

## ***Investment and growth in Europe, 1950-1973***

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### Summary

Post-war Europe provides an opportunity to study the importance of relative prices of capital, and the user cost of capital in particular, in explaining the convergence in investment rates between countries of similar “social capabilities” and income levels. We present a calculation of the user cost of capital for 9 European countries, the USA and Canada. We show that the user cost of machinery matters in explaining investment.

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## 1. Introduction

The two decades after the II World War represents a stage of growth without precedents in the economic history of Europe, in which the GDP growth of European western countries averaged 4.1% and convergence reached the most spectacular marks in history. A wide variety of explanations have been offered for the remarkable behaviour of western economies during the Golden Age. The analyses of its causes have pointed out diverse elements. Since the pioneer works on growth accounting that stood out the advances in total factor productivity, a lot of reflections have been made on the role of technology transfers and structural change. While Keynesian works stress diverse aspects related with the expansion of added demand as economic stability consequence of the Bretton Woods, the expansion of international trade, or the role of the new international order and the development of the welfare state.

More recently, critics to the neoclassical pattern of growth and the development of the new growth theory have rescued the relevance of investment in physical and human capital. Technological innovation no longer appears as the exogenous residual of Solow, but as a consequence of investment decisions that require a mark of institutional conditions and favourable economic policies. From this point of view, it is considered that in post-war Europe favourable circumstances favoured investment in physical and human capital and permitted the realisation of the huge growth potential that offered the technological backwardness of European countries with respect to the United States.

In parallel, empirical studies that analyse income differences among countries stands out the different investor behaviour of the countries and point out the relative price of capital goods as a key determinant of investment. It has been observed that in low income countries, the prices of capital goods are comparatively higher than in higher income level countries, and that these differences could explain the lower real investment rates in poor countries.

Most of the literature, although following very different approaches, coincides in standing out the importance of the increase of the investment in the explanation of the growth of European nations after the II WW. It would be convenient to analyse the weight of different factors in this investment boom, and in particular, the real cost of investment. In most countries, empirical researches about investment decisions suggest that the real investment is sensitive to changes in user cost of capital.

Although for the investment boom of the 1990s in most advanced countries, like United States, traditional aggregate econometric models completely fail to capture the magnitude of the investment when investment became more sensitive to the cost of capital. They show that aggregate models do not capture the increase in replacement investment associated with compositional shifts in the capital stock towards high depreciation assets, like computers. And aggregate models find little or no role for the real user cost, so do not pick up the strong effects of relative price declines on investment in computers<sup>1</sup>. These works find that a disaggregated approach, which model investment in separate kinds of capital goods, explains better the behaviour of investment. In the period analyzed Europe made a great effort in investment in machinery and equipment that embodied new technology. There was an important compositional change in investment towards machinery and equipment in spite of other capital goods. For this reason, aggregate approaches to investment possibly not capture the magnitude of the changes operated during this years that lead to a decline in the costs of capital.

However, the empirical literature about economic growth and investment only contemplates the relative prices of the capital, and not the user cost, as appears in the theoretical models on investment. In these models the user cost of capital represents the actual cost of the investment that consists not only of the relative price of replacement of capital goods, but also of the financial costs and the cost of depreciation of the asset: the nominal interest rate reflects the financial market conditions, and the depreciation rate reflects the obsolescence of capital goods. If the replacement cost is also expressed in relative terms with regard to the price of the other goods, you can capture the economic obsolescence caused by technological change.

The article has two main goals. First, it makes a disaggregated analysis of investment, to estimate the relevance of the investment in machinery and equipment, and especially of the sensibility of this type of goods to the cost of capital. Second, it analyse the different components of the user cost of capital. This analysis wants to contribute with new evidence to assess the exceptional conditions of economic stability that converged in Europe during these years and that favoured investment growth. In the user cost of capital are synthesized real and monetary conditions. In the monetary side the agreements of Bretton Woods favoured the exchange stability and with it trade and international movements of capital, besides favouring

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<sup>1</sup> Tevlin and Whelan (2000), for the United States. Bakhshi and Thompson (2003), for United Kingdom.

the convergence in the long term nominal interest rates. In the real side, the elimination of barriers to trade and the agreements with the United States favoured technology transfers through the capital goods trade that led relative depreciation of this type of goods in many European countries.

We find that, as has been stated by other economist and historians, there had a considerable dispersion of user cost of capital at the beginning of the Golden era of growth over the quarter century after 1950. This dispersion, however, narrowed considerably until 1965 and, afterwards, the convergence forces stopped. We also find a downward trend in the relative prices of capital-goods, and especially in equipment, that drove the reduction in user cost disparity. We argue that the integration of physical and financial capital markets is the main reason for the reduction in divergence. Finally, we show that countries with relatively high capital-goods user cost undertook relatively low rates of investment, implying that such cost differences had important growth implications.

## 2. User cost of capital and its relevance in investment decisions

In the last decades a numerous literature has established a robust link between the relative price of capital and economic growth. Jones, for example, uses data underlying the Penn World Tables to argue that “an increase in the relative price of machinery reduces capital accumulation and therefore reduces the growth rate of the economy”<sup>2</sup>. However in this relationship a decisive link has been lost. As Collins and Williamson write “Per capita income growth depends to a large extent upon capital accumulation, accumulation depends upon investment and the investment decision hinges on a comparison of capital’s user cost with his marginal product.”<sup>3</sup> The substitution of the capital’s user cost for the relative price of capital goods could be an omission that matters.

The user cost of capital is determined by a combination of conditions in financial capital markets and in physical capital markets. The real user cost is given by the Hall-Jorgenson formula<sup>4</sup>. The user cost expression is derived under profit maximisation using the capital accumulation identity and the assumption of no adjustment cost:

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<sup>2</sup> Jones (1994), p. 372.

<sup>3</sup> Collins and Williamson (2001), p. 59.

<sup>4</sup> Jorgenson (1963) and Hall and Jorgenson (1967).

$$W = \int_0^{\infty} e^{-rt} R(t) dt \quad [1]$$

Where  $r$  is the interest rate and  $R$  the net income defined as,

$$R = pQ - sL - qI \quad [2]$$

Where  $p$  is the price of output,  $s$  the salary,  $q$  the price of capital,  $Q$  the output,  $L$  represents the quantity of labor and  $I$  the rate of investment. The maximization of the net value under the conditions of a neoclassical production function and the restriction that capital stock growth is equal to the investment less the depreciation drives to the conditions of marginal productivity,

$$\frac{\partial Q}{\partial L} = \frac{s}{p} \quad [3]$$

$$\frac{\partial Q}{\partial K} = \frac{c}{p} = \frac{q(r + \delta) - \dot{q}}{p} \quad [4]$$

The numerator of the second fraction is the well-known user cost of capital. It represents the implicit rent of a capital unit for a period of time, for example one year. This result can be explained with simplicity. We suppose that a company buys a capital good in the period  $t$  at a price,  $q_t$ . In the following period, the company sells the capital good for a price  $q_{t+1}$ , without installation costs neither transaction costs. The result of the use of the capital good is an increment in the production,  $PMK$ , similar to its marginal productivity,  $pPMK$ . The depreciation forces the company to restore  $\delta q_t$  capital units to replace the units lost by the use. The investors want to receive a remuneration of  $r$ . The present value of the derived revenues of the capital will be  $-q_t - q_{t+1} [(pPMK) + q_{t+1}] / (1+r)$  that should be equated to zero for the marginal investments. Fixing the expression obtains  $(pPMK) = q_t[r + r - (q_{t+1}/q_t)]$ , where the last term represents the losses or earnings in the value of the capital good due to changes in its market price.

In the empirical works, as Chirinko argues in a comprehensive survey on investment models, "it appears that investment is most sensitive to quantity variables (output or sales) with price

variables having only modest effects”<sup>5</sup>. This could contradict the common results obtained in the literature on economic growth that find a relevant role for prices in the investment behaviour. Aggregate models invariably find little or no role for the real user cost of capital, so they understate the positive effects of the falls in the relative prices of equipment on investment<sup>6</sup>.

