

## OUTPUT AND CAPITAL INPUT PER CAPITA CONVERGENCE IN LATIN AMERICA: 1960-1995. A PRELIMINARY ANALYSIS<sup>1</sup>

VÍCTOR J. ELÍAS

### Abstract

*This paper studies the convergence in output per capita in 7 Latin American Economies, during the period 1960-1995, breaking it down on its two main determinants: total input and total factor productivity. Total input is in turn broken down in two inputs (labor and capital) and each one of these inputs is separated in its quantity and quality components. The paper presents the convergence of the capital input per capita only. Hence, it presents a partial picture of convergence. However, it gives some useful insights about the economic growth pattern of Latin American economies.*

### Resumen

*Este trabajo estudia la convergencia en producto per cápita en 7 economías latinoamericanas durante el período 1960-1995. El producto per cápita se separa en sus dos principales determinantes: insumo total y productividad total de factores. A su vez, el insumo total se divide en dos insumos (trabajo y capital) y cada uno de estos insumos se separa en sus componentes de calidad y cantidad.*

*El trabajo presenta solamente la convergencia del insumo de capital per cápita. En consecuencia, se presenta un cuadro parcial de la convergencia. Sin embargo, arroja algunas luces respecto del patrón de crecimiento económico de economías latinoamericanas.*

<sup>1</sup> This work is part of a research we are doing with Professor Dale W. Jorgenson<sup>2</sup> (Harvard University). I appreciate the very efficient research assistance of Mariana Colacelli.

This preliminary paper was presented in a special meeting in Buenos Aires organized by the University of Alcalá.

□ University of Tucumán and Foundation Banco Empresario.



## 1. INTRODUCTION

This paper mainly tries to present a set of homogeneous data to study the economic convergence in seven Latin American Country (LA7). This preliminary version reports a subset of the data base needed to have a more complete picture of the convergence phenomenon.

The main objective is to study the convergence in output per capita in 7 Latin American economies<sup>2,3</sup>, during the period 1960-1995, breaking it down on its two main direct determinants: total input and total factor productivity (TFP). Total input is in turn broken down in two inputs (labor and capital), and each one of these inputs is separated in its quantity and quality components.

At this stage of the paper we will not cover all the sources of output per capita convergence. We will present the convergence of the capital input per capita only. At a later stage we will cover the labor input and TFP convergence also. Even though we present a partial picture of convergence it gives some useful insights about the economic growth pattern of Latin American economies.

In order to homogenize the output and capital figures across the seven economies, purchasing power parity (PPP) deflators were used. PPP for output and investment were used to deflate output and capital stock (quantity component of capital input). All the estimates were expressed in terms of 1985 US dollars first, and then they were expressed in terms of output and capital input per capita of US for year 1985. This is done to make comparisons with the convergence behavior of many industrialized countries (the G7).

In the next section we will present the annual behavior of the relative output and capital input per capita of each one of the seven economies (relative to US 1985), and the capital input per capita broken down in the quantity and quality components. Then figures for the behavior of convergence are presented. The convergence is estimated as the annual coefficient of variation across the seven Latin American economies and including US also.

Following Dougherty and Jorgenson's approach for the analysis of convergence for G7 economies, we choose also the US as a base for comparison. Besides of being a benchmark is also useful to have an idea of the local versus global convergence for both kinds of countries.

## 2. CONVERGENCE OF THE OUTPUT PER CAPITA

In Table 1 the output per capita of the seven Latin American economies and US is presented. The PPP deflators for output from the Penn Table were used, and they change substantially the relative position of each one of the Latin American countries. Table 2 gives the average annual rate of growth of the output per capita for different subperiods: 1960-1973; 1973-1989; 1989-1994 and for the whole period 1960-1994.

<sup>2</sup> See Dale W. Jorgenson and Chrys Dougherty "There is no Silver Bullet: Investment and Growth in the G7", mimeo, Harvard University, 1997.

<sup>3</sup> The seven Latin American economies are: Argentina, Brazil, Chile, Colombia, Mexico, Peru and Venezuela.



