Human capital, economic growth and development

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HUMAN CAPITAL, ECONOMIC GROWTH AND DEVELOPMENT. NEW EVIDENCE.

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Abstract

In spite of the essential role conferred to human capital by endogenous growth theorists, various empirical approaches called into question these theories. Recently, Aghion and Cohen (2003) underline the fact that according to the degree of development of a country, the role of education is different. Following our preceding study on the European countries (Diebolt & Jaoul, 2004a; Jaoul, 2004a), the aim of this paper is to determine the type of relation existing between higher education and economic growth. We carry out a cliometric study aiming, on the one hand, to test the contributions of endogenous growth theories and, on the other hand, to highlight the assumption formulated by Aghion & Cohen i.e. the relation varies from one country to another according to the degree of development. Our article is articulated into three parts: after a recall of the theoretical framework (1), we present the data base and the methodology used (2). Then we discuss our empirical results (3) and finally we propose a new model explaining relationships between higher education and economic growth.

Keywords: Causality, Economic development, Economic growth, Higher education.

Classification *JEL* : C32, I21, N10, N30, O15.

INTRODUCTION

Today, education doesn't only concern the parents and their children or teachers and pupils, but its development became an element of survival of industrialized countries. In a context of strong international competition both at the economic level and in higher education, the organization and the quality of the system "higher education - research – innovation" became essential for developed economies. Modern societies confer to higher education much importance and the share of the national wealth which is devoted each year to this sector, summarizes the stake for governments of a correct use of such a mobilisation of resources[1].

Higher education, research, innovation, demography, technical progress..., are elements to which it has been conferred a role, more or less important, in the process of economic growth. If we cannot deny the role of higher education, there is still an evidence: even if the way by which it affects the economic growth are rather well known, we still do not know neither how knowledge affects the economic growth, nor which is the nature of the relationship between education and economy.

It's well known that growth affects all countries, but it affects them in an unequal way. Moreover, what is more surprising it is that within the same continent, like Europe for example, it appears in an irregular way in the long-run. In the middle of the XVIIIth century, Western Europe is characterized by a diffusion of the scientific spirit and by a commercial and financial capitalism. History shows that the starting point initially took place in the United Kingdom at the beginning of the XVIIIth century before extending to other countries.

The French economy take-off is later, on the one hand because France did not know the same agricultural revolution as England but especially because during nearly a quarter century, France knew a Revolution and many wars which mobilized human energies in sectors quite different from that of the production. In spite of the creation of first textile companies about 1830 and first railroad in 1845, it is only under the Second Empire that occured the explosion of the French economy with the development of the banking structure and the fast extension of the railroad network[2].

In fact, it is possible to release four periods in the evolution known by Western Europe:

- 1870 - 1913: period of great expansion characterized by an increase in growth rates.
- 1913 - 1945: phase of deceleration by the presence of two world wars and the great depression of the 1930s.
- 1945 - 1973: the golden age. The Thirty Glorious appears exceptional for two reasons: the rebuilding is fast and the growth accelerates.
- Since 1973: new deceleration of the growth related to the crisis of the Welfare state.

Unlike philosophers, for a long time economists were unaware of a possible influence of the knowledge in growth process because of the history of industrialization of modern societies. Indeed, during the first Industrial Revolution (1780-1880), the role of knowledge does not seem to be determining, inventions being the product of isolated and not educated

[1] In France, in 1974, the domestic expenditure of education represented 6,3 % of the GDP; it represents, in 2002, 6,9 % of this aggregate. Within this expenditure, the share represented by higher education is 16,3 % (Source: EPD).

[2] It goes from 1900 km in 1847 to 18000 km in 1870.

activities. However, during the second Industrial Revolution (1880-1970) the role of knowledge became essential.

If the relation education - economy is the subject of many economic studies, both at the theoretical and empirical level, the interest of political authorities to it, is relatively recent. In France, it is necessary to wait for the *"11ème plan"* for truly wondering about the relation between the education system and economic growth. Although education is today the first budget of the State (99,7 billion Euros *i.e.* 7,5 % of the GDP), its efficiency causes an essential question: does there exist really an organization of the education system supporting the economic growth process?

