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INDUSTRIAL EMPLOYMENT, INVESTMENT EQUIPMENT AND ECONOMIC GROWTH

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ABSTRACT

Industrial Employment, Investment Equipment and Economic Growth*

The industrialization of labour is the main engine of growth during the early stages of economic development. In less-developed countries (LDC), equipment investment has played a less important role than non-equipment investment and it has only proved growth enhancing when it either encountered a substantial industrial labour force or fostered a large increase in the share of industrial employment. These findings draw attention to the effects of investment on the composition of the labour force and, unlike recent claims emphasizing industrialization via equipment investment, they suggest that employment industrialization policies may hold the key to success in the LDC world.

JEL Classification: O14, O30 and O57
Keywords: economic development, equipment investment, industrial employment and labour intensive technology

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NON-TECHNICAL SUMMARY

The 'new' growth theory has been accompanied by a proliferation of studies investigating the empirical determinants of long-term growth. A large number of variables has been considered in numerous cross-sectional (country) studies. The empirical results have more or less proved consistent with economic priors, although there seems to exist doubts concerning the robustness of the claimed relationships. A variable that seems to indeed enjoy a robust relationship with economic growth is the share of investment in GNP.

In two important recent papers, Delong and Summers go beyond the standard aggregate measures of investment and argue that it is not general investment but rather equipment investment that is crucial to the growth process. These results, which survive a battery of robustness tests, indicate that an increase of three percentage points in the share of GDP devoted to equipment investment leads to an increase in the growth of GDP per worker of one percentage point per year. This is indeed a large effect. Moreover, the claim of Delong and Summer that such a strong relationship is also present outside the highly industrialized world has important implications for the growth prospects as well as the design of economic policy in the numerous countries that seem to have been caught in low-development traps. It has been argued that the existence of 'human' and 'social infrastructure' (literacy, technology-handling skills, organizational practices, time and work values) is a prerequisite for economic development through industrialization. In other words, that countries cannot take advantage of industrial technology unless they already possess 'social capabilities' of the type described above. Delong and Summers's work, however, suggests the absence of such preconditions for growth and may consequently lead to alternative growth strategies for many poor countries that lack the preconditions.

This Paper analyses the cross-country growth experience using the Delong and Summers data set. It establishes that equipment investment may be important but only in later stages of industrialization. In the early stages another factor, namely industrial *employment*, plays the important role. For the low and middle-income countries as of 1960, differences in industrial employment patterns can account for almost half of the observed differences in growth rates. There is a one percentage point differential in the annual rate of *per capita* income growth between two countries whose shares of industrial employment differ by ten percentage points (by four percentage points in the case of poor countries). Equipment investment – or, for that matter, also the output size of the industrial sector – does not have any additional explanatory power for growth in this group once the effects of industrial employment have been accounted for, but non-equipment investment – or total investment – does. On the other hand, industrial employment matters less in the high-income countries (and total investment does not matter either).

Looking more closely at the role of equipment investment reveals a noteworthy pattern. Namely, that high levels of equipment investment in the low–medium income group were associated with high growth mainly in countries that either had a large, non-shrinking industrial work-force; or which expanded their industrial work-force significantly. That is, it was not equipment investment *per se*, as suggested by Delong and Summers, but investment that either promoted the industrialization of labour or was supported by a large industrial work-force that contributed positively to growth. This finding has some bearing on the 'growth preconditions' thesis. On the one hand, it seems that Delong and Summers's claim regarding the absence of industrialization preconditions is rather exaggerated. Industrial skills – proxied by the share of industrial employment – do seem to make a difference. On the other hand, the existence of such skills does not seem to be an absolute prerequisite as long as labour can be industrialized swiftly.

The key policy conclusion is that policies that encourage the adoption of new technologies may produce ambiguous growth effects depending on their implications for technical substitution (complementarity) between the factors of production as well as on the stage of economic development. Non-industrialized countries need to evaluate alternative industrialization strategies based on their effects on industrial employment.

The "new" growth theory has been accompanied by a proliferation of studies investigating the empirical determinants of long term growth. A large number of variables has been considered in numerous cross-sectional (country) studies, the most popular being various measures of initial real income and human and physical capital[1]. While the empirical results have more or less proved consistent with economic priors, Levine and Renalt argue that the only robust relationship as far as aggregate variables are concerned is that between the rate of growth and the share of investment in GNP.