TABLE 1  
 OUTPUT PER CAPITA, AL7 COUNTRIES AND US.  
 (US = 100 in 1985)

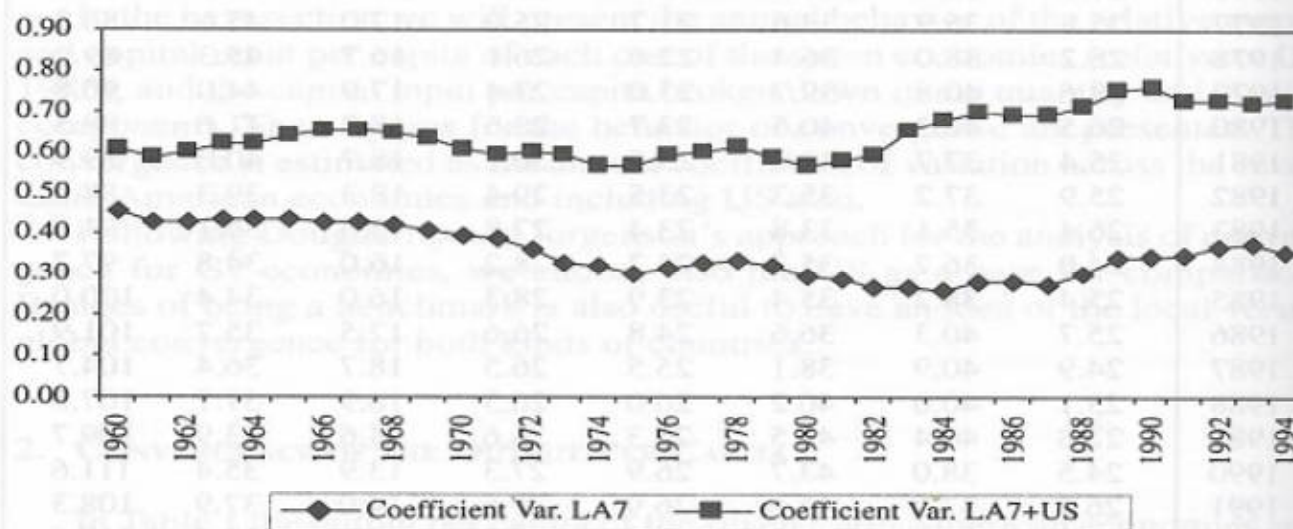
Year	Argentina	Brazil	Chile	Colombia	Mexico	Peru	Venezuela	US
1960	21.3	14.6	28.4	14.0	16.2	12.4	37.4	55.6
1961	20.7	15.7	29.6	14.3	16.4	13.0	36.8	55.9
1962	19.9	16.0	30.5	14.6	16.5	13.8	37.7	58.6
1963	21.7	15.8	31.3	14.6	17.2	13.9	37.8	60.5
1964	23.4	15.8	32.1	15.1	18.5	14.3	39.7	63.6
1965	23.3	15.8	33.0	15.2	19.0	14.6	40.4	67.5
1966	23.6	16.1	34.7	15.5	19.6	15.0	40.0	71.1
1967	24.3	16.4	34.9	15.7	20.0	14.9	40.6	71.5
1968	26.1	17.5	35.3	16.2	20.9	14.9	41.3	72.9
1969	27.1	18.5	36.6	16.7	21.4	14.9	41.4	73.9
1970	28.1	19.7	38.9	17.3	22.1	15.5	40.9	73.1
1971	28.4	21.4	40.3	17.8	22.2	16.0	40.9	74.3
1972	29.7	23.0	39.2	18.5	23.1	16.4	40.9	77.6
1973	29.7	25.5	38.6	19.2	24.2	17.2	41.4	80.9
1974	29.9	26.9	39.6	19.9	24.9	17.8	41.6	78.6
1975	27.8	30.5	29.8	19.4	25.2	17.2	42.5	77.6
1976	27.7	33.9	31.2	20.7	25.0	17.3	44.3	82.7
1977	25.8	35.9	33.6	21.7	25.0	17.0	45.6	86.2
1978	28.2	38.0	36.4	22.6	26.1	16.7	45.3	89.9
1979	28.6	40.8	39.7	23.0	27.4	17.9	44.0	90.8
1980	26.5	40.3	40.6	23.7	28.6	18.2	41.6	88.5
1981	25.4	37.7	42.0	23.7	30.2	18.7	40.0	89.9
1982	25.9	37.2	35.3	23.5	29.4	18.3	39.3	88.5
1983	26.4	35.1	33.8	23.4	27.8	15.6	36.1	91.9
1984	24.0	36.2	35.2	23.7	28.2	16.0	34.8	97.7
1985	25.4	38.2	35.4	23.9	28.3	16.0	34.4	100.0
1986	25.7	40.3	36.6	24.8	26.6	17.5	35.7	101.9
1987	24.9	40.9	38.1	25.5	26.5	18.7	36.4	104.7
1988	23.1	40.0	40.2	26.0	26.3	16.9	37.7	107.6
1989	22.8	40.4	43.5	26.3	26.6	14.6	33.9	109.7
1990	24.5	38.0	43.7	26.9	27.3	13.9	35.4	111.6
1991	26.2	37.6	45.6	26.9	27.6	14.0	37.9	108.3
1992	27.5	36.5	49.4	27.2	27.8	13.3	39.4	110.6
1993	29.1	37.2	51.5	28.0	27.4	13.8	38.1	111.7
1994	27.5	38.5	52.8	29.0	27.7	15.3	36.0	115.2