Since Adam Smith in 1776, and especially since the 1960s, great efforts to answer this question were formulated and gave rise to the theory of human capital (Mincer, 1958; Schultz, 1961 ; Becker, 1964). After 1975 and the persistence of the economic difficulties it's only about the middle of the 1980s that a new start of the economic analysis of education began. Following the model developed by Solow (1956), endogenous growth theorists (Lucas, 1988; Romer, 1986, 1990) confer to human capital (Lucas) and knowledge (Romer) an essential place in the economic growth process, various empirical approaches partially, even completely, called into question the New Growth Theories. More recently, Aghion and Cohen (2003) highlight the impact of the technological level of development in the growth process. For them, according to the degree of development of a country, the role of education is different.

Following our preceding study on the European countries (Diebolt & Jaoul, 2004a; Jaoul, 2004a), the aim of this article is to try to determine the type of relation existing between higher education and economic growth. Our cliometric study aims, on the one hand, to determine if these theories are confirmed for the case of France, and then to see whether the results are different from one country to another according to the degree of development. Our article is articulated into three parts: after a recall of the theoretical framework (1), we present the data base and the methodology used (2). Then we discuss our empirical results (3).

1. THEORETICAL FOUNDATION

1.1. Education, engine of the growth: state of the knowledge

In the 1960s, theorists of human capital analyze the impact of education on individuals productivity and advantages which result from this both at the individual and collective level. If various factors (population, capital, knowledge) play a role for the growth process, their role can be unequal according to periods, to countries or areas. Thus, many analyses of growth sources were proposed, putting forward one or the other of factors, and regarding growth as a purely external phenomenon or trying to make it endogenous.

Classical authors (Smith, 1776; Ricardo, 1817) are the first to outline a growth theory by presenting it like the result of the capital accumulation. However, they share a rather pessimistic vision of the long run: according to them, growth is dedicated to cancel itself gradually in a stationary state because of marginal decreasing returns in agriculture.

During the 1940s, several authors (Domar, 1946 ; Harrod, 1948) extended Keynes' study (1936). Their pessimism concerning the possibility of sustainable growth and ensuring

full employment is immense[3], but they do not assign this problem to the decrease of marginal returns; like Keynes, they thought to problems of rigidity and coordination.

From the end of the 1950s, Neo-classical analysis of growth, whose central problem is the search for a balanced growth with full employment, develops and imposes its power with Solow's model (1956) which comes in response to models from Harrod and Domar. Solow shows that an economic growth, stable and regular, with durable full employment, is possible thanks to the flexibility of the real wage, who allows ensuring balance on the labour market. Moreover, he highlights the fact that, without technical progress (or knowledge), effects of decreasing returns of the capital imply a stop of the growth. Solow places the exogenous technological knowledge in the centre of the model, this one allowing a long term economic growth. However, it is necessary to introduce an element to explain a durable growth by thwarting decreasing returns of the capital. Form this point of view, Solow introduces a neutral exogenous technical progress within the meaning of Harrod, compatible with a balanced growth because it does not modify the capital coefficient. In Solow's model, without technical progress, the growth thus appears limited by decreasing returns of the capital. The introduction of technical progress makes it possible to exceed this problem. However, this one is exogenous and is given to economic agents so that the growth rate per capita, equal to the rate of technical progress is fixed outside the model. We can see that the neo-classical model does not give a true explanation of the growth. Moreover, many econometric work, highlighted the "Solow's residue", i.e. a considerable share of the growth rate which remains unexplained. This let suppose that there was another factor of production additional to traditional factors of production (capital and labour), whereas the context of constant returns of scale (Rule of exhaustion) made the remuneration of this one impossible. The solution will be to make this third factor endogenous.