In the rest of the paper we are interested in estimate the effects of the user cost of capital in investment decision.

### 3. Stylized facts

#### 3.1 Investment rate and its composition.

Once finished the phase of recovery to the Second World War, the growth of the western economies continued to a quick rhythm. In different works it has been insisted in the existence of a narrow correlation between growth and the increase in the investment rate in the GDP during the fifties.

We have constructed series of investment and their components for diverse European countries the USA and Canada for the period 1950-75 based on the OCDE figures. The information contained here contributes with new evidence in favour of the relationship between investment and economic growth. It can be observed in table 1, the investment growth in 1950-75. The rate of investment increased in these twenty-five years around 4.5 percentage points, although huge differences are appreciated among countries. The expansion was positive in all the European countries, being those of lower income level, as Spain, Portugal, Ireland and Greece, those that registered the highest increases while the United States maintained an inverse relationship. In table 2 the same evolution can be observed in machinery and equipment.

The relationship between investment and growth can be observed in a naïf way in figure 1 where the investment ratio is graphed against the rate of growth of GDP per capita along the period 1950-1975. The points that represent the highest rates of growth and the biggest investment rates correspond to the European countries with smaller income level per capita (as Spain), and those with a quick recovery after the war (as Germany). In the opposite side, they are some Nordic countries, as Denmark and Norway whose high investment rates belong

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<sup>5</sup> Chirinko (1993), p. 1883.

<sup>6</sup> Bakhshi, Oulton and Thompson. (2003).

together with a very moderate growth of the GDP and with a productive structure very slanted toward very intensive goods in capital.

In table 3 we have tried to validate this relationship through an econometric exercise by regressing the growth of GDP per capita on investment in equipment and machinery on the initial level of GDP per capita (to capture the possible convergence of the followers countries to the technological leaders), the population's rate of growth (to pick up the necessities of amplification of the capital stock) and the participation of the investment in non residential construction on the national product (to control the increment in the productivity caused by other forms of capital accumulation different from the team goods) . As it can be observed, the results confirm the robustness of the relationship among the growth of GDP per capita and investment. An increment in the standard deviation of aggregate investment will cause an increase in the growth rate of the GDP per capita of 0.45%. If we separate for components of the investment, machinery and equipment still has a stronger relationship with the growth of the rent per capita, because an increment in its standard deviation causes an increment in the rate of growth of the output per capita of 0.6%.

## Cuadro 1

## Investment rate

	1950-1954	1955-1959	1960-1964	1965-1969	1970-1974	Increase
Austria	22,67	24,82	25,18	25,89	27,82	5,15
Belgium	21,86	22,60	23,39	24,21	22,17	0,31
Denmark	21,12	19,89	21,36	23,68	25,05	3,93
France	17,92	18,94	19,05	21,98	23,96	6,04
Germany	20,83	22,87	23,89	22,71	24,38	3,55
Greece	16,70	18,80	23,47	26,61	30,35	13,65
Ireland	17,56	16,27	18,74	23,74	26,96	9,4
Italy	22,80	25,49	27,03	23,24	22,85	0,05
Netherlands	21,12	23,23	23,63	26,47	25,19	4,07
Norway	26,48	28,01	27,68	27,94	29,95	3,47
Portugal	18,62	20,71	24,48	25,96	26,73	8,11
Sweden	21,27	21,93	23,15	24,54	23,38	2,11
United Kingdom	14,79	16,36	17,86	20,08	19,85	5,06
Canada	21,69	23,73	20,65	22,38	22,05	0,36
USA	23,78	22,74	20,38	20,68	20,58	-3,2
Spain	17,46	18,20	20,27	26,02	26,68	9,22
Average	20,42	21,54	22,51	24,13	24,87	4,45

Source: OCDE Historical Statistics

Table 2

## Investment Rate in machinery and equipment

	1950-1954	1955-1959	1960-1964	1965-1969	1970-1974	Increase
Austria	9,33	9,62	10,05	9,88	10,84	1,51
Belgium	7,42	8,50	6,17	6,56	6,55	-0,87
Denmark	6,57	6,65	8,06	8,76	9,21	2,64
France	5,81	6,20	6,82	7,34	9,07	3,26
Germany	9,76	11,38	10,40	10,96	9,03	-0,73
Greece	7,05	7,18	9,75	12,69	9,22	2,17
Ireland	4,85	4,80	6,05	7,74	8,89	4,04
Italy	8,19	8,84	9,53	7,31	8,66	0,47
Netherlands	6,06	7,94	8,25	8,54	8,81	2,75
Norway	16,52	18,23	15,84	16,04	13,77	-2,75
Portugal	5,91	6,08	8,86	9,78	12,32	6,41
Sweden	5,91	5,87	6,67	6,55	6,84	0,93
United Kingdom	5,86	7,28	8,07	7,91	8,35	2,49
Canada	6,96	6,67	5,96	7,20	7,60	0,64
USA	6,12	5,63	5,10	5,94	6,88	0,76
Spain	4,43	4,92	6,83	8,37	8,85	4,42
Average	7,29	7,86	8,27	8,84	9,05	1,76

Source: OCDE Historical Statistics

Table 3

## Investment and GDP growth

	(1)	(2)	(3)	(4)
Ln GDP per capita initial	-0.01621 (-11.16)	-0.01611 (-11.21)	-0.0176 (-12.41)	-0.01637 (-12.05)
Population growth		0.0008 (0.0042)		
Machinery and equipment	0.1992 (4.89)	0.1939 (4.28)	0.1941 (4.69)	
Non residential construction			0.1236 (3.05)	
Investment total				0.1142 (16.24)
Constant	0.14791 (11.02)		0.1549 (11.80)	0.1418 (11.24)
Observations	45	45	45	45
R <sup>2</sup>	0.84 (0.48)	0.85 (0.46)	0.86 (0.47)	0.93 (0.52)
Summary Statistic: Mean and standard deviation (in parentheses)				
GDP growth	0.0.076 (0.01359)	Population growth		0.0066 (0.00502)
LN GDP per capita initial	8.32099 (0.5753)	Equipment		0.08994 (0.03050)
Non residential construction	0.04370 (0.01595)	Aggregate investment		0.22628 (0.0398)

Notes: The dependent variable is the growth rate of GDP per capita. Estimation by GMM. R<sup>2</sup> not corrected in parentheses.

Figure 1

Investment rate and GDP growth, 1950-1973

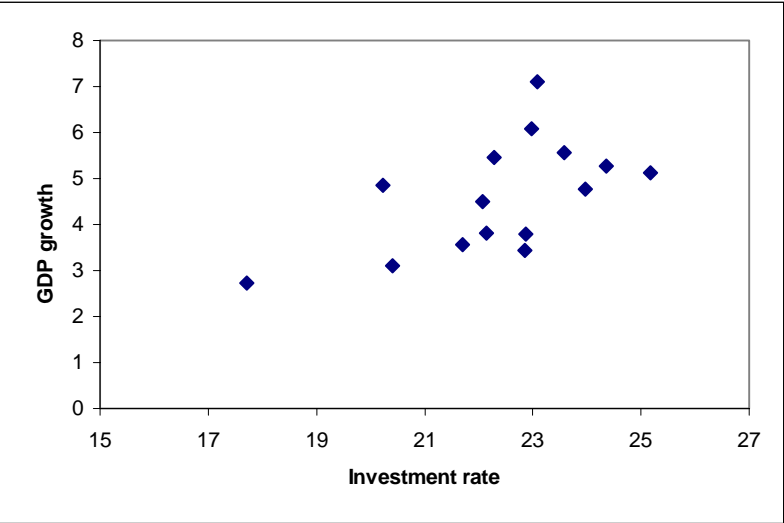
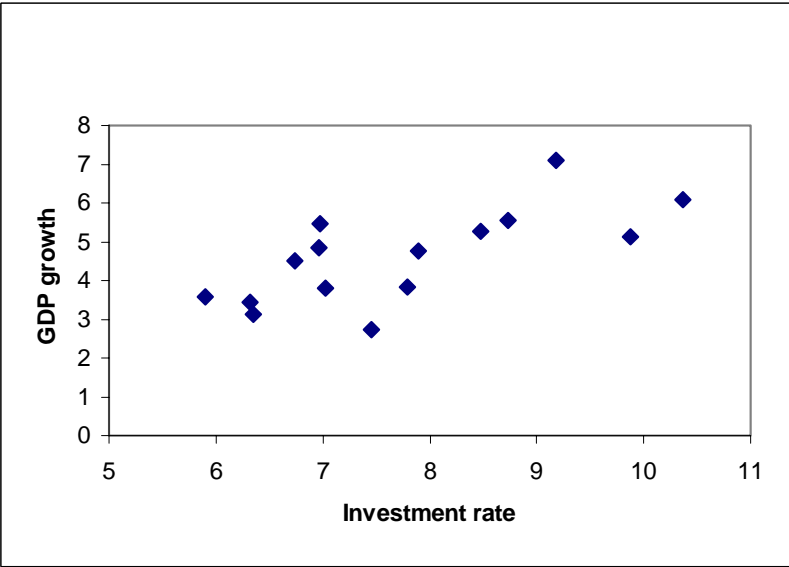


