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European Department I

Assessing Eastern Europe's Capital Needs

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Abstract

The paper aims at assessing the capital needs of Eastern Europe in catching up to EC standards of living using the framework of a CES (constant elasticity of substitution) production function model. This function, parameterized on the EC, is assumed to apply with certain inefficiency factors in Eastern Europe in 1992. Quantitative results, given the heroic set of assumptions required, are bounded by large ranges. The approach provides a framework for assessing the factors which will determine the future capital needs in Eastern Europe and underscores the crucial role of efficiency gains in this process.

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Summary

This paper assesses the capital Eastern Europe will require to catch up to the average standard of living of the EC countries. Per capita GDP figures for 1992 for Eastern European countries, based on purchasing power parity estimates, are used to derive the annual GDP growth rates necessary to achieve defined targets by 2002: for Czechoslovakia and Hungary, two thirds of the average per capita GDP projected for the EC; for Bulgaria, Poland, and Romania, one half. The required growth rate for the region as a whole is about 12 1/2 percent. The capital needs required to generate these growth rates are estimated with a CES (constant elasticity of substitution) production function model, parameterized on the EC.

This approach underscores the importance of improvements in efficiency in determining the capital needs associated with any growth path. Thus assuming no efficiency gains from 1992 on, the postulated growth rate for Eastern Europe as a whole would require ratios of investment to GDP of over 100 percent--which is clearly unrealistic. Alternatively, if all inefficiencies (compared with the EC) could be eliminated by 2002, the cumulative investment needs for the region would be about US\$2.5 trillion, or 30 percent of projected national income over this period.

The policy implication is that rapid growth requires the rigorous implementation of reform policies, including market liberalization, the establishment of effective ownership, and institution-building in such areas as legal, statistical, and accounting systems. Such reforms are essential for promoting both efficiency gains and investment.

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Assessing Eastern Europe's Capital Needs 1/ 2/

1. Introduction

The paper aims at assessing the capital needs of Eastern Europe in approaching EC standards of living. The methodology is the framework of an assumed western constant elasticity of substitution (CES) production function, parameterized on the EC. This function is assumed to apply, with certain inefficiency factors, to Eastern Europe in 1992. Using purchasing power parity (PPP) estimates, an initial position for Eastern Europe is derived for 1992, including estimates of the starting capital stock. The model then illustrates the capital needed to achieve the postulated growth--12 1/2 percent per annum for East Europe as a whole--on certain assumptions. A particular focus is the potential role of efficiency gains in this process.

2. Methodology and Initial 1992 Position

The basic approach is to characterize supply conditions in Eastern Europe in 1992 by a western-style production function. 3/ 4/ This is a constant elasticity of substitution (CES) production function. It links productivity growth to capital accumulation and improvements in the efficiency of the utilization of labor and capital services. Annex 1 provides a detailed description of the CES production function model. A series of assumptions are required to apply this model to Eastern Europe. Central assumptions--on output, capital stock and inefficiency parameters are discussed below. Other assumptions are detailed in Annex II and summarized below.

a. Output

The aim is to value Eastern European countries' output in 1992 so that (1) the GDP per capita and (2) the resulting capital stock generated by the model is comparable with the EC. Purchasing power parity (PPP) exchange rates were thought to meet best these twin objectives. PPP projections were based on estimates of both PlanEcon and the CIA 5/; inevitably, these PPP projections are highly uncertain. In all countries, the projected PPP

1/ Eastern Europe, for the purposes of this study, includes Bulgaria, Czechoslovakia, Hungary, Poland and Romania.

2/ More detailed results are available on request from the author.

3/ A similar approach applied to east Germany was used by Mr. McDonald and Mr. Thumann. For details, see German Unification - Economic Issues Chapters IV and V edited by Mr. L. Lipschitz and Mr. D. McDonald, International Monetary Fund, Occasional Paper No. 75, December 1990.

4/ The function has no specific human capital term. The build up of human capital will clearly influence the movement in efficiency factors (discussed below) and itself be influenced by the level of investment.

5/ December 1990 PlanEcon Report and 1990 CIA Handbook of Statistics.

exchange rate is considerably more appreciated than projected 1992 official exchange rates. Projected GDP per capita using PPP exchange rates varies from US\$2,800 in Romania (14 percent of EC 1992 average) to US\$8,400 in Czechoslovakia (41 percent of EC average) (Table 1). On projected official exchange rates, the GDP per capita of Eastern Europe as a whole is around 10 percent of the 1992 EC average; on PPP rates it is slightly over 20 percent.