In two important papers, De Long and Summers[2] go beyond the standard aggregate measures of investment and argue that it is not general investment but rather equipment investment that is crucial to the growth process. These results, which survive a battery of robustness tests, indicate that an increase of three percentage points in the share of GDP devoted to equipment investment leads to an increase in the growth of GDP per worker of 1.02 per year. This is indeed a large effect. Moreover, the claim of De Long and Summer that such a strong relationship is also present outside the highly industrialized world has important implications for the growth prospects as well as the design of economic policy in the numerous countries that seem to have been caught in low development traps. It has been argued[3] that the existence of "human" and "social infrastructure" (literacy, technology handling skills, organizational practices, time and work values) is a prerequisite for economic development through industrialization. In other words, that countries cannot take advantage of industrial technology unless they already possess "social capabilities" of the type described above. De Long and Summers's work , however, suggests the absence of such preconditions for growth and may consequently lead to alternative growth strategies for many poor countries that lack the preconditions.

This paper analyzes the cross-country growth experience using the De Long and Summers data set. It establishes that equipment investment may be important but only in later stages of industrialization. In the early stages another factor, namely

industrial *employment*, plays the important role. For the low and middle- income countries[4] as of 1960, differences in industrial employment patterns can account for almost half of the observed differences in growth rates. There is a one percentage point differential in the annual rate of per capita income growth between two countries whose shares of industrial employment differ by ten percentage points (by four percentage points in the case of poor countries). Equipment investment -or, for that matter, also the output size of the industrial sector- does not have any additional explanatory power for growth in this group once the effects of industrial employment have been accounted for[5], but non-equipment investment –or total investment- does. On the other hand, industrial employment matters less in the high income countries (and total investment does not matter either).

Looking more closely at the role of equipment investment reveals a noteworthy pattern. Namely, that high levels of equipment investment in the low-medium income group were associated with high growth mainly in countries that either had a large, non-shrinking industrial workforce; or which expanded their industrial workforce significantly. That is, it is was not equipment investment per se -as suggested by De Long and Summers- but investment that either promoted the industrialization of labor or was supported by a large industrial workforce that contributed positively to growth. This finding has some bearing on the "growth preconditions" thesis. On the one hand, it seems that De Long and Summer's claim regarding the absence of industrialization preconditions is rather exaggerated. Industrial skills -proxied by the share of industrial employment- do seem to make a difference. On the other hand, the existence of such skills does not seem to be an absolute prerequisite[6] as long as labor can be industrialized swiftly.

Additional support for the emphasis placed on industrial employment in non-industrial countries is obtained from the following two empirical findings: First, that investment in structures (or total investment) contributes significantly to growth. And

second, an increase in the share of equipment investment (holding the share of total investment fixed) is *negatively* associated with growth. These observations have the following interpretation: An increase in the share of equipment investment *at the expense* of other types of investment, reduces industrial employment when the labor intensity associated with equipment investment is smaller than that of structures. If industrial employment is indeed the engine of growth then the introduction of industrial labor saving technologies may undermine growth during the early stages of development (but may be growth enhancing in later stages of development).

The key policy conclusion is that policies that encourage the adoption of new technologies may produce ambiguous growth effects depending on their implications for technical substitution (complementarity) between the factors of production as well as on the stage of economic development. Non-industrialized countries need to evaluate alternative industrialization strategies based on their effects on industrial employment.

THE EMPIRICAL ANALYSIS

We establish several points regarding cross country differences in the rate of per capita income growth in the 1960-1985 period. First, the key determinants of cross country differences in growth performance in the low and middle income countries group (as of 1960) appears to be the pattern of industrial employment together with non-equipment investment (or total investment). Second, equipment investment supported faster growth in the low-middle income group only when it either encountered a large industrial workforce or supported a significant expansion of industrial employment. Third, equipment investment may have hurt growth in those countries when it was undertaken at the expense of more labor intensive capital investments. And fourth, in the high income group (again as of 1960) equipment investment seems to be an important contributor to economic growth but mostly in the

"second tier" subset of this group (the upper middle group). In the high income group, industrial employment matters less and the size of total investment does not have much influence.

As the variables used in this paper have been discussed in detail in other published work we will abstain from their detailed presentation. A list of variables precedes the Tables reporting the empirical results.

The sample is split into two sub-samples. The dividing point is a GDP per worker level that is equal to 30% of the corresponding level in the US in 1960. While such a separation is arbitrary our results are robust to different choices of the threshold value (we also report the findings corresponding to other sub-samples).