Figure 2

Investment rate in machinery and equipment and GDP growth, 1950-1973



### 3.2. The user cost of capital and its components

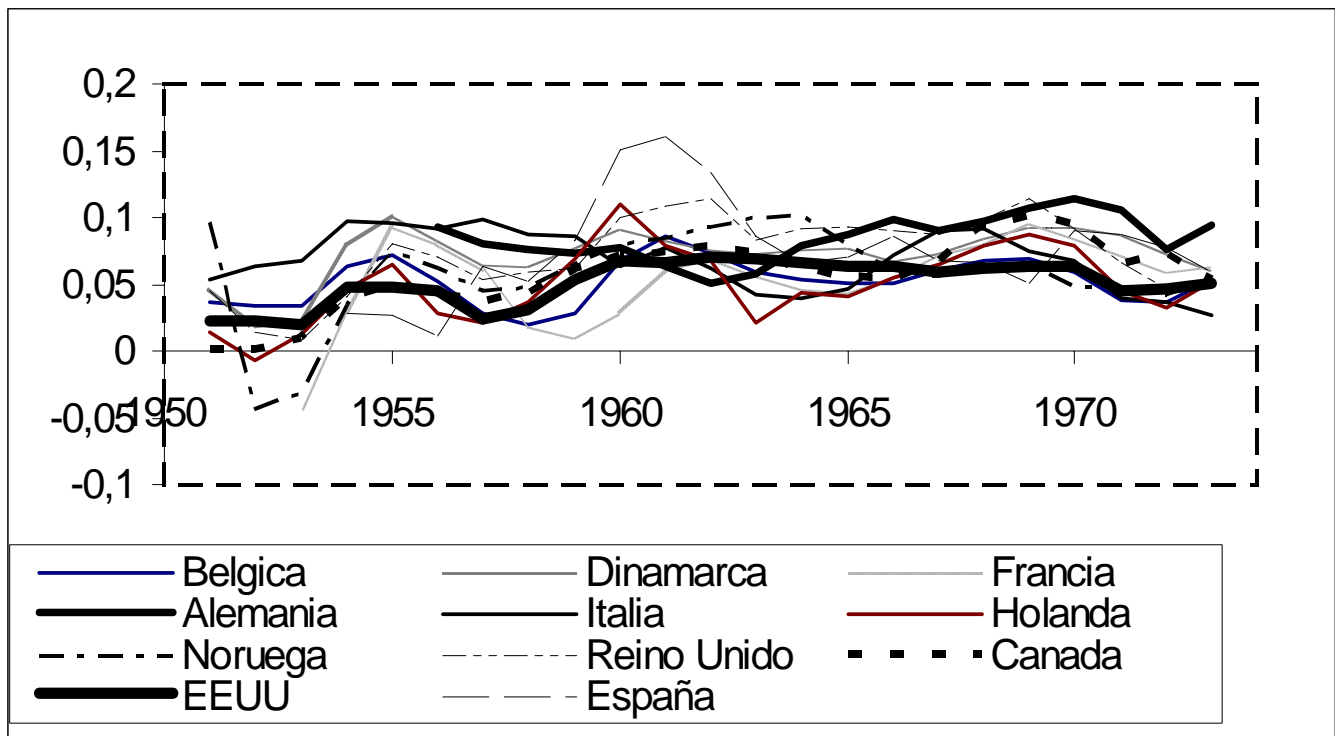
Figure 3 shows our estimates of the real user cost of capital, as defined in equation (4), for aggregate capital goods and, at a more disaggregate level, for machinery and equipment. Only in the case of machinery and equipment we can find evidence of a downward trend along the sixties, and not for all the countries. This trend was more pronounced for less developed countries as Spain and Norway.

Since the series of the user cost of capital are expressed in internationally comparative levels, it would be interesting to verify if the negative association between income level and relative prices of the machinery highlighted by the literature, also leads to a similar association between income level and the user cost of machinery, since the replacement cost, measured by the relative price of capital goods, is the main determinant of the cost of capital. According to this, it can be observed as the lowest user costs correspond to the most developed country, the United States, while the highest costs were reached in the less developed countries of Europe, occupying an outstanding place Spain whose costs were in 1954 more than double the average and they quadrupled those of the United States.

However, the negative association between user cost of capital and income level is not so clear in the case of the investment in non residential construction. It can be observed, as between the countries with lower user cost stands, besides the United States, some of the less developed countries in the sample like Spain; while the highest costs correspond to United Kingdom, Denmark, France and Norway.

If we look at the evolution of the user cost of equipment (figure 3), most of the period was characterized by a progressive convergence to the lowest level in the United States. From the mid of the sixties it seems to stop the period of convergence, and there is a spread of the series to continue in parallel with the upward trend of the United States characterized from 1965 by a growth rate of 0,5%. The evolution of Spain, a less developed and protectionist country at the beginning of our period, reflects what we expect to be a general pattern between backward countries: a high level of departure and a quick fall along the whole period to converge to the lower levels of the remaining countries, although in 1973 the opportunity cost of investing in machinery continue being the highest of the whole sample.

Figure 3 .User cost of machinery and equipment, 1951-1973



Regarding the non residential construction, an elevation of the user cost can be seen until the middle of the fifties, and from then on until the mid of the sixties an uninterrupted descent in most of the countries. Again, it is prominent the behaviour of the Spanish costs, so much for the speed of their growth up to 1956 as of their later descent starting from then.

Expressed in logs, these estimates of the user cost of capital are the sum of two components: the relative price of capital, and a non-relative price component. The first component is simply the price of capital relative to the price of output. The second component conflates the cost of finance, depreciation and capital gain. In appendix 3 we represent the decomposition of the user cost of machinery and equipment for all the countries of the sample.

Even looking within specific categories, the cost of capital combines components that appear to have very different properties. The relative price of equipment has a very persistent

downward trend, but the relative price of non-machinery goods seem to be relatively stable. The non price components for both variables seem to be relatively stable, with an upward trend after 1965. The graphs show an upward trend of user cost past 1966. Since then the cost of capital goods is lead by the non price components, specifically by increases in the interest rate.

There are reasons to believe that the price and non-price components of the cost of capital have different properties. The pattern of declining relative prices for equipment comes from technological innovations in the equipment- industries in general<sup>7</sup>. The vigorous openness to foreign trade and market integration that experienced Europe also contributed to this decreasing trend in the relative prices of capital goods<sup>8</sup>. At the beginning of the fifties all countries have machinery and equipment relative prices higher than the United States. Until 1966, the rate of growth of the relative prices of machinery and equipment was lower than in the United States. Some countries as Spain since 1959, France, Italy, Norway and Denmark, experienced clearly a decreasing trend. Possibly the pressure of demand on the main capital exporter countries could explain the increasing prices in United States, Germany or Great Britain<sup>9</sup>. In the remaining countries the decline in relative prices was guided by trade liberalization and favourable conditions to international relationships<sup>10</sup>. The decreasing trend in the relative prices of machinery and equipment was general after 1966. This evolution could be associated with the biggest advance in the productivity in the machinery industries in front of those of consumption. But also with a relative rise in the price of the consumption goods, because you is arriving at the end of a stage of strong growth, in the one that the increase of the employment and the growth of the salary rents, as well as the development of the sales to term of durable goods, they exercised a strong pressure on the consumption.