Over the projection period, it would be expected that the PPP and official exchange rates should converge. This is a normal feature of development. It is particularly likely as Eastern Europe integrates into the world economy, inappropriate structures are phased out and subsidies are reduced ^{1/}--all of which are likely to be accompanied by an appreciation of the real (actual) exchange rate. No change in the 1992 PPP rates is assumed in the projections. However, the use of PPP exchange rates gives rise to two problems of interpretation of the results. First, investment ratios to national income (GDP) are calculated on PPP rates, well above current market rates. Second, to the (large) extent that investment goods will have to be procured from the west, these goods will not be purchasable at PPP but rather actual exchange rates. Calculating their economic cost (consumption foregone or external financing requirement) implicitly at PPP rates amounts to a significant understatement. ^{2/}

The GDP projections for 1992 make some allowance for a recovery of CMEA trade from the depressed levels of 1991. Based on these projections converted at PPP exchange rates, and the projections of population growth, GDP per capita levels were derived. From these levels, targets were postulated for each Eastern European country in relation to the projected EC average GDP per capita (Table 1). For Czechoslovakia and Hungary, a target of two thirds of the projected EC average was chosen; for Bulgaria, Poland and Romania, the target was one half; the average for the region as a whole is around 54 percent. The resulting required annual growth rates of GDP (allowing for population growth) range from 7.7 percent per annum in Czechoslovakia to 17 percent in Romania; for the region as a whole the rate is 12 1/2 percent.

^{1/} These are all factors which would contribute to improved efficiency-i.e. increases in g and h discussed below.

^{2/} Though this could be partly compensated for by a decline in the relative price of investment goods over the period, the ability of Eastern European countries to import some investment goods at prices lower than 1992 EC prices (implicitly assumed in the model projections) and by the likelihood that construction (a major component of total investment) is likely to be relatively cheaper in Eastern European countries than in the EC.

b. Capital stock and inefficiency parameters

No attempt has been made to estimate the capital stock from existing East European data. This is because the concept sought is capital which is usable in a western-style production function. The relationship between this concept and actual capital stock in Eastern Europe 1/ is obscure. 2/ Rather the approach adopted is to define the remaining parameters of the model for Eastern Europe and solve for the initial capital stock. 3/

Aside from the initial capital stock, there are three factors which are required, namely, the elasticity of labor services with respect to the capital output ratio (f) and the two efficiency parameters--general factor efficiency (g) and labor-specific efficiency (h). Factor (f)--the degree to which technical progress is embodied in capital accumulation--was assumed to be 0.5 based on the general proposition that half technical progress is embodied in capital accumulation. The general efficiency parameter (g) reflects the absence of a well functioning system of capital allocation and poor management. It affects both capital and labor. The labor-specific efficiency parameter (h) reflects labor hoarding, fostered by the traditional policy in Eastern Europe of preserving employment. Two efficiency factors are used to permit different inefficiencies in the provision of labor and capital services. The attachment of the specific efficiency factor to labor services reflects the widespread prevalence of labor hoarding and the greater potential mobility of labor than capital. Thus part of the inappropriate allocation of capital is unavoidably reflected in the valuation of capital and not in its inefficiency. Part of the existing inefficiency of capital use in Eastern Europe is reflected in a lower capital stock (valued for western production purposes) and part in continuing inefficient use (g).

There is no basis for deciding on the initial level of (g) or (h). Fixing one parameter, given the assumptions made to here, determines the level of the other. Given output, the share of labor and the size of the labor force, the effective use of labor and capital services is constrained so that a higher value of (g) implies a lower value of (h) and vice versa.

1/ On which data are in any case imperfect.

2/ Borensztein and Montiel use cross section estimates of the determinants of growth rates, to calculate wasteful investment for Hungary, Czechoslovakia, and Poland in the range of 50-75 percent. They use these estimates to adjust the initial capital output ratio and project investment requirements. But this approach, as they admit, assumes all past inefficiencies are attributable to capital and assumes no future inefficiencies. Hence it does not provide a useful guide to the capital stock being sought here.

3/ For the theoretical framework see Annex I.

The higher the level of (g), the lower the level of the initial capital stock, as the same capital services can be provided by a lower capital stock. 1/

On the basis of the following specific assumptions 2/ 3/:

- σ (elasticity of substitution between capital and labor services) = 0.5
- P_L and P_K parameter values derived from the EC
- NDP equals 0.8 1992 projected GDP valued at PPP exchange rates
- Labor share (in NDP) 0.7
- f (elasticity of labor services with respect to the capital/output ratio) = 0.5

and assuming neither (g) nor (h) exceed 1 (the EC level), the initial capital stock for Eastern Europe as a whole would lie in the range US\$2.6 trillion ($g = 0.325$) to US\$0.8 trillion ($g = 1$). In practice, the extremes of this range would appear implausible. It would seem inherently unlikely that the efficiency of capital use would approach EC levels 4/ given the pervasiveness of the legacy of central planning. The implication of (h) approaching 1 is that a specific labor efficiency factor is not warranted. From the argument advanced earlier--given the write down of existing capital--this seems improbable. In the absence of a sound basis for setting these efficiency parameters, the basic approach adopted is to set (g) equal to (h). This, admittedly arbitrary, assumption avoids the arbitrary imposition of values for either (g) or (h). The efficiency of capital use (g) is assumed to be greater than the efficiency of labor use ($g \times h$). This is consistent with the approach adopted under which the existing capital stock has been "written down" to levels consistent with a

1/ The evidence of the low value of state enterprises privatized in east Germany and the massive infrastructure investment needs, would suggest a relatively low initial capital stock and high value of g. Equally a low initial value of g would imply that any piece of capital equipment could be used more efficiently, and would be more valuable, outside Eastern Europe. This seems unlikely.