The first row in Tables 2 and 3 replicates the main De Long and Summers regression equation: the growth of GDP per worker is regressed on the share of equipment and non-equipment investment, labor force growth and the GDP gap. The key De Long and Summers finding is reproduced: Namely, differences in equipment investment are the main source of cross country differences in growth performance. The second row introduces the two industrial labor variables as well as a human capital variable that is typically used in the empirical growth literature (secondary school enrollment). Several interesting patterns emerge. First, for the low-moderate income group, the industrial employment variables account for almost half of the differences in the cross country growth experience (Appendix 1, Table A1, row 1) while the estimated coefficient on equipment investment is statistically insignificant. Note, that the insignificance of the equipment variable cannot be attributed to multicollinearity problems (see the correlations reported in Table 1). Second the share of non-equipment investment (or the share of total investment) is an important determinant of productivity growth in this group. Third, investment in equipment is significant in the high income group. Fourth, other measures of "industrialization," such as the share of manufacturing in GNP, do not seem to matter for less developed countries (Appendix 1, Table A1, row

2). This indicates that it is not the output size of the industrial sector that makes a difference in the LDCs[7]. It is worth also reporting that these patterns remain invariant when continent dummy variables are included to account for the possibility that differences in employment may proxy for some continent effect.

The reader may be bothered by the fact that the regression equations have included some endogenous explanatory variables and hence there may be an endogeneity problem in some of the estimated equations. This issue is discussed later on in the "Interpretation" subsection.

Additional results of interest emerge when considering various other sub-samples, as shown in Table 4. The key findings are that the role of industrial employment -as judged from the size of the estimated coefficient on the beginning of period industrial employment variable- decreases as the initial productivity per worker cut off point increases. For instance, in the sample with the 10% cut off value (that is for countries with less than 10% of US GDP per worker in 1960), about three more percentage points in the share of industrial employment translate into a one percentage point higher growth (while it takes eight percentage points in the 30% sample). And second, the importance of equipment investment is confined to a *subset* of the high income group. In particular it matters mainly in the "second tier" subgroup[8] (that is, in counties in which GDP per worker was 30% to 50% of the US level[9]). A possible interpretation of this finding is that countries in this group (the second tier) are below the technological frontier but they have a well trained workforce that enables them to move towards it –and in the process realize large productivity gains- by acquiring the appropriate equipment. For the top tier group, which uses –and hence is constrained by – frontier technology, equipment investment does not carry such benefits[10].

Table 5 offers a perspective on the significance of the industrialization of labor for economic growth. Namely, it describes how the fitted growth rates would change as a result of a change in the values of the industrial employment variables. For the low-

moderate income countries, a one standard deviation increase in the initial employment share would boost the annual output growth rate by 1.3 to 1.4 percentage points; a one standard deviation increase in the growth rate of the share of industrial employment would bring about a 1.5 percentage point increase in growth. These effects are quite large.

Table A2 in Appendix 2 reports the data on the low-middle income countries used in the analysis and reveals some other interesting features concerning the association of equipment investment and productivity growth. Notice that high shares of equipment investment tend to coexist with high rates of growth mainly in those countries which either already had a relatively large industrial work force in the beginning of the sample period (Japan, 32%, Hong Kong, 53%, Greece, 24%, Brazil, 20%) or experienced a significant expansion in the share of industrial employment during the sample period (Botswana from 4 to 13, Korea from 15 to 27). On the other hand, the countries with high shares of equipment investment that had a bad growth record, fared poorly on the industrial employment front: Jamaica experienced a 20% reduction in industrial employment (from 20 to 16) despite an above average share of equipment investment (0.061); and Zambia and Zimbabwe saw their industrial workforce increase at a below average rate, from 8 to 10 and 8 to 11 respectively (the corresponding equipment shares were 0.07 and 0.084). In general, among the low -as of 1965- initial industrial employment countries, the ones that grew fast, uniformly experienced a large increase in the industrial labor force (about 100%); the increase fell short of 35% in those with the poor growth record[11]. The average values of IE65, IEG and EQ are 17.5, 50% and 0.049 in for the low-middle income countries whose growth performance was above average, and 11.8, 28% and 0.041 in those countries whose performance was below average.