Spain presents the most surprising evolution, because relative prices were 2.32 times those of the United States in 1954. This means that, keeping in mind the enormous difficulties for the capital foreign capital inflows and for investment in Spain, the Spanish economy would have had to make a very superior effort than the rest of countries to finance the same real

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<sup>7</sup> Hulten (1992).

<sup>8</sup> Eaton and Kortum(2001), modelize the relationship between relative prices of capital goods and the development of trade in capital goods. They demonstrate that less developed countries import capital goods from a selected bulk of most advanced countries and that the imported goods affects negatively to the relative price of capital in less developed countries.

<sup>9</sup> Eaton y Kortum (2001), show that exports comes from a reduced sample of advanced countries.

<sup>10</sup> Taylor (1998) argues that in Argentina barriers to trade increased the relative price of capital goods. We also think of a similar pattern in Spain.

investment. At the end of the period the Spanish prices were only 20 superior percent to the North Americans. This allows standing out the importance that opening to foreign imports of machinery and to the influx of foreigner capital.

In contrast, real interest rates will, in the long-run, be related to the marginal productivity of capital, which will be a stationary variable in any general equilibrium model, as was the case in Europe at the end of the period considered. European long term interest rates were characterized from the middle of the fifties by their convergence with the North American rates, because they grew slower. Some countries, as Spain and France, even experienced a descent in absolute terms of their nominal interest rates. This evolution of the interest rates seems to be a consequence of the commitment to exchange rate stability in the international monetary system. The zeal to keep this commitment helped to the control of inflation in the post war period Europe and with it to the reduction of the differentials of interest rates with the United States. This would be positive, without a doubt, in favour of the investment in Europe. But in the second stage, once stabilized the European types of interest around the North Americans a tendency is observed to grow in parallel to a superior rate to that of the precedent period, of 4.01% in 1965-1973 against 1.78% in 1951-1965. The long term factors, after a period of strong growth of the investment seem to be imposed.

We could conclude that during the considered period the user cost of equipment experienced a very moderate growth in all the countries of the sample, even more moderate in less developed countries. This fact was more remarkable in the second half of the period, caused by the depreciation of the relative price of the capital goods, because the nominal types of interest of long term were achieving higher levels.

Table 5

## Decomposition of the determinants of the user cost of capital

(Average rates of cumulative annual growth, in %)

1951-1965					
	Equipment			Other capital goods	
	Financial cost	Relative price	User cost	Relative price	User cost
Spain	-3,12	-0,57	-2,12	0,88	1,73
Italy	0,91	-1,05	-0,69	0,52	1,51
France	-1,53	-0,06	-0,63	0,18	-0,39
Denmark	2,59	-0,91	0,05	2,21	7,22
Netherlands	2,52	0,30	1,09	1,40	1,77
Germany	0,06	1,41	1,44	2,16	2,97
Belgium	2,42	0,62	1,47	1,58	2,76
USA	3,59	0,75	1,64	-0,04	1,35
Norway	4,37	0,62	1,79	1,61	2,63
United Kingdom	4,30	0,44	1,84	1,20	2,09
Canada	3,47	1,27	2,28	-1,08	-1,83
Average	1,78	0,26	0,74	0,96	1,98
1965-1973					
	Financial cost	Relative price	User cost	Relative price	User cost
Netherlands	4,45	-2,56	-0,86	2,45	3,21
Spain	3,23	-1,56	-0,03	2,90	5,43
Denmark	5,26	-2,35	0,06	0,50	2,77
France	5,76	-1,99	0,22	0,28	1,93
Canada	4,76	-1,56	0,22	1,86	2,22
Belgium	1,82	-0,47	0,27	2,20	3,97
Germany	3,73	-1,28	0,35	-0,14	0,83
USA	5,17	-1,34	0,36	2,58	5,49
Norway	2,73	-0,47	0,49	0,70	2,53
Italy	0,84	0,57	0,93	1,27	3,02
United Kingdom	6,33	-0,15	2,69	1,16	2,74
Average	4,01	-1,20	0,43	1,43	3,10

#### 4. User cost of capital and investment behaviour

As noted above, although the relative price of capital goods has been featured prominently in a number of recent cross-section studies on the twentieth century economic growth, the price variable that matters in investment's decisions is the user cost of capital. Following the methodology employed by Jones, Restuccia and Urrutia and Williamson and Collins, we offer an empirical assessment of the link between the user cost of capital and investment rates in Table 5. We use the investment rates rather than the change in capital stock (a truer measure of capital accumulation) because disaggregated capital stock estimates are not as widely available as investment estimates. The investment share in GDP is regressed on the log of GDP per capita, the user cost of capital goods (or machinery), and, in some specifications, the relative price of capital goods (or machinery) and the non price components of the user cost. We also include time period indicators. Each observation in the regression represents a particular country over one of the following five periods: 1951-1955, 1956-1960, 1961-1965, 1966-1970 and 1971-1973.

We have tried with different specifications of the user cost. The first one is the more complete and derives from the Jorgenson and Hall formula, is also the represented in the graphs of the appendix:  $u = (P_K/P_C)(r + \delta + \Delta P_K/\Delta P_C)$ . The second and the third are simplifications of this formula. The second discarding the appreciation of the relative price of capital-goods and the third using the nominal interest rate instead of the real interest rate, because the change in prices is already considered in the change of relative prices of capital-goods. The fourth specification assumes the existence of monetary illusion in the investors and substitutes the real interest rate for the nominal interest rate. This is the one we have used in the regressions. All others were tried, but the regressions were not well-fitted.

We find that the correlation between investment rates and the user cost of capital goods or equipment is in all cases negative and statistically significant, even after controlling for differences in levels of GDP per capita. According to Table 5, column 1, a one-standard-deviation in the user cost of capital goods is associated with a decline in the total investment share of 1.97 percentage points (an elasticity of  $-0.37$ ). According to Table 5, column 2, a one-standard-deviation in the user cost of equipment is associated with a decline in the equipment investment share of 1.56 percentage points (an elasticity of  $-0.49$ ).

Table 6

## Investment share and user cost of capital, 1951-1973

	(1)	(2)	(3)	(4)
User cost of capital-goods	-0.0088431 (-2,25)			
User cost of equipment		-0,002743 (-3,34)		
Capital goods price			- .0027069 (-4.59)	
Equipment price				- 0,0007188 (-4,29)
Non price component of user cost of capital goods			.001506 (0.35)	
Non price component of user cost of equipment				.0005292 (0.20)
Ln GDP per capita	-0.0217299 (-0,53)	-0.0430913 (-1.66)	.0226883 0.60	- .041243 (-1,53)
1951-1955	-0.0763536 (-2,02)	-0,04719 (-2.62)	- .0235466 -0.65	-0.0319089 (-1,39)
1956-1960	-0.0564605 (-1,93)	-0,0293573 (-2.07)	- .0117018 -0.42	-0.0170402 (-0.96)
1961-1965	-0.043578 (-1,93)	-0,0208843 (-2.06)	- .0078808 -0.37	-0.0089412 (-0.67)
1966-1970	-0.0175037 (-1,33)	-0.00894 (-1.42)	-0.00546 -0.47	-0.004567 (-0.64)
Constant	.433013 3,71)	0,2522085 (4,09)	.481717 3.37	.2637064
Observations	53	53	53	53
R <sup>2</sup>	0,17	0,27	0,09	0.19
Summary statistics: Mean and Standard Deviation (in parentheses)				
Investment rate	.26262 (.0480133)	.1084133 (.0407351)	.26262 (.0480133)	.1084133 (.0407351)
User cost	10.96601 (2.232182)	19.45054 (5.706795)		
Capital- good price			97.14239 (8.337757)	118.4008 (22.8359)
Non price components			11.26301 (1.970639)	16.26301 (1.970639)

Columns 3 and 4 decompose the user cost in its two components: the relative price of capital, and a non-relative price component. The first component is simply the price of capital relative to the price of output. The second component conflates the cost of finance and depreciation in the specification we are using in the regressions. As we suspected, the relevant variable is the relative price of capital-goods. The non price components is positively related to the investment share but the coefficient estimates is not significant. This is a result that also was found in Williamson and Collins and must be due to demand side forces that tend to raise investment and interest rates simultaneously or to problems with the international comparability of the interest rates, or both<sup>11</sup>. However, the influence of the relative prices in the investment behaviour is significant and persistent.

