includes, amongst others, other energy spoiling Eastern European countries.

23 Actually, we use the redefinition that was applied in Gremmen and Vollebergh (1986). I.e., we also include primary education, contrary to the original definition of the Harbison Myers index.

24 As Gremmen and Vollebergh (1986) show, educational enrolment and attainment data are closely correlated, implying that the error in this respect is likely to be minor. However, the available data indicate that Czecho-Slovakia ranks more highly relative to the EC countries, in attainment terms than it does in enrolment terms.

25 Years: 1987, 1988 or 1989.

R&D + 5 x (number of scientists and engineers working in R&D). Since the number of technicians concerned was neither available for the UK (and therefore not for the EC) nor for the World as a whole (and therefore not for RoW), we confine ourselves in this respect to the number of scientists and engineers working in R&D.[26]

The above four yardsticks lead to the estimates for labour, capital stock, education and R&D, respectively, that are given in the Appendix. On the basis of Tables A1 - A4 in that Appendix, we can derive the ranking of the factor endowments of the EC, relative to those in Rest of the World in the EC test, and the analogous ranking of the factor endowments in Czecho-Slovakia relative to those in the Rest of the World in the CZ test. When applying the following abbreviations:

l = labour force,
k = capital
Educ = education[27]
R&D = research and development

these results can be summarized in the following two tables:

Table 1: Relative factor endowments EC vs RoW (in order of magnitude)

k_{EG}/k_{RoW}	$R\&D_{EG}/R\&D_{RoW}$	$Educ_{EG}/Educ_{RoW}$	l_{EG}/l_{RoW}
0.159	0.123	0.075	0.065

Table 2: Relative factor endowments Czecho-Slovakia vs RoW (in order of magnitude)

$R\&D_{CZ}/R\&D_{RoW}$	l_{CZ}/l_{RoW}	$Educ_{CZ}/Educ_{RoW}$	k_{CZ}/k_{RoW}
0.0127	0.0035	0.0028	0.0014

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26 We did not correct the amount of labour (the first production factor mentioned above) for the number of R&D scientists and engineers, which is defended by the usual assumption that such R&D workers are analytically split into a regular labourer on the one hand, and their special R&D skills, on the other.
Moreover, as the figures in the Appendix show, the difference between our labour estimate and the possibly corrected one, is extremely minor.

27 Education is calculated as (labour force) x HMENR, and not (population) x HMENR, since a higher degree of education for persons not belonging to the labour force cannot be regarded as an extra production factor.
In calculating education this way, we assume that the degree of education of persons in the labour force is either identical to the one of the average member of the population, or that his extra education (when compared to his average country-men) is equal in all regions.

4. Conclusions

Assuming that our sources are reliable[28] and that our yardsticks measure the respective endowments correctly, the above figures indicate that:

1. the EC is relatively well endowed with capital and relatively poorly endowed with labour; in R&D and in Education, the EC takes an average position;
2. Czecho-Slovakia is relatively well endowed with R&D and relatively poorly endowed with capital; in labour and in education, Czecho-Slovakia takes an average position.

Following Vanek (1968), we can conclude therefore that in general the EC should focus, not surprisingly, on capital intensive products and processes and not on labour intensive ones. Moreover, and (maybe) more surprisingly, we find that Czecho-Slovakia should focus on R&D intensive products and processes and not on capital intensive ones. The latter conclusion, that Czecho-Slovakia has a comparative advantage in R&D, is in contrast with the one found by Hare and Hughes on the basis of their output oriented analysis, that like the other Eastern European countries they investigated, Czecho-Slovakia would have an advantage in labour and possibly in education intensive sectors.[29] Inclusion of R&D as a relevant production factor makes labour and education shift to an intermediate position. As Vanek indicated, in such a case one cannot *a priori* determine whether this country should concentrate on labour and education intensive sectors or not.

Before our empirical conclusion that Czecho-Slovakia has an advantage in R&D intensive sectors, would be converted into 'the truth', a point of warning is appropriate here, in view of the assumptions on which this conclusion is built. For one thing, as in the Heckscher-Ohlin framework, we assumed homogenous production factors. However, does that assumption also hold in reality? Are Czecho-Slovakian R&D workers, for instance, *cet.par.* equally efficient as their colleagues in the rest of the world? Moreover, we concentrated on one source of comparative advantage, only (relative factor endowments), and neglected all other possible determinants in this respect, like the possibilities of economies of scale, the opportunities for product differentiation and all other elements listed by Porter (1990). Inclusion of these factors may change the picture again.