In Figure A the so called sigma convergence is presented (using the coefficient of variation across countries). The top line includes the seven LA economies plus US (used as the reference country). The bottom line includes only the seven LA economies. While the last one shows some degree of convergence (within LA economies), the another one shows a divergence (the LA economies getting further away from US).

TABLE 2  
GROWTH IN OUTPUT PER CAPITA, LA7 COUNTRIES AND US, 1960-1994  
(Average Annual Percentage Growth Rates)

	Argentina	Brazil	Chile	Colombia	Mexico	Peru	Venezuela	US
Output per Capita:								
1960-73	2.96	4.25	2.35	2.46	3.06	2.66	0.89	2.51
1973-89	-1.52	2.74	0.75	2.00	0.39	-1.33	-1.70	1.72
1989-94	4.60	-0.96	3.87	1.95	0.81	0.94	1.20	0.98
1960-94	1.09	2.85	1.82	2.14	1.58	0.62	-0.11	2.14

FIGURE A  
CONVERGENCE OF OUTPUT PER CAPITA (COEFFICIENT OF VARIATION)  
LA7 vs. LA7 and US.



### 3. CONVERGENCE OF THE CAPITAL INPUT PER CAPITA

Table 3 presents the *quantity of capital* per capita (capital stock per capita), using the PPP for investment goods as the deflator to put all the figures in comparable terms. In the Table 6 the average annual rates of growth of this input component for different subperiods are presented.

In Table 4 we present the *quality of capital* relative to US for the whole period, and in Table 6 the average annual rates of growth are computed by the three defined subperiods.



TABLE 3  
CAPITAL STOCK PER CAPITA, AL7 COUNTRIES AND US.  
(US = 100 in 1985)