## 5. Conclusions

During the last decade a quite wide consensus in literature on economic growth has emerged about the factors that determine the differences in income levels between countries. One of the most stood out has been the differences in the rates of investment, being observed a positive association between income level and investment rates. Differences in relative prices of investment between countries has been emphasised as the main determinant of differences in investment rates.

In this work we have tried to improve the understanding of the determinants of the investment share between countries. In numerous works it depends on the relative prices of the goods of investment, but in this investigation the user cost of capital has been used as the representative variable in the decisions of investment, according to the neoclassic model of Jorgenson and Hall. The user cost of capital is a variable more appropriate than the relative prices of the capital, because it represents the cost of the services offered by capital assets, and therefore, the variable to which the investors pay attention when making their investment decisions. This article develops a data set that documents the user cost of capital-goods in 11 countries from 1950 to 1973. Some stylized facts seem to be robust.

First, the convergence in the investment rates observed in the European countries during the post-war period finds its reflection in the convergence in the user costs of capital goods. Second, the reduction in the dispersion of user cost is driven by relative price of capital goods

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<sup>11</sup> Williamson and Collins (2001)

and by the nominal interest rates convergence until the middle of the sixties. The behaviour of both variables was due to the exceptional frame of international relations that was developed in western countries in the years after World War II. Besides the traditional argument of the integration of the international markets, that caused the narrowness of the dispersion of relative prices of capital goods, and specially equipment, in this work it is show that also the integration of the financial markets was important for the convergence in nominal interest rates.

With this new data in hand, the remainder of the article pursues to ask whether the user cost of capital goods had a significant impact on investment. The answer is yes: at times and in places where the use of capital were relatively expensive, investment rates were relatively low. This finding expands the many articles that confirm the connection between investment rates and investment-goods prices. The impact of the user cost of capital-goods is statistically significant and economically powerful.

#### APPENDIX 1. Backing out investment in capital goods and machinery and equipment until 1950 in international comparative levels

The data used in this work come from the calculations carried out for the International Comparison Program (ICP) of the United Nations. The objective of the ICP is to allow the international comparison of real products and capacity of purchasing power of the currencies. The ICP is broadly well-known since it provides the basic data for the construction of the PENN World Table. The ICP provides data for a wide range of products, offering its values in national currencies and in international dollars<sup>12</sup>.

Studies carried out previously have used the Penn World Table to establish the relationship between prices of the capital goods and economic growth. De Long and Summers (1991) document the relationship between investment in machinery and equipment and GDP per capita using the PWT data and the decomposition that the ICP allows. Jones (1994) use the benchmark years from the ICP to establish the relationship between investment rate and relative prices of the capital goods for a wide group of countries in 1980. Recently, Restuccia and Urrutia (2001) and Collins and Williamson (2001) have built estimates of the evolution of

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<sup>12</sup> Kravis, Heston and Summers (1982)

the relative prices of different classes of capital goods for different time periods achieving the same conclusions.

For this study it has been built a database of relative prices of the capital goods and different disintegrations and of other macroeconomic variables for a group of 15 countries of the OECD for the period 1950-1982. The countries included in the sample are Germany, Austria, Belgium, Canada, Denmark, United States, Spain, France, Greece, Great Britain, Holland, Ireland, Italy, Norway and Portugal. Starting from the disaggregated data offered by the ICP for 1980, we have built series of the relative prices of the Gross Domestic Capital Formation and their main components: Residential Construction, Non Residential Construction and Machinery and Equipment. Also we have built series of GDP per capita, and Gross Domestic Capital Formation and their main components at 1980 international dollars.

The series have been built starting from the 1980 data. The ICP offers prices on international dollars for this benchmark year of a wide group of products. To estimate the evolution of prices and product we have used data from national accounts of each country. Data from OECD's Main Economic Indicators has allowed building real and nominal series of the GDP and its components for the 15 countries of the database. Later on the implicit deflators have been calculated for all the variables. The rates of growth of those deflators have been employed to calculate the prices in international dollars for the period 1950-1982<sup>13</sup>. The relative levels of prices of the capital goods have been built by dividing the deflators of these variables into the deflator of the consumption<sup>14</sup>.

We wanted to use a benchmark year not far from the beginning of the series to reduce the bias in the prices that appears as we go moving away from the initial year. 1980 are the benchmark year third phase of the ICP, being 1970 and 1973 the benchmark years of the two previous phases. The number of participant countries in the study has been growing in each successive phase. The first year in which we meet with a significant number of European countries of different income levels is 1980<sup>15</sup>. Therefore our election of the benchmark year to build the series has been determined by the readiness of an enough number of countries.

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<sup>13</sup> More specifically, we take the 1980 benchmarks from United Nations (1987) and then we calculate the implicit price deflators from 1948 to 1982 using nominal and real series in Main Economic Indicators.

<sup>14</sup> Consumption is used as a measure of the output good instead of GDP because the GDP price index includes investment prices.

<sup>15</sup> Spain appeared for the first time in 1975 and Portugal in 1980. Sweden, however, entered in 1985.

*APPENDIX 2. Constructing the user cost of capital and machinery and equipment by countries in comparative levels, 1950-1975*

The annual series of cost of use of the capital, expressed in international prices have been constructed for each country taking as reference the purchasing power parities in 1980 of the International Comparisons Programme (ICP) of the United Nations. The objective of the ICP is to make possible the international comparisons of the real product and to establish purchasing power parities between the currencies of different countries. They are the basic reference of the Penn World Tables (PWT)<sup>16</sup>.

The information contained in the Penn World Tables, although widely used by other authors<sup>17</sup> in order to analyze the relation between the relative price of the capital assets and the economic growth, was insufficient to cover the objectives of this work. First, the PWT only provide data from 1960 on, and they do not allow covering the analysis of investment in the previous decade. Second, its level of disaggregation did not allow analysing the investment in machinery during post-war period. On the other hand, in the present work it was tried to turn aside attention from the relative price of the capital to its cost of use, which is the variable of reference in the theoretical models on investment and that allows us, in addition, to emphasize the effect of the integration of the financial markets on post-war period investment.

In order to take care of all these aims, we have constructed an annual series of the user cost of capital goods, and of its main components, like the investment in machinery and equipment and non-residential construction, for 11 countries of the OECD from 1950 to 1973. The countries included in the sample are Germany, Austria, Belgium, Canada, Denmark, The United States, Spain, France, Great Britain, Netherlands, Italy and Norway. First we have assembled annual series of prices from the OCDE statistics. Second, we have used the benchmark data from the ICP for 1980 to build a comparable estimate for the relative prices of capital goods. Third, we have constructed an annual series of relative prices of capital goods and its components, discounting retrospectively the rates of variation of implicit price index of the investment and the consumption, extracted from the National Accounting of each country. The prices of the capital have been expressed in relation to those of consumption, and not with respect to the GDP, because the investment is a component of this one.

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<sup>16</sup> Kravis, Heston and Summers (1982)

<sup>17</sup> De Long and Summers (1982), Jones (1994), Restuccia and Urrutia (2001), Collins and Williamson (2001)

We tried to establish the benchmark year the nearest to the year of beginning of the series, with the intention to reduce biases derived from the problem of the index numbers, but finally we had to use 1980, because the previous benchmarks, 1970 and 1975, included a reduced number of countries.