Table 6 offers more formal support to the described interplay between equipment investment and industrial employment. The first row corresponds to low-

moderate income countries that either experienced an above average growth in their industrial employment (irrespective of their initial share of industrial employment); or had an above average initial share of industrial employment and did not suffer a decrease in this share during the sample period. The second row corresponds to the remaining low-moderate income countries. As can be seen, equipment investment has a strong, positive effect in the former group; while it is insignificant in the second group (the estimated equations also included labor force growth and the income gap; the estimated coefficients of the other variables are not reported).

INTERPRETATION

The empirical analysis has revealed a number of interesting patterns concerning cross-country growth experience. This represents a valuable contribution on its own. Nevertheless, it naturally raises the issue of whether the observed behavior can be interpreted based on the existing growth literature. Some thoughts are offered below.

Auerbach, Hassett and Oliner[12] in their criticism of the De Long and Summers papers ask whether their findings are consistent with the Solow model, in which case the interpretation that equipment investments yield important external benefits is unjustified. While no externalities-based argument has been advanced in the present paper, one would still like to know whether the empirical results reported here can be accounted for by the Solow model or whether an alternative model is needed.

It is a relatively simple exercise to augment the neoclassical model to incorporate exogenous human capital -which is the factor that is associated with employment- as Mankiw, Romer and Weil[13], have done. Such a model, however, cannot reproduce the main finding of this paper, namely, that the growth effects of -components of- physical and human capital are not monotonic functions of income. While one cannot rule out that some version of the Solow model may exist that is

consistent with this result, I have not been able to construct one. Furthermore, alternative approaches exist that in my view have little trouble accounting for the empirical evidence.

Another interpretation of our findings can be offered based on Crafts' account of the industrialization experience of the UK[14]. According to this interpretation, economic development involves several phases; the early ones being associated with the "industrialization" of labor, while the later ones with the "industrialization" of capital and the shift in the technological frontier. In early stages of development, economies tend to have sizable labor resources employed in low productivity agriculture and they also lack the general skills associated with an industrial society (work ethics, discipline etc.). With mechanization, labor moves into the industrial sector and this increases aggregate productivity and output. Learning by doing on the job -interpreted broadly to include the acquisition of general industrial skills and ethics- becomes then a source of sustained growth. The pattern of industrial employment (overall share in the labor force as well as its rate of change) determines the rate of learning and hence productivity growth. During this phase, factors that support the process of labor industrialization, such as capital investments, contribute positively to growth. Mechanization, however, that leads to widespread labor substitution by capital can hinder this process and undermine growth.

During a later stage, an economy that has already mastered the required industrial skills (possesses a disciplined and educated work force) but is still below the technological frontier can move towards it by acquiring the available appropriate technology. This technology tends to be embodied in capital goods, so the share of equipment investment in this “upper middle” income countries is an indicator of the shift towards the technological frontier[15].

Finally, a later stage involves countries that have already reached the technological frontier. Such countries can advance (achieve high growth) only through

the invention and implementation of new technologies.

The empirical results can then be thought as suggesting a stages of growth scenario where each stage is associated with a critical factor of production and with (perhaps limited) variations in the quantities of other factors not mattering much. In the early stages, the structure of employment does the job. In the later ones, first capital accumulation and then technological innovation become the critical factors for growth.

How is the interpretation offered above affected by the possibility that the industrial employment growth variable may not be strictly exogenous (note, though, that the equipment variable is potentially subject to the same problem)? While one may be tempted to discount our argument of causality running from the structure of employment to growth, several important points should be kept in mind. First, as far as we know, there are no theories in the literature that suggest a reverse causation, that is, that higher growth would result in labor industrialization and lower growth in labor de-industrialization in the LDC countries (while modern theories of growth typically suggest a causal link from human capital to growth). Moreover, there is no reason to believe that if a simultaneity problem existed it would be present in the LDCs but not in the high income countries (recall that the De Long and Summers results survive in the high income countries). Second -and most importantly- we should not throw the baby out with the bath water. Whether industrial employment growth is a truly exogenous driving force or it is the outcome of some other force *the fact of the matter is that industrial employment and output growth (or non-equipment investment and growth) have moved in tandem.* This certainly imposes restrictions on the menu of possible growth scenarios (or policies). For instance, it seems sensible to argue that the current paper has demonstrated that a policy of employment de-industrialization seems *less likely* to promote growth in LDCs than one that increases the employment base of the industrial sector. This is the central message of this paper and it seems quite robust. It should also be kept in mind that it does not seem possible to address the issue of growth

via labor industrialization without including some measure of the change in industrial employment as a regressor (ideally, one would like to use an appropriate instrument in the place of employment growth but none exists within the context of our regressions).