2/ As well as the general assumption that firms are profit maximizing and the labor market is in equilibrium. In practice, breaches of this assumption are likely to be reflected in g and h.

3/ Explanations for the assumptions on σ , NDP and labor share are contained in Annex II.

4/ That is, g approaching 1. For an initial period, even new investment is likely to be less efficiently used than in the EC due to infrastructural problems and lack of training/expertise--see discussion of g and h below.

western production function; no such adjustment has been made (for obvious reasons) to the stock of labor. The 1992 position of Eastern Europe based on this assumption is shown in Table 2.

Relative productivity for Eastern Europe as a whole (output per worker) is 21 percent of the EC average--ranging from 13 percent in Romania to 35 percent in Czechoslovakia. 1/ This lower relative productivity results from three factors namely the lower capital/labor ratio in Eastern Europe compared to the EC, the general efficiency in the use of factors (g), and the labor specific efficiency factor (h). The value of $(g = h)$ under the equality condition, follows the same ranking--from 0.5 in Romania to 0.77 in Czechoslovakia as does the capital/labor ratio relative to the EC average. 2/ The "usable" capital stock for the region as a whole is estimated at US\$1.3 trillion. 3/

3. Projections to 2002

In addition to the assumptions summarized under the initial position, various other assumptions are required. The labor force projections are described in Annex II. No change in the elasticity of labor services with respect to the capital/output rate (f) is assumed. The depreciation rate is assumed to be a constant 6 percent. 4/ No explicit allowance has been made for the vintage effect--that Eastern Europe's capital stock, particularly under the high investment scenarios, will be newer and therefore arguably more productive than the capital stock in the EC. 5/

1/ These results--though not the ranking--are in line with the results of Gustiniani et al 1991 (Bank of Italy mimeograph) who found labor in Czechoslovakia, Hungary, Poland and Romania respectively 31 percent, 23 percent, 19 percent, and 24 percent as productive as labor in Austria. Cited in Collins and Rodrik (see below).

2/ The evidence from east Germany--footnote 1 page 4--could imply that the initial capital stock in the poorer countries is overvalued under this approach and higher values of g should be assumed. The values of h would fall in consequence under the assumptions made.

3/ Collins and Rodrik (IIE May 1991)--Eastern Europe and the Soviet Union in the World Economy--estimate an initial capital stock for Eastern Europe of US\$0.6 trillion. This estimate assumes relative productivity of one half developed countries--although the authors admit this is a high estimate--and a capital/labor ratio of one eighth (respectively well above and below the results obtained). Since this estimate assumes no inefficiency in the use of capital, it is most comparable to the estimate when $g = 1$, which is US\$0.8 trillion.

4/ Based on the assumption that 80 percent of the capital stock is composed of structures--depreciating fully in 40 years--and 20 percent of machinery and equipment--depreciating over 5 years.

5/ In practice, it is difficult to separate the vintage effect from changes in efficiency factors. This vintage effect is implicitly captured in the movements in the efficiency factors (g and h).

One percent annual growth in output is assumed to occur exogenously, while the remainder of the target growth rate is generated by endogenous factors. 1/ The capital/labor ratio in the EC is assumed to increase by 3 percent per annum. No change in the efficiency of factor use within the EC is assumed. 2/ The target growth rates described earlier (Table 1) are taken as given. Both required growth rates and projected efficiency gains (movements in g and h) are assumed to be linear within the projection period (1992-2002). On the basis of these assumptions, capital needs are generated consistent with various efficiency improvements. These are capital needs related to production: no attempt has been made to assess investment required for other purposes such as environmental clean up.

a. Efficiency gains

Given these assumptions, a striking result of the model is the importance of efficiency gains i.e. movements in the efficiency factors (g and h) from their 1992 position. For Eastern Europe as a whole, with no changes in these efficiency factors, cumulative investment of US\$17 trillion 3/ would be required to achieve the growth target of 12 1/2 percent per annum. This would require investment/income (GDP) ratios well in excess of 100 percent, a capital/labor ratio nearly double the projected 2002 EC level (reflecting the continued inefficient use of capital) with extremely low rates of return to capital. This is clearly an implausible scenario. At the other end of the range, cumulative investment needs would be around US\$2 1/2 trillion if EC efficiency levels could be achieved by 2002. Investment/income ratios would vary around 30 percent, while the required 2002 capital/labor ratio would be less than two-fifths the EC level.