Once constructed the annual series of the relative prices of capital goods expressed in comparative levels internationally, we proceed to elaborate the cost of use of the capital. The expression that gathers the cost of use from the capital it has been derived in the previous section:

$$U = (q/p) (r + \delta - \dot{q}/p)$$

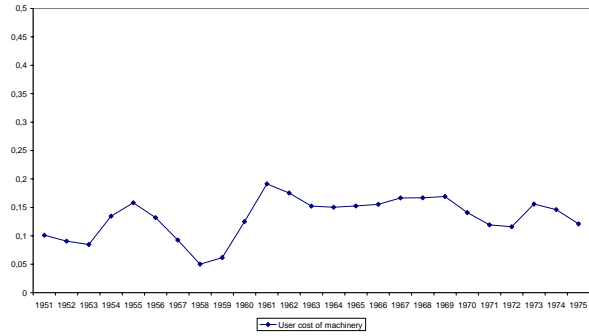
where  $u$  it is the cost of use of the capital,  $q/p$  the price of replacement of the capital assets expressed in relation to the prices of consumption,  $r$  is the real interest rate in the long term,  $\delta$  the rate of physical depreciation of the capital, and  $\dot{q}/p$  represents the revaluation of the capital assets. The nominal interest rate has been obtained for each country from the International Financial Statistics of the International Monetary Fund. With respect to the rate of depreciation, the same one has been applied to all the countries. We have considered an depreciation rate of 0.10 for the equipment and of 0.5 for the whole capital-goods.

The cost of use of the capital thus defined consists of two components: the cost of replacement of the capital assets,  $(q/p)$ , and the financial cost of investment, given a rate of depreciation. In the following section it will be analyzed how it evolved, as well as each one of its components in the considered countries from 1950 to 1973.

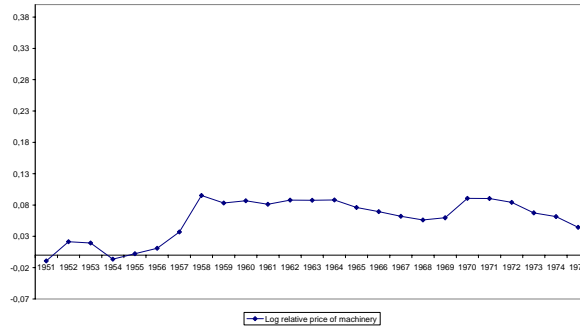
**APPENDIX 3.-**

**The components of the user cost of machinery and equipment by countries.**

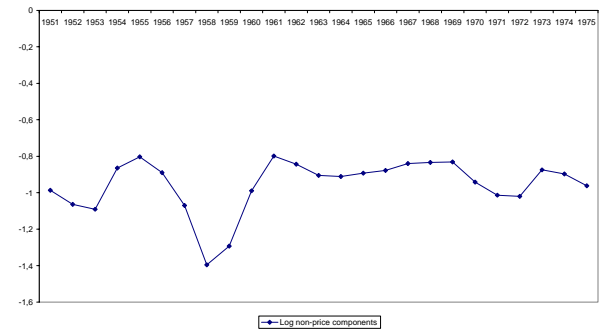
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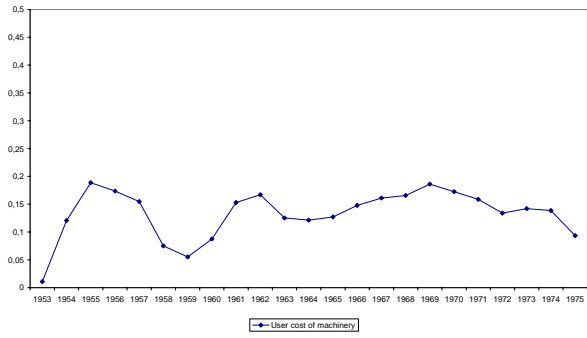
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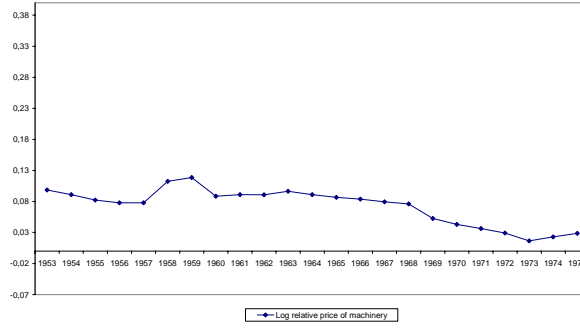
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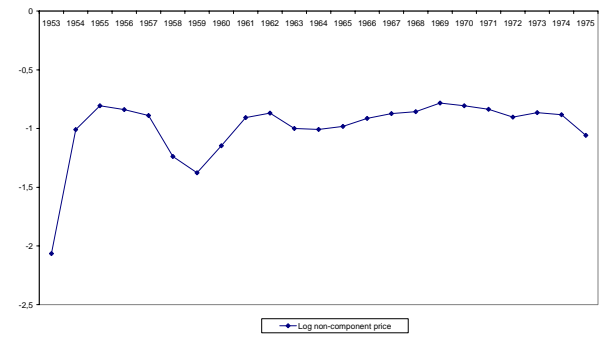
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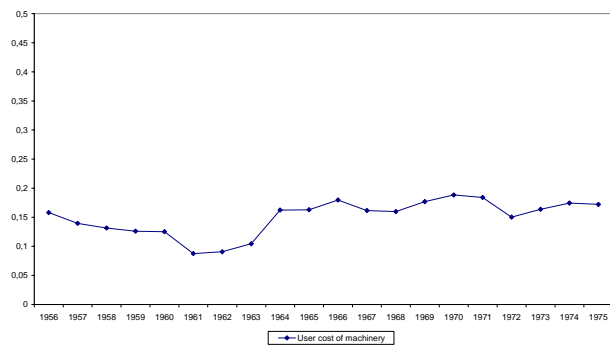
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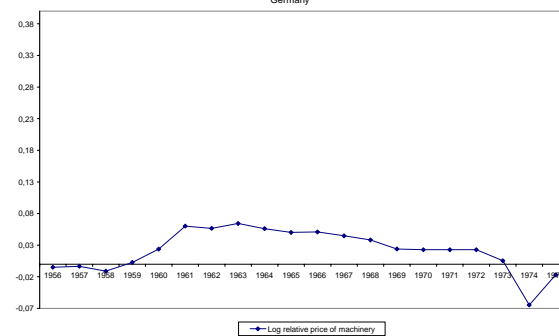
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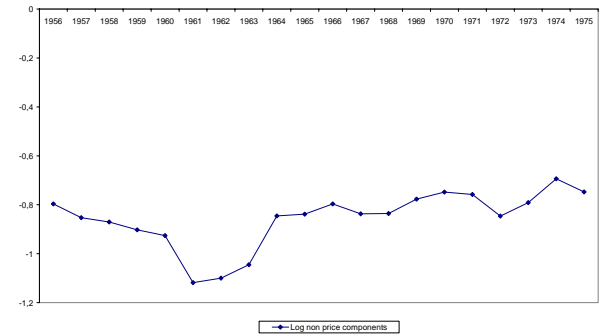
Germany