CONCLUSIONS

The results from this paper seem to indicate that a particular type of industrialization, namely one involving employment rather than output or capital plays a key role in the development process of low-moderate income countries. Consequently, the emphasis placed by De Long and Summers on the role of equipment investment in poor countries seems unjustified. On the contrary, non-equipment investment seems to be a more significant contributor to growth, perhaps because it has more favorable effects on industrial employment (it is more labor intensive than equipment investment). Better technologies may not represent a panacea but need to be evaluated on the basis of their implications for capital-labor substitutabilities and complementarities.

Unlike De Long and Summers, I also think that the empirical evidence supports Abramovitz's and Landes' view on "human infrastructure" as a critical factor in the development process. The industrial employment variables used in this study measure the existence and/or the creation of such "preconditions" that allow a country to enjoy the fruits of the industrial revolution.

Variables

Dependent variable (YGR6085)= average rate of GDP per worker growth, 1960-85 (D-S)
IE65 = share of labor force employed in the industrial sector, 1965 (WB)
IE80 = share of labor force employed in the industrial sector, 1980 (WB)
IEG = percentage change in the share of labor force employed in the industrial sector between 1965 and 1980 (WB)
EQ = Equipment investment's share in GDP, 1960-85 (D-S)
NEQ = Non-Equipment investment's share in GDP, 1960-85 (D-S)
GAP = 1 - {GDP per worker as a percentage of GDP per worker in the US, 1960} (D-S)
LFG = Labor force average growth, 1960-85 (D-S)
SCH = percentage of working age population in secondary school, 1960-85 (M-R-W)
MF = share of manufacturing in GDP, 1960-85 (D-S)
INV = share of total investment in GNP, 1960-85 (D-S)

Key: WB = World Bank Development Report, 1988, Table 31, p.282, D-S = De Long and Summers, M-R-W = Mankiw, Romer and Weil[16].

TABLE 1

CORRELATIONS

	IE65	IEG	EQ	INV	MF
IE65		-0.52	-0.003	0.29	0.3
IEG	0.71		0.55	0.2	-0.25
EQ	0.569	-0.32		0.68	0
INV	0.3	-0.32	0.56		0.14
MF	0.53	-0.16	0.17	0.14	

Key: GAP < 30% above the diagonal; GAP >30% below the diagonal

TABLE 2

DETERMINANTS OF PRODUCTIVITY GROWTH
Low-Moderate Income Countries (less than 30% of US GDP per worker)

IE65	IEG	EQ	NEQ	GAP	LFG	SCH	R^2 Adj	N
		0.254 0.105	0.076 0.055	-0.004 0.036	0.315 0.364		0.20	40
0.131 0.030	0.031 0.005	-0.090 0.099	0.084 0.041	0.063 0.039	0.360 0.282	0.045 0.023	0.61	38

Standard errors below

TABLE 3

DETERMINANTS OF PRODUCTIVITY GROWTH
High Income Countries (more than 30% of US GDP per worker)

IE65	IEG	EQ	NEQ	GAP	LFG	SCH	R^2 Adj	N
		0.213 0.050	-0.016 0.034	0.033 0.011	0.008 0.181		0.54	20
0.095 0.042	0.029 0.019	0.218 0.059	-0.016 0.036	0.024 0.016	0.272 0.252	-0.002 0.015	0.60	20

Standard errors below

TABLE 4

DETERMINANTS OF PRODUCTIVITY GROWTH
Various Sub-samples

	GAP	IE65	IEG	EQ	NEQ	GAP	LFG	SCH	R^2 Adj	N
LOW-MODERATE	15-30% of US GDP per worker			0.361 0.158	0.103 0.053	0.052 0.074	0.607 0.424		0.40	18
		0.097 0.037	0.026 0.011	0.011 0.219	0.149 0.048	0.076 0.066	0.548 0.380	-0.00 0.035	0.52	17
	< 20%			0.175 0.135	0.066 0.076	0.036 0.073	0.621 0.497		0.08	31
		0.200 0.054	0.031 0.006	-0.063 0.108	0.053 0.052	0.096 0.071	1.155 0.353	0.032 0.025	0.62	30
	< 10%[a]			0.370 0.150					0.28	13
		0.304 0.115	0.027 0.012	0.128 0.189					0.53	13
HIGH	30%-50%[a]			0.283 0.081					0.55	10
		0.034 0.060	0.045 0.030	0.220 0.094					0.58	10
	> 50%[a]			0.122 0.057					0.26	10
		0.052 0.028	0.012 0.021	0.116 0.066					0.44	10
ALL				0.217 0.058	0.029 0.029	0.007 0.007	0.075 0.209		0.24	57
		0.064 0.020	0.020 0.005	0.094 0.069	0.024 0.032	-0.007 0.007	0.127 0.188	-0.011 0.013	0.38	58