To sum up, the situation with regard to the comparative advantages of Eastern European countries seems to be rather discomforting. On the one hand, there are readily applicable estimates available, that are based on output oriented measures. However, this kind of measures cannot be applied to the countries under consideration. On the other hand, estimation on the basis of input oriented measures, although appropriate, will need a substantial further research effort.

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28 As reported with the tables in the Appendix, our sources are confined to UN Yearbooks and World Bank publications.

29 See Section 1 above.

APPENDIX: The Data on Factor Endowments

Table A1: Labour Force (LF)[30]

Country (1)	LF % of total population (2)	Estimated population in 1990 in mill. (3)	Labour force (4)	Ranking of (2)[31] (5)
EEC:				
Belgium	41.9	9.8	4 106 200	9
Denmark	56.7	5.1	2 891 700	1
France	43.9	56.1	24 627 900	7
Germany[32]	48.3	61.0	29 463 000	5
Greece	38.9	10.0	3 890 000	11
Ireland	37.0	3.7	1 369 000	14
Italy	42.0	57.1	23 982 000	8
Netherlands	41.2	15.0	6 180 000	10
Portugal	47.8	10.3	4 923 400	6
Spain	38.8	39.2	15 209 600	12
UK	49.5	57.2	28 314 000	4
EC total[33]	44.7	324.5	144 956 800	-
others:				
Sweden	51.4	8.4	4 317 600	-
Turkey	38.5	55.9	21 521 500	-
Czechoslovakia	53.2	15.7	8 352 400	2
World	45.0	5 280.0	2 376 000 000	-
RoW[34]				
CZ-case			2 367 647 600	-
EC-case			2 231 043 200	-

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30 Labour Force: The economically active population, including armed forces and unemployed but excluding homemakers and other unpaid caregiver.
Source: Human Development Report 1992; UNDP, pp. 195 and 202, Tables 16 and 22, calculated from "Degree of Participation" and "Estimated population" (both in 1990).

31 Ranking: excluding the EC total, the possible EC members Sweden and Turkey, World and RoW.

32 Data for the former GDR are not included.

33 Calculated from figures above.

34 The "Rest of the World" varies per case:
in the EC case RoW = World - EC;
in the CZ case RoW = World - Czechoslovakia.

Table A2: Capital

Country (1)	Fixed invest. 1980-1990 in billions[35] (2)	PPP-rates in DM in '87 (3)	(2) x (3) (4)	Ranking of (4)[36] (5)
EEC				
Belgium	9 423.50	4.795 DM/100 BF	451.86	7
Denmark	1 286.57	20.45 DM/100 DK	263.10	8
France	11 560.20	29.88 DM/100 FF	3 454.20	2
Germany	4 276.70		4 276.70	1
Greece	13 361.80	16.54 DM/1000 DR	221.00	9
Ireland[37]	42 731.00	2.54 DM/1 IRP	108.54	12
Italy	2107 671.00	1.41 DM/1000 IL	2 971.82	3
Netherl	914.44	89.87 DM/100 FL	821.81	6
Portugal	12 778.00	16.53 DM/1000 PES	211.22	10
Spain	79 631.00	1.71 DM/100 SP	1 361.69	5
UK	757.08	3.196 DM/1 BP	2 419.63	4
EC-Total			16 561.57	-
Others				
Sweden	2 002.96	24.96 DM/100 SK	499.94	-
Turkey	131 045.80	15.56 DM/10000 TL	203.91	-
CZ	2 088.05	6.31 DM/100 KCS	131.75	11
RoW[38]				
CZ-case			119 331.76	-
EC-case			103 852.07	-

[35] In prices of 1987, source: "World Tables 1992", World Bank. For calculations, see footnotes to Table 3.1.

[36] Ranking: excluding ROW, the EC total and the possible EC members: Sweden and Turkey.

[37] The amount in column (2) for Ireland is in millions.

[38] As indicated above, to get comparable investment data for the Rest of the World (RoW), we multiplied commercial energy consumption in the Rest of the World with the ratio found in the EC between summed investments on the one hand (16 561.57), and commercial energy consumption (1 399.73) on the other (Source: Handbook of International Trade and Development Statistics, UN Table 6.9, p. 492-529). The latter ratio equals 11.832. The commercial energy consumption in RoW varies by definition with the test concerned:
For the EC test: 10 176.95 (world total) - 1.399.73 (EC) = 8 777.22 in mln. metric tons of coal equiv.
For the CZ test: 10 176.95 (world total) - 93.13 (CZ) = 10 083.82 in mln. metric tons of coal equiv.