Year	Argentina	Brazil	Chile	Colombia	Mexico	Peru	Venezuela	US
1960	9.1	6.3	15.9	6.3	5.7	5.1	20.5	68.2
1961	9.5	6.4	16.5	6.4	5.7	5.2	20.1	68.4
1962	9.8	6.4	17.1	6.4	5.8	5.3	19.7	69.0
1963	9.9	6.5	17.7	6.4	5.9	5.4	19.4	69.9
1964	9.9	6.5	18.2	6.4	6.1	5.5	19.4	71.0
1965	10.1	6.5	18.6	6.4	6.3	5.6	19.4	72.0
1966	10.3	6.6	19.1	6.4	6.5	5.8	19.4	74.5
1967	10.5	6.7	19.5	6.4	6.7	5.9	19.3	76.0
1968	10.8	6.9	19.9	6.5	7.0	5.9	19.9	77.7
1969	11.2	7.1	20.4	6.6	7.2	5.8	20.6	79.4
1970	11.7	7.9	21.0	6.7	7.5	5.8	20.9	80.3
1971	12.1	8.9	21.4	6.8	7.8	5.8	21.4	81.6
1972	12.5	9.9	21.7	7.0	8.1	5.9	22.2	83.4
1973	12.8	11.2	21.7	7.1	8.5	6.1	23.2	85.8
1974	13.1	12.7	21.9	7.3	9.0	6.6	23.7	87.2
1975	13.4	14.2	21.8	7.5	9.5	7.0	24.3	87.7
1976	13.6	15.8	21.6	7.7	9.8	7.2	25.2	88.9
1977	14.1	17.1	21.4	7.9	10.1	7.3	26.8	90.5
1978	14.3	18.4	21.4	8.1	10.5	7.2	28.5	92.4
1979	14.7	19.6	21.6	8.4	11.1	7.1	29.2	94.0
1980	15.0	21.1	22.0	8.7	11.7	7.2	29.1	94.6
1981	15.2	21.4	22.5	9.0	12.7	7.3	29.1	95.5
1982	15.1	21.9	22.3	9.3	13.2	7.5	29.3	95.7
1983	15.0	22.0	21.8	9.5	13.2	7.4	28.7	96.4
1984	14.7	22.1	21.5	9.8	13.2	7.3	27.8	98.3
1985	14.2	22.3	21.3	9.9	13.3	7.1	27.0	100.0
1986	13.8	22.6	21.2	10.1	13.2	7.1	26.3	101.5
1987	13.5	23.0	21.2	10.2	13.2	7.2	25.7	102.8
1988	13.2	23.2	21.5	10.4	13.2	7.2	25.3	104.1
1989	12.8	23.5	21.9	10.5	13.1	7.1	24.4	105.3
1990	12.3	23.5	22.5	10.6	13.2	7.0	23.6	105.9
1991	12.0	23.4	23.0	10.6	13.4	6.9	23.1	105.8
1992	11.7	23.1	23.9	10.7	13.6	6.9	23.0	106.1
1993	11.6	22.9	25.1	11.0	13.8	6.8	22.7	106.8
1994	11.6	22.9	26.4	11.5	14.0	7.0	22.1	108.1
1995	11.5	23.1	27.8	12.0	13.8	7.2	21.5	109.4
1996	11.5	23.2	29.4	12.4	13.8	7.3	20.8	

TABLE 4  
CAPITAL QUALITY, AL7 COUNTRIES AND US.  
(US = 100 in 1985)

Year	Argentina	Brazil	Chile	Colombia	Mexico	Peru	Venezuela	US
1960	78.0	60.7	72.2	105.7	87.3	95.6	1.0	85.8
1961	77.6	60.6	72.2	105.5	87.1	95.7	2.0	86.2
1962	77.2	60.4	82.2	105.3	87.0	95.7	8.0	85.7
1963	76.8	60.3	82.2	105.1	86.9	95.8	9.0	85.7
1964	76.4	60.2	1.8	104.9	86.7	95.8	9.0	85.8
1965	76.1	60.1	6.8	104.8	86.6	95.9	1.0	85.9
1966	75.7	60.0	2.8	104.6	86.4	95.9	1.0	86.7
1967	75.3	59.8	7.8	104.4	86.3	96.0	1.0	88.2
1968	74.9	59.7	0.5	104.2	86.2	96.0	8.0	88.7
1969	74.5	59.6	2.5	104.1	86.0	96.1	1.0	89.5
1970	74.1	59.5	2.5	103.9	85.9	96.1	7.0	91.4
1971	73.7	60.0	8.5	102.9	85.3	95.1	1.0	91.4
1972	73.3	60.5	1.8	102.0	84.8	94.1	2.0	91.6
1973	72.9	61.0	1.8	101.1	84.2	93.1	8.0	92.1
1974	72.4	61.5	0.8	100.2	83.6	92.1	1.0	94.5
1975	72.0	62.0	2.0	99.3	83.1	91.1	4.0	96.3
1976	71.6	62.5	8.0	98.4	82.5	90.2	0.2	95.7
1977	71.2	63.0	1.0	97.5	82.0	89.2	7.0	95.7
1978	70.8	63.5	8.0	96.6	81.4	88.2	6.0	96.2
1979	70.4	64.0	1.0	95.7	80.9	87.3	1.0	97.4
1980	69.9	64.5	64.6	94.9	80.3	86.4	50.3	99.1
1981	69.5	64.6	64.3	94.2	80.4	86.2	49.9	99.1
1982	69.1	64.7	64.0	93.5	80.4	86.0	49.4	100.1
1983	68.6	64.8	63.7	92.8	80.4	85.9	49.0	99.7
1984	68.2	64.8	63.4	92.1	80.5	85.7	48.6	99.1
1985	67.8	64.9	63.1	91.4	80.5	85.5	48.2	100
1986	67.4	65.0	62.8	90.7	80.5	85.3	47.8	101.2
1987	67.0	65.0	62.5	90.1	80.6	85.2	47.4	102.4
1988	66.5	65.1	62.2	89.4	80.6	85.0	47.0	103.1
1989	66.1	65.2	61.9	88.7	80.6	84.8	46.6	103.9
1990	66.6	64.8	62.2	88.5	81.2	85.4	46.1	104.9
1991	67.1	64.3	62.5	88.3	81.7	85.6	45.7	105.9
1992	67.6	63.9	62.7	88.2	82.2	85.8	45.3	104.9
1993	68.1	63.4	63.0	88.0	82.7	86.0	44.8	104.1
1994	68.7	63.0	63.2	87.8	83.3	86.2	44.4	103.9
1995	69.2	62.6	63.5	87.6	83.8	86.4	44.0	104.5
1996	69.7	62.2	63.8	87.4	84.4	86.6	43.6	