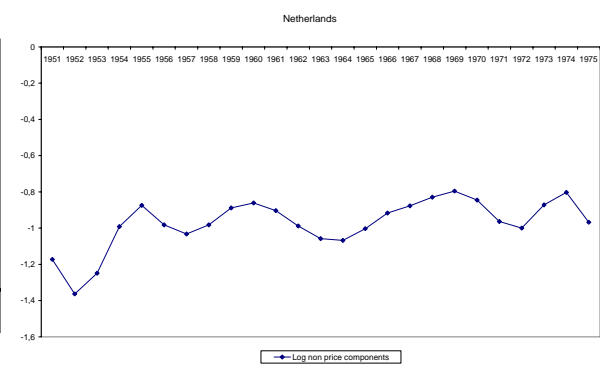
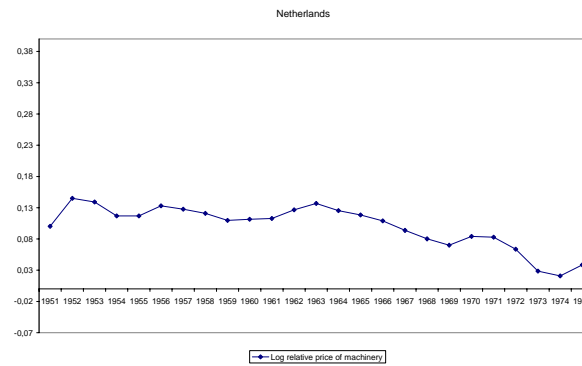
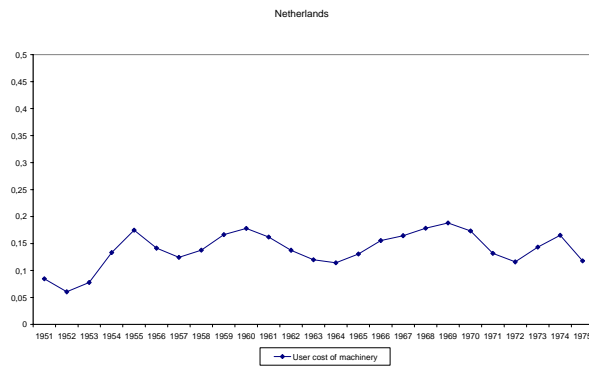
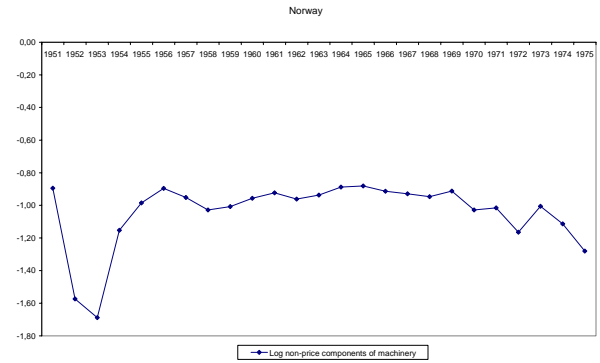
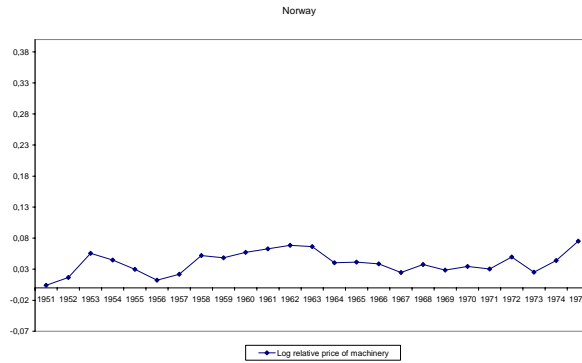
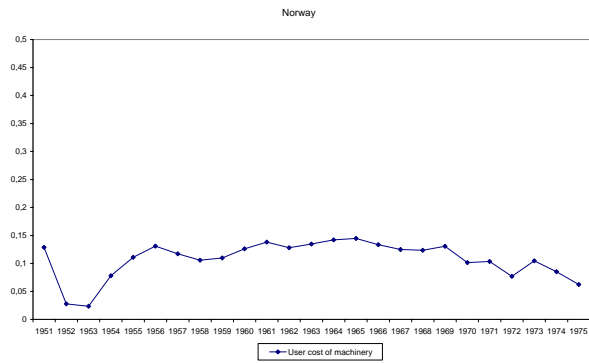
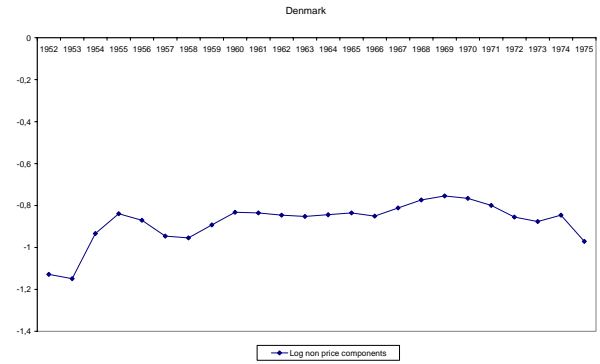
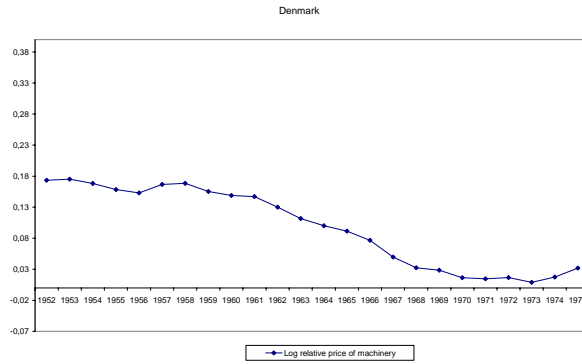
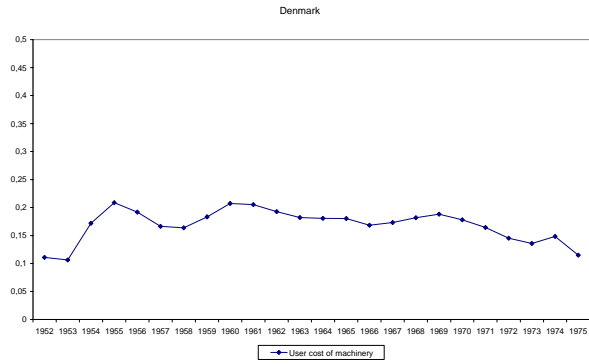


Germany

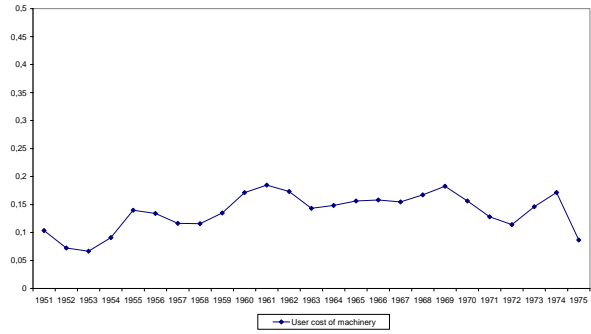


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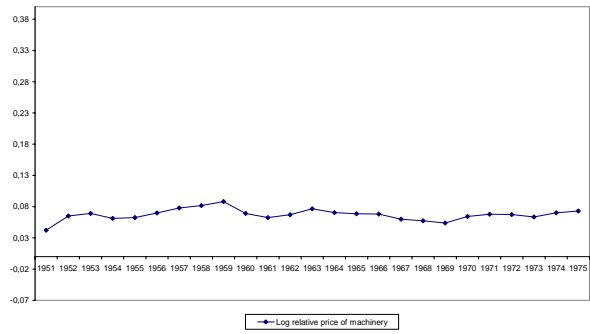