By contrast, the impact of the starting position on cumulative investment needs is much less pronounced. Thus, if labor is efficient to begin with (h = 1), but a similar increase in (g) and (h) is assumed to 2002 4/, both the initial capital stock and cumulative investment needs are highest at US\$2.6 trillion and US\$7.4 trillion, respectively. If, at the other extreme, all inefficiency is attributed to labor (g = 1), the initial capital stock is US\$0.8 trillion and cumulative investment needs US\$4.8 trillion. The first scenario, with a high initial capital stock, would imply a crucial role in generating growth for improvements in general efficiency (g). Under the second scenario, with a much lower initial capital stock, future investment levels could be considered the crucial

1/ See Annex I for a more comprehensive discussion.

2/ As discussed in Annex I, this arguably leads to an overstatement of investment needs if Eastern Europe can achieve a higher level of EC efficiency. This of course would require a greater degree of efficiency improvement.

3/ All results in 1992 U.S. dollars.

4/ g and h both increase by 0.2 by 2002; thus, in this example, 2002 h = 1.2, i.e., above average 1992 EC efficiency.

determinant of growth, given the shortage of initial capital. While large improvements in labor efficiency (h) would also be crucial, 1/ these would, in part, be determined by investment levels.

A key question is therefore the efficiency improvements that can be expected in Eastern Europe. Clearly movements in the efficiency factors (g and h) are a function of the reform policies pursued. Improvements in efficiency essentially are likely to result from liberalizing markets (improving factor allocation), establishing effective ownership (privatization), institution building in such areas as legal, statistical, accounting and banking systems, establishing local administrations and human and physical capital formation. It would not appear unduly optimistic to expect the bulk of the benefits from liberalizing markets and establishing effective ownership to be achieved by 2002--though the ownership structure may still differ substantially from that of most EC countries. It may also be the case that most institution--building will be completed by 2002, though it is perhaps questionable whether these institutions will be functioning to EC standards of effectiveness. In part this is a reflection of the fact that accumulation of human capital in such areas as the law, accounting, customer service, product innovation, management, marketing and banking--necessary to breathe life into the new institutional framework--takes years. Equally, the removal of infrastructural impediments is likely to be a lengthy process, extending beyond 2002. 2/

This qualitative discussion suggests that, not surprisingly, it would appear reasonable to expect major efficiency gains over the projection period, but that complete elimination of all inefficiencies is unlikely. On the assumption that half the current efficiency gap can be eliminated by 2002, cumulative investment needs are around US\$6.5 trillion for Eastern Europe as a whole with investment/income ratios from 65-82 percent. By 2002, the capital/labor ratio has reached around 80 percent of the EC average and the real rate of return to capital has declined to 3 percent. If three quarters of the current efficiency gap can be eliminated by 2002, cumulative investment needs decline to US\$4.2 trillion, with investment/income ratios around 50 percent. The capital/labor ratio rises to slightly above half the EC level while the real rate of return on capital declines to 5 1/2 percent. The first scenario is clearly less plausible than the second scenario: it is not plausible to envisage investment/income ratios of over 70 percent with real rates of return below 5 percent in the second half of the decade. In effect, the growth rates targeted are not achievable unless faster efficiency gains can be obtained than a narrowing of the current efficiency gap by one half.

1/ A higher initial value of g, given the way the model is set up with output assumed, implies a lower initial value of h.

2/ Impediments arise from infrastructure below the level appropriate for Eastern Europe's state of development not below EC standards. Thus a catch up to EC levels of infrastructure is not required by 2002.

Table 3 indicates the impact on a country by country basis of achieving current EC average levels of efficiency by 2002 and contrasts this with a more modest efficiency improvement of slightly more than a half. Overall, cumulative investment needs are less than half with the more rapid efficiency gain. For the current less efficient countries--Bulgaria, Poland and Romania--where EC catch up implies a particularly rapid efficiency gain--investment needs are less than one-third the level required with the slower efficiency improvement. In consequence, investment/income ratios fall dramatically from the 80 to 100 percent range to the 20-50 percent range. Similarly, capital/labor ratios for these three countries rise to around one third of the projected EC level by 2002 rather than over four fifths.

A key question influencing relative country performance is the extent to which initial differences in efficiency between countries are expected to persist or efficiencies are expected to converge. If efficiencies converge, investment needs in the currently more efficient countries--Czechoslovakia and Hungary--rise in relative terms, while the reverse is the case if efficiency catch-up is limited.