The rate of growth of the capital quality is measured as the weighted average of the change in the share of each capital component, with the weight defined by the ratio of the rate of return of a given capital component to the average rate of return of the total capital. We considered two kinds of classification of the fixed capital. The first one based on institutional characteristics: public and private; and the other based on the kind of capital: machinery, residential plant, nonresidential plant, transportation equipment and other kinds of capital. We combined these two rates of change of the quality of capital to get one indicator, and from the rate of change we built an index equal to 1 in 1985. Then we estimated the relative value of the quality of capital of each one of the seven LA economies with respect to US in 1985. In order to get the relative values among the seven economies we consider the relative value of the output-capital ratio among them in 1985, and then estimated the relative quality of capital for each one of the seven economies multiplying first for the lowest relative value of industrialized countries with respect to US and then by the index generated as it was explained above. This is very tentative and needs further work, as we do not have national accounts that classify the capital income by kinds of capital as we use here.

The *capital input* per capita is presented in Table 5. It is computed multiplying the capital quantity per capita and the capital quality values (with US = 100 in 1985). Table 6 presents its average annual rates of growth in the analyzed subperiods.

In Figure B and in Figure C we observe the sigma convergence for the capital quantity per capita (KStock), the capital quality and the capital input. For the capital quantity we can observe some convergence within the seven LA economies (Figure B), but not when the US is included (Figure C). As we can see in the Figure B the quantity component of the capital converges, but the quality does not. As the convergence of the quantity component of the capital is not so strong the capital input (including quantity and quality) does not converge.

#### 4. A COMPARATIVE ANALYSIS OF G7 AND LA-7 CONVERGENCE

From the study of Dougherty and Jorgenson (1997) the following convergence behavior for the G7 were found:

1. Convergence in output per capita in the period 1960-74, no convergence thereafter.
2. This convergence is mainly due to TFP convergence. There is no total input per capita convergence.
3. The no convergence of the total input per capita have two forces working in different direction. Convergence in capital input per capita ( both in capital stock and quality) and divergence in labour input per capita ( due to the big divergence of labour quantity and some convergence of quality).
4. The convergence period for the output per capita , it is observed for the G7 but not for the G6 (excluding US). The convergence is with respect to U.S, and not within de G6.