Standard errors below

[a] Due to the small number of observations, only the industrial employment and equipment variables were included.

TABLE 5:

EFFECT OF A ONE-STANDARD DEVIATION CHANGE IN INDUSTRIAL EMPLOYMENT ON ECONOMIC GROWTH (PERCENTAGE POINTS)

GAP	IE65	IEG
< 10%	1.35% 0.045	1.62% 0.60
< 20%	1.40% 0.07	1.55% 0.50
< 30%	1.3% 0.10	1.45% 0.47
ALL	0.9% 0.14	0.9% 0.44

The number below is the standard deviation of the industrial employment variable within the sample under consideration

TABLE 6:

THE INTERPLAY OF INDUSTRIAL EMPLOYMENT AND EQUIPMENT INVESTMENT
LOW-MODERATE INCOME COUNTRIES

Industrial Employment	EQ	R^2	N
Above Average	0.312 0.099	0.25	27
Below Average	0.116 0.22	0.0	13

Standard errors below

APPENDIX 1

TABLE A1

OTHER DETERMINANTS OF PRODUCTIVITY GROWTH

Low-Moderate Income Countries

IE65	IEG	EQ	INV	NEQ	MF	GAP	LFG	SCH	R^2 (Adj)	N
0.127 0.024	0.027 0.005								0.48	40
0.233 0.05	0.027 0.004				0.001 0.031				0.59	31
0.114 0.026	0.029 0.005	-0.163 0.121	0.108 0.040						0.54	40

Standard errors below

APPENDIX 2

TABLE A2
THE CHARACTERISTICS OF LOW-MODERATE INCOME COUNTRIES

country	ie65	ie80	ygr6085	1 – gap	eq
botswana	0.04	0.13	0.0676	0.077576	0.131
japan	0.32	0.34	0.0535	0.282559	0.1223
hongkong	0.53	0.51	0.0484	0.249555	0.0767
korea	0.15	0.27	0.0479	0.103948	0.0557
cameroon	0.04	0.08	0.0458	0.071914	0.0415
greece	0.24	0.29	0.0446	0.182576	0.0655
brazil	0.2	0.27	0.0437	0.149005	0.0646
indonesia	0.09	0.13	0.0345	0.071105	0.0221
thailand	0.05	0.1	0.0341	0.105808	0.0395
malaysia	0.13	0.19	0.0332	0.174244	0.0446
pakistan	0.18	0.16	0.0295	0.087122	0.0263
panama	0.16	0.18	0.0295	0.196004	0.0388
ecuador	0.19	0.2	0.0283	0.177803	0.0303
tunisia	0.21	0.36	0.0279	0.131289	0.0428
ivory	0.05	0.08	0.0278	0.112118	0.0243
paraguay	0.2	0.21	0.0261	0.157822	0.0189
morocco	0.15	0.25	0.0243	0.08332	0.026
colombia	0.21	0.24	0.0239	0.216146	0.0229
dominica	0.14	0.15	0.0199	0.156852	0.0321
tanzania	0.03	0.05	0.0184	0.030982	0.086
phillipines	0.16	0.16	0.0179	0.13493	0.0445
malawi	0.03	0.07	0.0153	0.036806	0.0361
guatemala	0.15	0.17	0.0149	0.200696	0.0384
honduras	0.12	0.16	0.0148	0.115677	0.0446
kenya	0.05	0.07	0.0146	0.076363	0.0462
portugal	0.3	0.37	0.0138	0.183789	0.0729
srilanka	0.14	0.14	0.0137	0.145122	0.0138
bolivia	0.2	0.2	0.0124	0.130885	0.0167
costarica	0.19	0.23	0.0121	0.271801	0.0433
india	0.12	0.13	0.0115	0.079113	0.0278
zimbabwe	0.08	0.11	0.011	0.09602	0.0843
peru	0.19	0.18	0.0107	0.267756	0.0267
ethiopia	0.05	0.08	0.0094	0.043116	0.0212
jamaica	0.2	0.16	0.0055	0.220514	0.0609
salvador	0.16	0.19	0.0046	0.165184	0.0223
mali	0.01	0.02	0.0044	0.059618	0.0433
senegal	0.06	0.06	-0.0011	0.112603	0.0193
nigeria	0.1	0.12	-0.0047	0.085342	0.0358
madagasc	0.04	0.06	-0.0102	0.096586	0.0219
zambia	0.08	0.1	-0.011	0.114059	0.0702