4. Conclusion

Caution needs to be used before using the production function model described to project investment requirements. Any such projection requires a heroic set of assumptions. Quantitative results are therefore bounded by large ranges. Further work on various areas such as the experience from other countries on efficiency gains, the relative productivity of Eastern European countries, different definitions of capital stock and investment and different depreciation assumptions would likely improve application of the framework provided by the model. But the limits of any such further work should be emphasized. Given that the approach assumes the application of an EC production function in Eastern Europe and assumes efficiency parameters applicable to such a function, there is inevitably little firm economic grounding for either the initial value or the subsequent movement of these parameters. Further research will not eliminate a large element of conjecture.

The advantage of the production function model described is that it provides a framework for illustrating the importance of factors which determine future capital needs in Eastern Europe. In particular, it emphasizes the crucial role to be played by efficiency improvements in determining both future capital needs and the likelihood these will be met. Thus, if average EC efficiency levels can be achieved in 10 years, growth close to the targets postulated--around 12 1/2 percent per annum for the region as a whole--is potentially achievable with investment income ratios around 30-40 percent, cumulative investment of around US\$2-3 trillion and a high real rate of return to capital. The initial starting position is of less importance. Assuming a low initial capital stock--an inherited capital stock worth little in western terms--with high starting general efficiency (g), investment needs would be lower as any given U.S. dollar investment

would augment capital by a proportionately larger amount. If this were the case--which evidence from east Germany could be interpreted to support--it would imply that high growth rates could be achieved with relatively low investment rates. Even in this case, however, efficiency improvements would play an important role in both generating growth and the rate of return required to attract the necessary investment. ^{1/} These efficiency gains could in turn be fostered by the import of western capital goods. Alternatively, a higher initial capital stock would imply, ceteribus paribus, larger investment needs and a greater role for improvements in general efficiency.

At first glance, the policy implications of the two assumptions about the starting position could differ. To achieve high growth, with a low initial capital stock, investment would appear the primary requirement while with a higher initial capital stock, improvements in efficiency would appear crucial. In practice, this distinction appears overdrawn. The prime policy requirement to improve efficiency and to promote investment is identical--namely the establishment of a flexible market-oriented economy. This requires the implementation of reform policies described in section 3 above. And, even with a relatively small initial capital stock, improvements in efficiency will play a key role in generating growth.

The policy implications of the framework described are the imperative to implement reforms such as liberalizing markets, establishing effective ownership and institution building in such areas as legal, statistical and accounting systems. These reform policies will both promote efficiency gains and investment. Direct foreign investment will no doubt play an important role in efficiency improvements. But even with rigorous reform policies, it is questionable whether the elimination of all current inefficiencies by 2002--particularly for the currently less efficient countries--is realistic. If, significant inefficiencies persist, the capital needs required to achieve the targets postulated would be much higher than the US\$2-3 trillion mentioned above. It is doubtful whether, in such circumstances, these capital needs could be financed. It is also questionable whether rates of return would be sufficient to attract this level of investment. In the absence, therefore, of a near catch up to current EC levels of efficiency, the growth targets would appear unrealistic.

^{1/} As noted earlier, as the model is set up, a higher initial value of g requires a lower value of h given the effective use of labor and capital services is constrained. In practice, high values for both g and h could be combined with a low initial capital stock, by relaxing this constraint, implying either higher initial output or a change in other initial parameters.

Table 1. Eastern Europe: GDP Per Capita Targets for 2002

	GDP Per Capita PPP <u>1/</u> (US\$) <u>1992</u> (1)	Target Projected EC Average GDP Per Capita <u>2/</u> <u>2002</u> (2)	Target US\$ <u>2002</u> (3)	Required Annual Growth Rate GDP Per Capita (4)	Annual Population Growth Rates (5)	Required Annual Growth Rate GDP (6)
	(In percent)					
Bulgaria	3,500	1/2	12,765	13.8	0.3	14.1
Czechoslovakia	8,400	2/3	17,020	7.3	0.4	7.7
Hungary	6,700	2/3	17,020	9.8	-0.1	9.7
Poland	3,200	1/2	12,765	14.8	0.4	15.2
Romania	2,800	1/2	12,765	16.4	0.4	16.8
Weighted average	4,352	54.4	13,899	12.3	0.3	12.6

1/ Purchasing power parity.

2/ EC average per capita income in 2002 was projected at US\$25,530 (in 1992 U.S. dollars).