TABLE 5  
CAPITAL INPUT PER CAPITA, AL7 COUNTRIES AND US.  
(US = 100.0 in 1985)

Year	Argentina	Brazil	Chile	Colombia	Mexico	Peru	Venezuela	US
1960	7.1	3.8		6.7	5.0	4.9		58.5
1961	7.4	3.9		6.7	5.0	4.9		59.0
1962	7.6	3.9		6.8	5.0	5.1		59.1
1963	7.6	3.9		6.7	5.1	5.2		59.9
1964	7.6	3.9		6.7	5.3	5.3		60.9
1965	7.7	3.9		6.7	5.4	5.4		61.8
1966	7.8	4.0		6.7	5.6	5.6		64.6
1967	7.9	4.0		6.7	5.8	5.6		67.0
1968	8.1	4.1		6.8	6.0	5.6		68.9
1969	8.3	4.3		6.8	6.2	5.6		71.1
1970	8.7	4.7		7.0	6.5	5.6		73.4
1971	8.9	5.3		7.0	6.6	5.6		74.6
1972	9.2	6.0		7.1	6.9	5.5		76.4
1973	9.3	6.8		7.2	7.2	5.7		79.0
1974	9.5	7.8		7.3	7.5	6.0		82.4
1975	9.6	8.8		7.5	7.9	6.4		84.5
1976	9.8	9.9		7.6	8.1	6.5		85.1
1977	10.0	10.8		7.7	8.3	6.5		86.6
1978	10.1	11.7		7.9	8.5	6.3		88.9
1979	10.3	12.5		8.0	8.9	6.2		91.6
1980	10.5	13.6	14.2	8.2	9.4	6.2	14.6	93.7
1981	10.6	13.8	14.5	8.5	10.2	6.3	14.5	94.6
1982	10.4	14.2	14.2	8.7	10.6	6.4	14.5	95.8
1983	10.3	14.2	13.9	8.8	10.6	6.3	14.1	96.1
1984	10.0	14.3	13.6	9.0	10.6	6.2	13.5	97.4
1985	9.6	14.5	13.4	9.0	10.7	6.0	13.0	100.0
1986	9.3	14.7	13.3	9.1	10.7	6.0	12.6	102.7
1987	9.0	15.0	13.3	9.2	10.6	6.1	12.2	105.3
1988	8.8	15.1	13.4	9.3	10.6	6.1	11.9	107.3
1989	8.4	15.3	13.6	9.3	10.6	6.0	11.4	109.4
1990	8.2	15.2	14.0	9.4	10.7	6.0	10.9	111.1
1991	8.0	15.0	14.4	9.4	10.9	5.9	10.6	112.0
1992	7.9	14.7	15.0	9.4	11.2	5.9	10.4	111.3
1993	7.9	14.5	15.8	9.7	11.4	5.9	10.2	111.2
1994	8.0	14.5	16.7	10.1	11.7	6.0	9.8	112.3
1995	8.0	14.5	17.6	10.5	11.6	6.2	9.5	114.3
1996	8.0	14.4	18.8	10.9	11.7	6.3	9.1	



**TABLE 6**  
**GROWTH IN CAPITAL INPUT AND CAPITAL STOCK PER CAPITA AND CAPITAL QUALITY, LA7 COUNTRIES AND US, 1960-1995**  
 (Average Annual Percentage Growth Rates)

	Argentina	Brazil	Chile	Colombia	Mexico	Peru	Venezuela	US
<b>Capital Input per Capita:</b>								
1960-73	2.09	4.47	n.a.	0.58	2.79	1.17	n.a.	2.32
1973-89	-0.60	5.05	n.a.	1.64	2.43	0.37	n.a.	2.03
1989-95	-1.03	-0.96	4.39	2.02	1.52	0.55	-3.07	0.74
1960-95	0.33	3.80	n.a.	1.30	2.41	0.70	n.a.	1.91
<b>Capital Stock per Capita:</b>								
1960-73	2.62	4.43	2.39	0.92	3.07	1.38	0.95	1.77
1973-89	0.00	4.63	0.06	2.45	2.70	0.95	0.32	1.28
1989-95	-1.78	-0.28	3.98	2.23	0.87	0.23	-2.11	0.64
1960-95	0.67	3.71	1.60	1.84	2.53	0.99	0.14	1.35
<b>Capital Quality:</b>								
1960-73	-0.53	0.04	n.a.	-0.34	-0.28	-0.21	n.a.	0.55
1973-89	-0.60	0.42	n.a.	-0.81	-0.27	-0.58	n.a.	0.75
1989-95	0.75	-0.68	0.41	-0.21	0.65	0.32	-0.96	0.10
1960-95	-0.34	0.09	n.a.	-0.54	-0.12	-0.29	n.a.	0.56