The countries are ranked in terms of the average growth rate of output per worker during the sample period

Notes

[*] We wish to thank an anonymous referee for his valuable suggestions.

[1] Robert Barro, "Economic growth in a cross section of countries," *Quarterly Journal of Economics*, 106 (1991): 212-245; Ross Levine and David D. Renalt, "A sensitivity analysis of cross country growth regressions," *American Economic Review, 82*, (1992): 942-63.

[2] Brad De Long and Larry Summers, "Equipment investment and economic growth," *Quarterly Journal of Economics*, 106, (1991): 445-502; Brad De Long and Larry Summers, "Do poor countries benefit from equipment investment," *Journal of Monetary Economics*, 32 (1993): 395-415.

[3] Moses Abramovitz, "Catching up, forging ahead and falling behind," *Journal of Economic History*, 46 (1986): 385-406; David Landes, "Why are we so rich and they so poor?" *American Economic Review*, 80 (1990): 1-13.

[4] We classify a country as a low or middle income one if its per capita income fell short of 30% of the US level in 1960. The sample breakdown employed by D-S, 1991, is 25%. Our results are robust with regard to the choice of other breakdown point (say, a 25% or 20% value). The choice of 30% produced some interesting insights regarding middle income countries.

[5] De Long and Summers, 1991, include additional variables (pertaining to literacy and education) to account for the possibility that in the low income

countries there may be a "...lack of the human and political infrastructure necessary to take advantage of modern technologies and to make fixed capital-intensive investments in technologies..."(p. 457). However, these additions do not affect the estimated coefficients of the equipment investment variable.

[6] As Abramovitz and others would have argued.

[7]Consequently, one cannot claim that *any* measure of the size of the industrial sector will work well in predicting growth when this sector is indeed the engine of growth. The contribution of the present paper lies in its identification of the most promising type of industrialization.

[8]This pattern is even more pronounced in the 20%-50% group, that is in the group that also includes countries such as Japan, Hong Kong and Malaysia.

[9]This group contains Argentina, Chile, Mexico, Uruguay, Austria, Finland, Spain, Italy, Ireland and Israel.

[10] I am grateful to a referee for suggesting this interpretation.

[11] The latter number is exclusive of Mali whose industrial employment share increased from 1 to 2. Even with Mali the average is around 40%.

[12] Alan Auerbach, Kevin Hassett and Stephen Oliner, "Reassessing the social

returns to equipment investment," *Quarterly Journal of Economics*, 109 (1994): 789-802. Auerbach, Hassett and Oliner also criticize De Long and Summers for lack of robustness. For instance, they claim that the results critically depend on the inclusion or exclusion of Botswana from the sample. The results in this paper are invariant to the inclusion or exclusion of Botswana or any other extreme observation.

[13] Cregory Mankiw, David Romer and David Weil, "A contribution to the empirics of economic growth," *Quarterly Journal of Economics*, 107 (1992): 407-32.

[14] Nicolas Crafts, "Recent research on the national accounts of the UK, 1700-1939, *mimeo,* 1994, University of Warwick. Crafts reports that the share of equipment investment in GDP in the UK ranged from a low of 0.011 during 1760-80 to 0.022 during 1899-1913 and concludes that "...British industrialization seems to have been accomplished by what by twentieth standards are very low rates of investment in quantifiable aspects of broad capital." (p. 9).

[15] Lucas (Robert E. Lucas Jr, "Making a miracle," *Econometrica*, 61 (1993): 251-272) claims that this was the mechanism at work behind the Korean growth miracle. As a matter of fact, all the newly industrialized countries of eastern Asia seem to have experienced similar patterns in the behavior of industrial labor and equipment investment.

[16] Mankiw, Romer and Weil.