Table 2. Eastern Europe Initial Position - (1992) 1/

	Relative <u>2/</u> Productivity	g = h	Labor Efficiency (g x h)	Capital/Labor Ratio (as Ratio EC Average)	Capital/Income (Ratio)	Capital Stock (US\$ billions)
Bulgaria	0.18	0.57	0.33	0.22	3.5	110
Czechoslovakia	0.35	0.77	0.60	0.32	2.6	340
Hungary	0.32	0.74	0.55	0.30	2.7	188
Poland	0.17	0.56	0.31	0.21	3.5	437
Romania	0.13	0.50	0.25	0.18	4.0	<u>259</u>
Total	---	---	---	---	---	1,334
EED 5	0.21	0.62	0.38	0.24	3.2	1,348

1/ Assumptions: $\sigma = 0.5$
 $f = 0.5$
Labor share = 0.7
 $g = h$

2/ Output per worker.

Table 3. Eastern Europe: 2002 Projections. Elimination of One Half,

All 1992 Efficiency Gap by 2002

Bulgaria Cumulated Investment		Czechoslovakia Cumulated Investment		Hungary Cumulated Investment		Poland Cumulated Investment		Romania Cumulated Investment		EE5 Total Cumulated Investment		EE5 Cumulated Investment	
KN1	KN3	KN1	KN3	KN1	KN3	KN1	KN3	KN1	KN3	KN1	KN3	KN1	KN3
(In billions of U.S. dollars)													
1993	29.1	15.3	51.8	40.7	35.9	29.1	121.4	65.0	71.9	37.5	310.2	187.6	310.4
1994	64.9	31.7	108.7	83.9	76.7	61.0	272.4	135.4	161.2	78.0	683.9	390.0	677.6
1995	108.7	49.2	171.1	129.8	123.0	95.9	459.6	211.6	271.5	121.6	1,134.0	608.0	1,110.8
1996	162.0	68.1	239.5	178.4	175.3	133.9	690.0	293.9	406.8	168.5	1,673.7	842.8	1,619.0
1997	225.8	88.3	314.5	229.9	234.2	175.3	969.2	382.8	570.1	218.9	2,313.7	1,095.3	2,209.6
1998	300.4	109.9	396.4	284.6	299.7	220.3	1,298.8	478.7	762.0	273.1	3,057.3	1,366.5	2,886.7
1999	384.8	132.9	485.9	342.5	372.0	268.9	1,673.4	581.8	979.1	331.2	3,895.1	1,657.4	3,648.1
2000	475.9	157.6	583.2	403.9	450.7	321.3	2,077.3	692.8	1,212.2	393.4	4,799.2	1,968.9	4,483.3
2001	568.6	183.8	688.8	469.0	534.9	377.4	2,485.3	811.8	1,447.0	460.0	5,724.7	2,302.0	5,372.0
2002	656.9	211.7	802.9	537.9	623.5	437.3	2,868.3	939.5	1,667.5	531.2	6,619.2	2,657.5	6,284.8

(In percent)

	Investment/Income		Investment/Income		Investment/Income		Investment/Income		Investment/Income		Investment/Income	
1993	80.5	42.2	36.3	28.5	46.4	37.7	85.4	45.7	93.9	48.9	65.1	39.1
1994	86.5	39.6	37.0	28.1	48.1	37.6	92.1	42.9	99.6	45.1	68.3	37.2
1995	92.7	37.2	37.7	27.7	49.7	37.5	99.0	40.3	105.3	41.6	71.5	35.4
1996	98.7	34.9	38.3	27.2	51.2	37.2	105.6	37.7	110.4	38.3	74.4	33.7
1997	103.5	32.7	38.9	26.8	52.4	36.9	110.9	35.3	113.9	35.2	76.7	32.0
1998	106.0	30.7	39.5	26.4	53.2	36.5	113.6	33.0	114.4	32.3	78.0	30.4
1999	104.9	28.7	40.0	25.9	53.5	35.9	111.9	30.8	110.7	29.6	77.8	28.8
2000	99.1	26.8	40.4	25.5	53.0	35.3	104.6	28.7	101.6	27.1	75.8	27.3
2001	88.3	25.0	40.7	25.1	51.7	34.4	91.6	26.7	87.5	24.8	71.5	25.8
2002	73.7	23.3	40.8	24.6	49.5	33.5	74.6	24.8	70.3	22.7	65.2	24.4

Common Assumptions: $f = \sigma = 0.5$
 Labor Share (1992) = 0.7
 $g = h$
 Target growth: 12.6 percent p.a.

KN1: 2002 $g = h = 0.77$ - Bulgaria, Romania, Poland, Czechoslovakia
 = 0.92 - Czechoslovakia, Hungary
 = 0.82 - EED5
 KN3: 2002 $g = h = 1$

ANNEX I

1. The model applied to the EC

The CES production function assumed in the study relates the inputs of capital services (KS) and labor services (LS) to net value added according to equation (1):

Formulae:

$$(1) \quad V = [p_L \cdot LS^{-\lambda} + p_K \cdot KS^{-\lambda}]^{-\frac{1}{\lambda}}$$

$$(2) \quad p_L = S_L^{1/\sigma} / w^{(1-\sigma)/\sigma}$$

$$(3) \quad p_K = S_K^{1/\sigma} / r^{(1-\sigma)/\sigma}$$

$$(4) \quad \lambda = \frac{1-\sigma}{\sigma}$$

p_L and p_K are constant, $1/\lambda$ is dependent on σ which is the elasticity of substitution between capital and labor services, S_L is the share of labor and S_K the share of capital, w is the wage rate and r is the rate of return on capital.