**FIGURE B**  
**CONVERGENCE OF CAPITAL INPUT AND CAPITAL STOCK PER CAPITA AND CAPITAL QUALITY (COEFFICIENT OF VARIATION)**  
 LA7

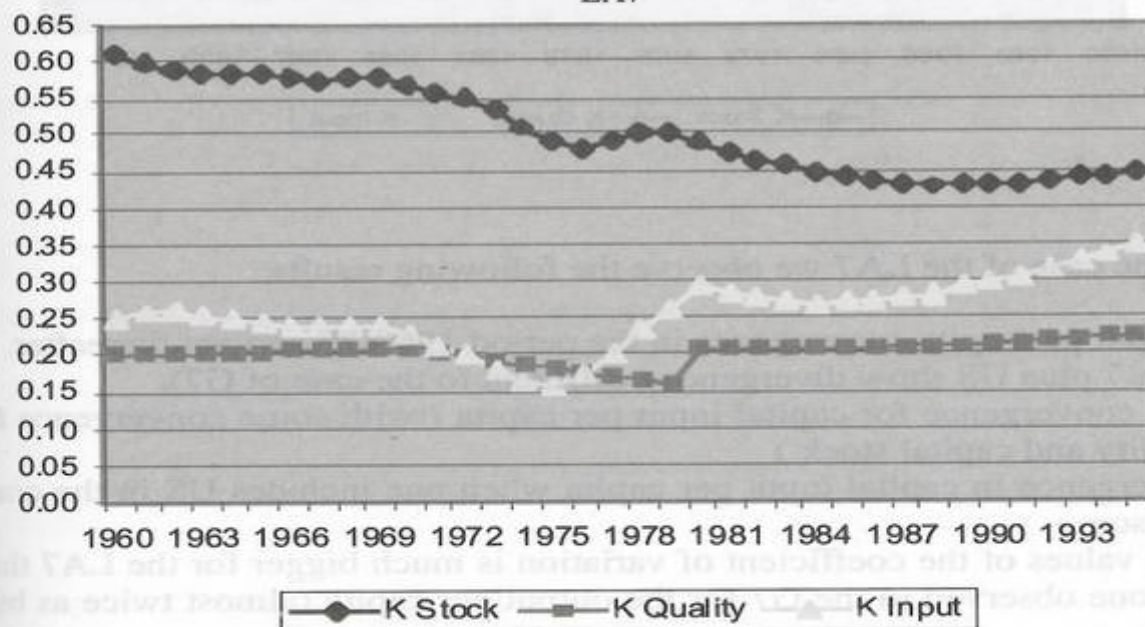
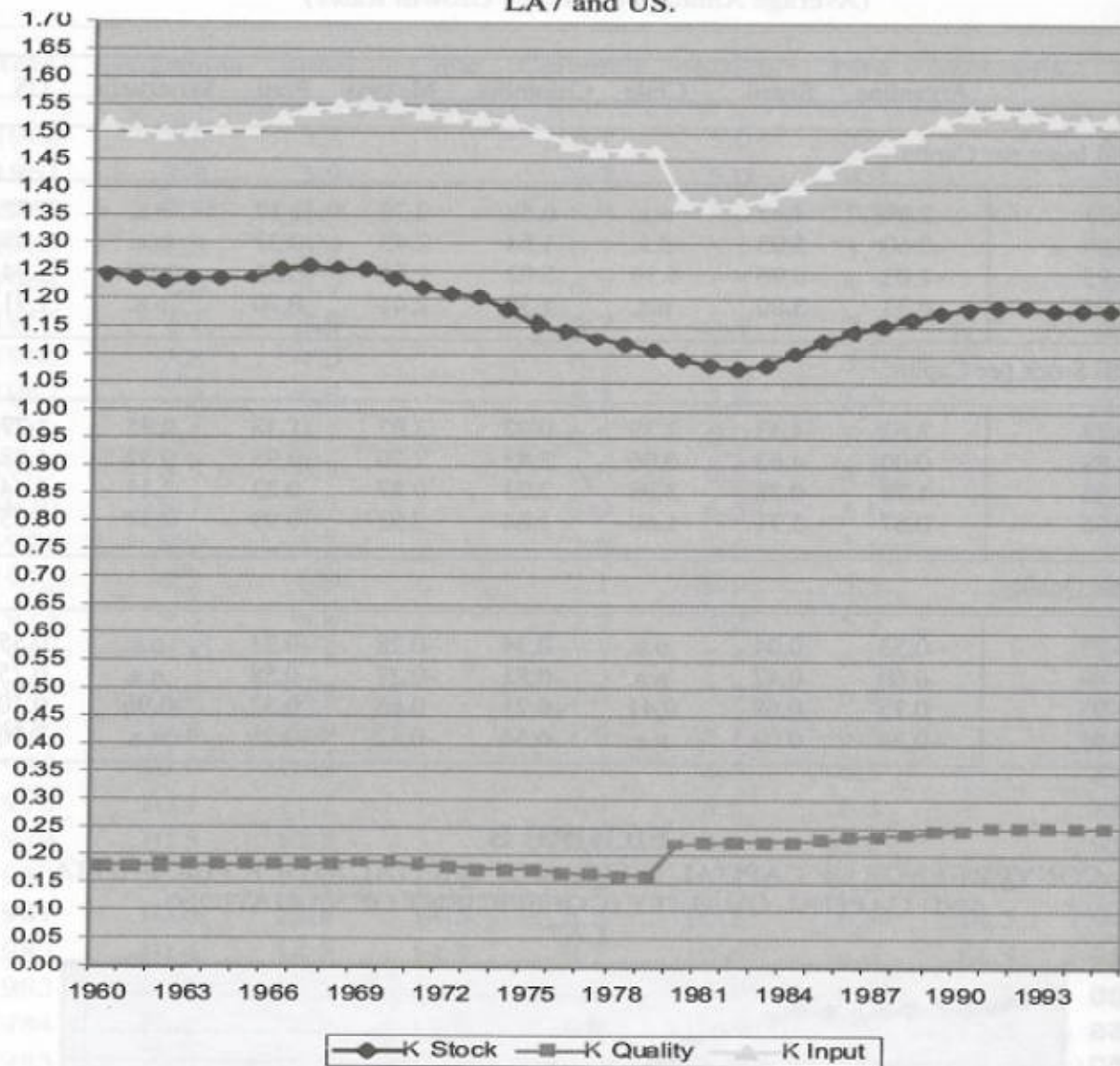