Table A3: Education[39]

Country (1)	Year (2)	HMENR (3)	Ranking of (3) CZ-case (4)	Ranking of (3) EC-case (5)
EEC				
Belgium	87	268	4	4
Denmark	88	260.5	6	6
France	89	289	1	1
Germany	89	274.5	2	2
Greece	87	239	7	7
Ireland	88	228	8	8
Italy	89	227	9	9
Netherlands	88	271	3	3
Portugal	89	172	13	13
Spain	87	264.5	5	5
UK	88	210.5	11	11
EC Total[40]		250.69	-	-
Others				
Sweden	89	253.5	-	-
Turkey	89	143.5	-	-
Czechoslovakia	89	179	12	12
World	89	218.3	-	-
RoW[41]				
CZ-case		218.42	10	-
EC-case		216.18	-	10

[39] Data for enrolment are found in UN Statistical Yearbook, 1991.

[40] The index for the EC is calculated as a weighted average of the indices for its members where the weights equal the share of the country's population in the EC total population.

[41] The index HMENR for the Rest of the World ($HMENR_{RoW}$) in the EC case follows from the definition of HMENR for the World ($HMENR_{W}$):
$HMENR_{W}$ = [EC Population/World population] x $HMENR_{EC}$ + [(World population-EC Population)/World Population] x $HMENR_{ROW}$, where $HMENR_{w}$ is directly calculated from the data given in the same source as the other enrolment data and is equal to 218.3 (1990).
In the CZ case, $HMENR_{ROW}$ is found in a similar manner. For population data: see Table 3.2.

Table A4: Research & Development[42]

Country	Year	SScientists and Engineers	Technicians	HMST[43]
(1)	(2)	(3)	(4)	(5)
EEC				
Belgium	88	16 646	20 124	103 354
Denmark	89	10 662	14 786	68 096
France	88	115 163	167 936	743 751
Germany	87	165 614	122 458	950 528
Greece	86	534	488	3 158
Ireland	88	6 351	1 291	33 046
Italy	88	74 833	38 287	412 452
Netherlands	88	37 520	26 900	214 500
Portugal	88	5 004	3 571	28 591
Spain	87	20 890	8 196	112 646
UK[44]	89	120 709	n.a.	n.a.
EC-Total		573 926	n.a.	n.a.
Others				
Sweden	87	22 725	29 086	142 711
Turkey	85	11 276	7 367	63 747
Czechoslovakia	89	65 475	42 876	370 251
World	90	5 223 614	n.a.	n.a.
RoW				
CZ-case		5 158 139	n.a.	n.a.
EC-case		4 649 688	n.a.	n.a.

n.a. = not available

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42 Source: "Statistical Yearbook", United Nations, 1991, Section 5.17.

43 HMTS = 5xS + 1xT, where S = number of scientists and engineers per country and T = numbers of technical personnel per country, both in the year indicated. Scientists and engineers, comprising of persons working in those capacities, i.e. as persons with scientific or technological training (usually completion of third level education) in any field of science, who are engaged in professional work on R&D activities, administrators and other high-level personnel who direct the execution of R&D activities.
Technicians comprising of persons engaged in that vocational or technical training in any branch of knowledge or technology of a specified standard (usually at least three years after the first stage of second-level education).
Scientists and engineers engaged in the administration of R&D are included with auxiliary personnel; of military R&D, only the part in civil establishments is included.

44 Numbers for the UK are lacking for the years concerned. To derive an estimate the following procedure was followed. For both 1978 and 1989 the number of R&D scientists and engineers in the UK "integrated in the productive sector" is known (65 900 and 85 100 respectively).
Sources: "Statistical Yearbook", United Nations, 1986 and 1992.
For 1978, this was equal to 70,5% of total Scientists and Engineers in R&D. By assuming that the same percentage hold in 1989, the number was calculated as 100/70.5 x 85 100 = 120 709.

From Table A4 it can be concluded that Czecho-Slovakia is relatively well endowed with R&D. From Table A3, however, Czecho-Slovakia appeared to score relatively poorly in terms of education. The two may be reconciled by taking into consideration the figures in Table A5 below, comparing science graduates as a % of total graduates, where Czecho-Slovakia ranks third. The reconciliation may be found, if a degree in "science" forms a good basis to employ a relatively high number of R&D workers.

Table A5: Science vs total graduates

Countries	Science graduates as % of total graduates 1987-1990[45]	Ranking
Belgium	38	9
Denmark	44	6
France	37	10
Germany	50	2
Greece	39	8
Ireland	43	7
Italy	47	4
Netherlands	32	12
Portugal	32	12
Spain	31	14
U.K.	45	5
Sweden	58	1
Turkey	34	11
Czechoslovakia	48	3

[45] Source: Human Development Report, 1992. Data for former German Democratic Republic not included.

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