The production function (1) is parameterized so as to make it consistent with projected supply conditions in the EC in 1992, on the assumption that the EC is operating on its production frontier. Thus KS for the EC is set equal to its measured capital stock (K), and LS is assumed to be equal to its total employment (L).

^{1/} The parameters p_L and p_K reflect the feasible technology for combining L^S and K^S .

It is assumed that the elasticity of substitution between capital and labor services is 0.5 1/, that firms are profit maximizing, and that the labor market is in equilibrium (in the sense that the marginal product of labor is equal to the real wage). Thus

$$(5) \quad LS = S_L V/w \text{ and}$$

$$(6) \quad KS = S_K V/r.$$

On these assumptions, information on factor shares in the EC's net national product is used to derive the parameter values in (1).

2. Application of model to Eastern Europe

It is assumed that the production functions in Eastern Europe are the same as in the EC. Thus the EC calculated values of p_L and p_K , as well as the assumed value of σ , are used for the production functions in Eastern Europe. Lower productivity levels in Eastern Europe reflect less capital per worker and inefficiencies in production practices. Lower capital reduces productivity directly and through the assumption that labor augmenting technical change is embodied to some extent in capital accumulation. 2/ Inefficiencies are assumed to take two forms: general inefficiency (g) and labor-specific inefficiency (h).

Thus, in Eastern Europe (E),

$$(7) \quad KS_E = g * K_E \text{ and}$$

$$(8) \quad LS_E = g * h * [1 + f (KL_E/KL_{EC}) - 1] * L_E$$

Equation (7) relates the supply of capital services in Eastern Europe (KS_E) to the capital in Eastern Europe derived from the model (K_E) and the general efficiency factor (g). Equation (8) provides that labor services in Eastern Europe (LS_E) are a function of the use of labor (L_E), the general efficiency parameter (g), the labor specific parameter (h), and the capital-labor ratio in Eastern Europe relative to the EC (KL_E/KL_{EC})-1, times the elasticity of labor services in response to this ratio (f). It is assumed that g, h and f are all < 1.

Based on projections/assumptions of value added (V_E) and the labor share (S_{LE}) in Eastern Europe, 3/ and the benchmark (EC) values for p_L and p_K , the average wage (w_E) and capital rental (r_E) can be derived for Eastern Europe (using equations (2) and (3) above). As in the EC, it is assumed that firms are profit maximizing and the labor market is in equilibrium. On these assumptions, labor services (LS_E) and capital services (KS_E) can be calculated from equations (5) and (6) above.

1/ This assumption is discussed in more detail in Annex II.

2/ The impact of this (f) factor is discussed in more detail below.

3/ Discussed in Annex II.

Capital in Eastern Europe, for the purposes of this production function, is assumed to exceed capital services by the inverse of general efficiency (g) (Equation 7). Equally actual labor is larger than effective labor services reflecting general inefficiency (g), labor specific inefficiency (h), the ratio of capital in Eastern Europe to the EC (KL_E/KL_{EC}) and the elasticity of labor services with respect to this ratio (f) (Equation 8). There are two equations and four unknowns (g, h, K and f). The approach used is essentially to determine capital (K)--usable capital in a western production function--by assumptions concerning g, h and f . Given two equations, assumptions for any two of g, h and f determine the capital stock (K) and the remaining variable. These assumptions are discussed further in the main text.

3. Dynamic structure of the model

Technical change (TC) is assumed to be, in part, exogenous and, in part, related to the rise in the capital-labor ratio (K/L). Thus

$$(9) \quad TC = c + [1 + f [(K/L)_t / (K/L)_{t-1}] - 1]$$

Where c is a constant, and f is the elasticity of labor services per unit of labor input to changes in the capital-labor ratio (as defined above). Technical change is assumed to be labor augmenting (c in equation (9) is embodied in L_E in equation (8)).

No comprehensive projections have been made for the EC. Specifically, no change has been assumed in the efficiency of factor use in the EC (i.e. increases in the EC equivalents of the Eastern European g and h factors). Clearly, increases in efficiency within the EC will play a role in the projected 2 1/4 percent a year growth in EC GDP per capita. To this extent, capital needs derived from the model may be overstated if these efficiency improvements also occur in Eastern Europe. By the same token, the efficiency catch-up in Eastern Europe (the movements of g and h) are understated in that the target (EC efficiency) is moving. As a (crude) proxy to deal with this omission, a 1 percent increase in value added (NDP) per annum in Eastern Europe is assumed to derive exogenously from the model. This can be interpreted as equivalent to exogenous technical change (c in equation (9) above). For the purposes of comparison to the Eastern European capital/labor ratios, this ratio in the EC is assumed to augment by around 3 percent per year, broadly consistent with the increased per capita output assumed.