FIGURE C  
 CONVERGENCE OF CAPITAL AND CAPITAL STOCK PER CAPITA  
 AND CAPITAL QUALITY (COEFFICIENT OF VARIATION)  
 LA7 and US.



In the case of the LA7 we observe the following results:

1. Output per capita convergence in the period 1960-75 and not thereafter.
2. L.A.7 plus US show divergence (different to the case of G7).
3. No convergence for capital input per capita (with some convergence for quality and capital stock)
4. Divergence in capital input per capita when one includes US in the comparison
5. The values of the coefficient of variation is much bigger for the LA7 than the one observed in the G7 for the output per capita (almost twice as big).



In the LA7 case, based on previous studies, we expected to find convergence in labour input, so we have the opposite to the case of the G7.

The role of the different sources of growth in the convergence phenomenon gives some support to study the technology as an endogenous factor, and as the main determinant of convergence. The evidence supports this conclusion for both groups of countries. It is important to study why the productivity source stopped to become a convergence determinant after 1974.

In the case of LA7 Countries only few of them showed a convergence with respect to US, but most of them did not converge. We expected a similar evidence to the one observed for the G7 Countries, but this did not happen. It will be interesting to study further this different behaviour.

## 5. CONCLUDING REMARKS

The measurement of the speed of convergence is not enough to understand this phenomenon; the study of the sources of convergence (Productivity versus Inputs) provides useful insights to build a better and more comprehensive model of economic growth.

The identification of these sources will help to clarify and to construct more relevant evidence to understand the convergence issue. The comparison of evidence from groups of countries at different stages of development will help to distinguish between local and global convergence.