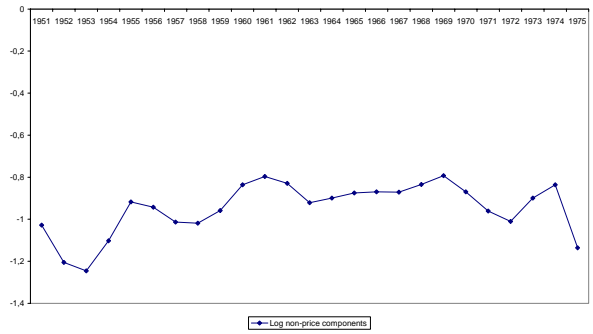
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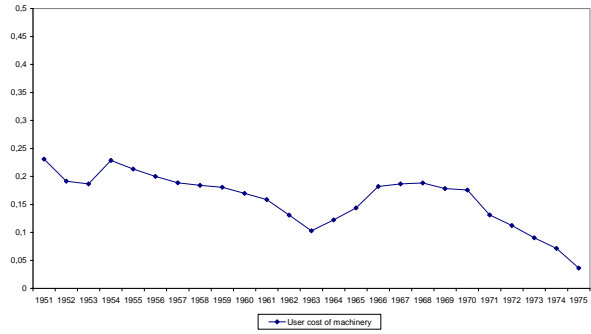
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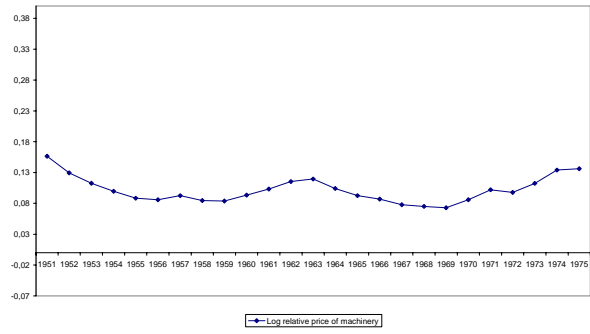
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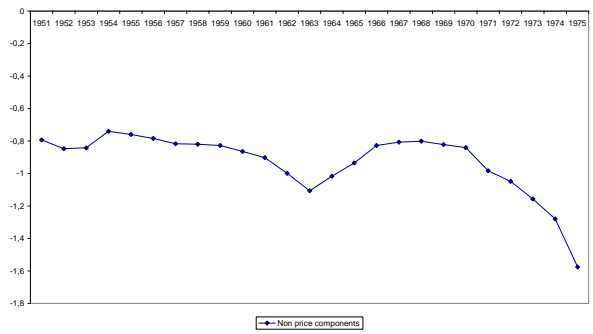
Italy



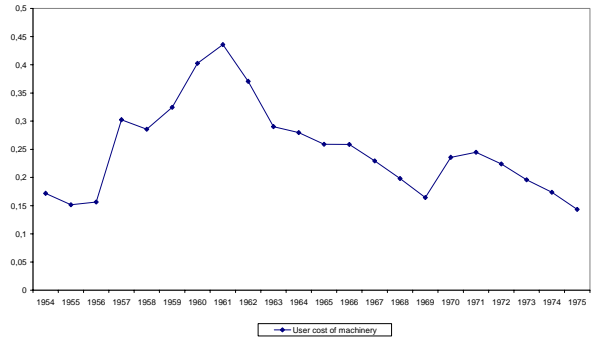
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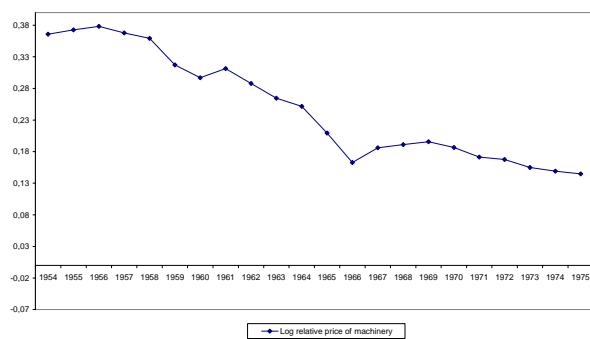
Italy



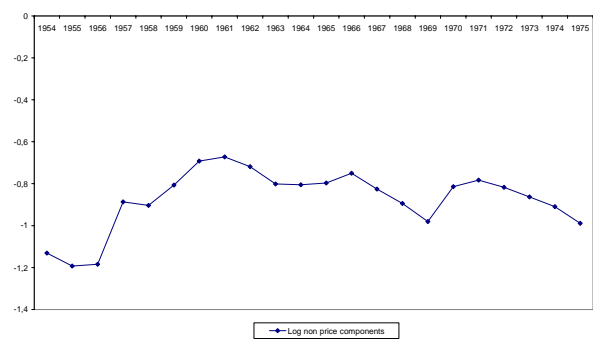
Spain



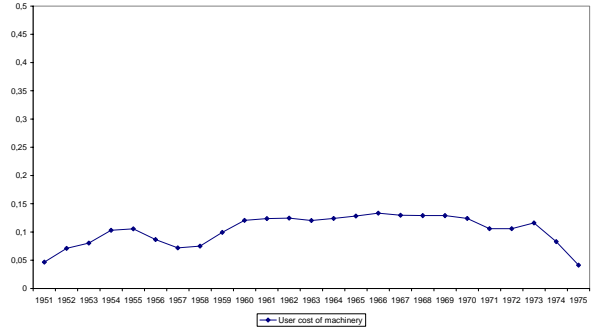
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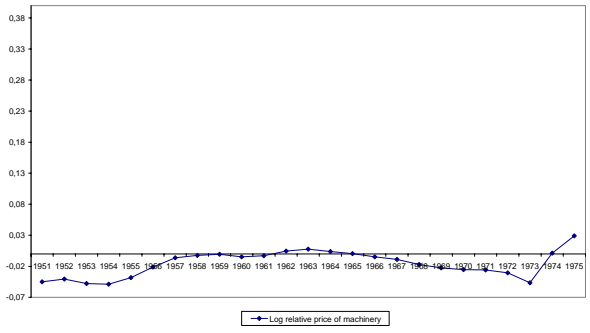
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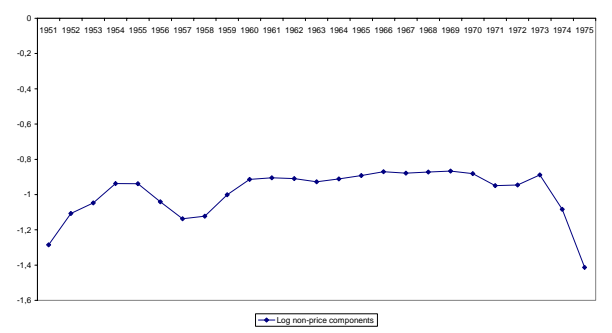
United States



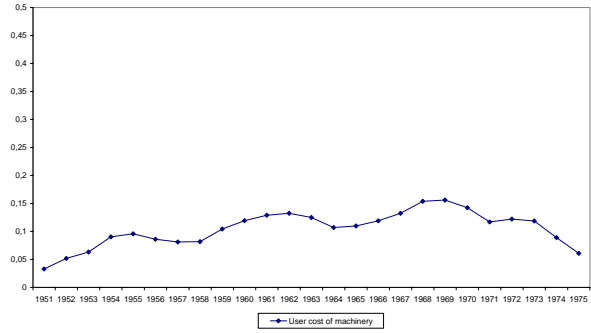
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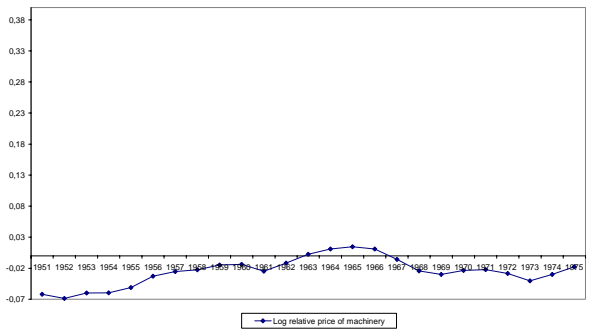
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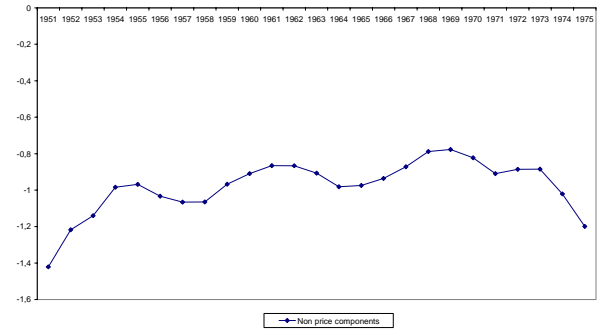
Canada



Canada



Canada





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