ANNEX II

A series of specific assumptions are required to apply the model described in Annex I to Eastern Europe. These are detailed below.

1. General assumptions

a. Elasticity of substitution between capital and labor services (σ)

This is assumed to be 0.5. While σ is a crucial parameter, it is notoriously hard to estimate in a precise manner. Artus found elasticities of substitution ranging from 0.5 to 0.8 in the major industrial countries. 1/ Helliwell et al found a range for G-7 countries of 0.65-1.0 2/; Torres and Martin found a mean estimate for G-7 countries of 0.65 (0.71 excluding Japan). 3/ A value (0.5) at the lower end of these estimates was chosen as the production function used is based on total capital including residences and infrastructure, while some of the estimates cited are based on narrower definitions of capital. A priori, the substitutability between capital and labor services is likely to be lower if structures are included in capital.

b. EC benchmark

Given that Eastern Europe's aspirations center on the EC, the EC was chosen as the benchmark for the production function. Following the procedure described in Annex 1, the parameter values of the model were established for the EC in 1992, based on OECD data and involving several projections and assumptions where data (such as on capital stock and net national product at factor cost) were incomplete. Projections were also made of EC GDP and population growth from 1992 to 2002. EC GDP per capita was projected to grow in 1992 U.S. dollars by around 2 1/4 percent per annum to reach US\$25,530 by 2002. GDP in national currencies was converted into U.S. dollars at 1992 projected exchange rates: these were implicitly assumed to equal PPP rates.

1/ J. Artus "The Disequilibrium Real Wage Hypothesis - An Empirical Evaluation" - IMF Staff Papers Vol. 31 (June 1984).

2/ Helliwell, J., P. Sturm, P. Jarrett and G. Salou (1986): The Supply Side in the OECD's Macroeconomic Model, OECD Economic Studies, No. 6, Spring 1986, pp. 75-131.

3/ Torres, R. and J. P. Martin (1990): Measuring Potential Output in the Seven Major OECD Countries, OECD Economic Studies, No. 14, Spring 1990, pp. 127-149.

2. Application to Eastern Europe

a. Labor force

Certain parameters of the EC production function were assumed to apply in Eastern Europe. 1/ Various assumptions for Eastern Europe were required. Like for the EC, population and labor force projections to derive GDP per capita and the active labor force were necessary. 2/ Two common assumptions were applied across Eastern European countries. First the unemployment rate in 2002 was assumed to be 9 percent, around the EC average for 1988-1991; a straight line projection from the 1992 position to this level was assumed. 3/ Second, the participation rate was assumed to decline from current high rates--ranging from 0.71 in Poland to 0.84 in Czechoslovakia--by one half of one percent per year from the 1992 projected position. 4/ While these twin assumptions might appear pessimistic, it is difficult to envisage the restructuring of Eastern Europe with rates of unemployment below the EC average. Some decline of participation rates towards EC levels would also appear likely. The result is a projected decline in the employed labor force for Eastern Europe as a whole from 41.2 million to just below 41 million. The only country where growth in the employed labor force (0.2 percent per annum) is projected is Poland, partly reflecting the high unemployment projected for 1992. The implication is that the sources of potential growth except for Poland are capital investment and efficiency gains, not higher inputs of labor.

b. Net domestic product (NDP)

The basis for the model is net domestic product which is assumed to be a constant 0.8 of GDP, in line with evidence for the EC. This assumption is likely to overstate required capital needs, as the ratio of depreciation to GDP rises reflecting a rise in the capital stock relative to GDP. As a result, the ratio of NDP to GDP is likely to fall, implying that an NDP growth rate derived via an assumption of a constant ratio would be consistent with a higher GDP growth rate.

1/ P_L and P_K as described in Annex 1.

2/ The total employed labor force was used for labor input, in the absence of data on hours worked.

3/ The unemployment rate for the EC, excluding Greece, Spain and Portugal, for 1988-1991 was 9.7, 8.9, 8.5 and 8.7 respectively (1991 estimate): source OECD.

4/ The EC participation rate averaged 0.66 from 1988 to 1991.

c. Labor share

A starting labor share of 0.7 in NDP was assumed for all Eastern European countries, somewhat below the EC average of 0.79. ^{1/} This is in line with conventional wisdom that a lower level of per capita income is associated with a lower labor share.

^{1/} An 0.7 labor share in NDP would be consistent with an 0.56 share in GDP, on the assumption that $NDP = 0.8 \text{ GDP}$.

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