In the 1980s, new growth theories break completely with the neo-classical vision and the standard Solow's model by endogenising technical progress and consequently, growth. The objective of these theories is to try to explain the long term growth of the income per capita by describing it as the product of the economic system. The growth rate of the economy is determined by behaviours of agents and economic variables. Two assumptions were in the centre of neo-classical theories: marginal decreasing returns and exogeneity of technical progress. The starting point of the endogenous growth is to assume that the marginal productivity of the capital is not cancelled when the stock of capital becomes larger but is constant.

Whatever the nature - exogenous or endogenous - of the growth, all these theories differ primarily by their design of knowledge: incorporated in the individual (Lucas, Uzawa); product of the R&D (Romer 1990); resulting from Learning by Doing (Arrow, D'Autume and Michel, Romer 1986). But what is their empirical validity?

1.2. THE EMPIRICAL INVALIDATION OF GROWTH THEORIES AND THE ASSUMPTION OF AGHION & COHEN (2003).

In spite of recent progress in terms of theoretical modelling of the knowledge, gaps persist at the empirical level because of the nature of the concept of knowledge. Indeed, it presents a problem of evaluation insofar as it is an immaterial and incommensurable good.

[3] They speak about balance "on the wire of the razor".

However, many empirical studies measured the importance of the knowledge and in particular of education on the economic growth, sometimes calling into question the dominant models. In 1962, Denison shows that the increase in the mean level of education explains more than 20% of the American growth between 1929 and 1957. But according to him, education would be more than one simple factor improving quality of the manpower and the productivity of the labour force insofar as it produces something: "innovation".

Thereafter, models of endogenous growth took into account these ideas in order to provide an explanation of the growth using new concurrently factors like the human capital. Later studies focused on the importance of these new factors and economies convergence[4]. From a sample of 98 countries, over the period 1960-1985, Barro (1991) confirms a positive correlation between the growth rate of the GDP per capita and the initial level of human capital, and a negative relationship with the initial level of GDP per capita.

Thereafter, Barro and Lee (1993) study for 129 countries, between 1960 and 1985, the rate of school success of the adult population at various levels and the growth rate of the GDP and lead to the conclusion thereby education levels have a strong explanatory capacity insofar as they highlight direct positive effects of education on growth rates. In 1994, Benhabib and Spiegel show that between 1965 and 1985, the growth rate of the human capital does not significantly explain the growth rate of the product per capita.

More recently, just like Bils and Klenow (2000), Diebolt and Monteils (2000ab) think that principal causality goes from the economy to education and not the reverse as new growth theories suggest it. Demeulemeester and Rochat (2003) are also careful with the role of higher education in the economic development: "(...) *it is absolutely not obvious that this relation active of more education towards more growth is also simple, mechanist and linear* (...). », (Demeulemeester & Rochat, 2003, p. 66).

Moreover, the economic development seems to have a considerable influence in the role given to higher education, (Aghion & Cohen, 2003). According to them, *"the organization of the education system differently affects the growth potential according to the economic level of development"*, Aghion and Cohen (2003, p. 14). Indeed, they underline the impact of the technological level of development in the growth process. According to the degree of development of a country, the role of education is different: for rich countries, (which are close to the technological border) the objective is to maintain the level economic reached in order to remain competitive and to face constraints of competition. They will adopt an innovative and creative behaviour by supporting higher education and research. For less developed countries, the objective is to reach the level of development of richer countries. They have a corrective and imitative behaviour and, in this direction, they privilege the financing and the development of the primary and secondary education. Demeulemeester and Rochat (2003) also show in their empirical analysis on Australia, Sweden and United Kingdom, that according to the history and specificities of countries, higher education does not contribute in an identical way to the development of the country.

Following these various empirical approaches, a total or partial questioning of new growth theories seems to appear. In order to try to come to a conclusion about the type of relationship existing between higher education and economic growth, we carry out a cliometric step aiming at, on the one hand, determine if these theories are checked in the case of France, and then see whether that varies from one country to another according to the degree of development.

[4] The principal explanatory element of convergence in the neo-classical model is the presence of decreasing returns in the physical capital. Thus, poor countries having small ratios capital work have marginal productivities of the capital high allowing a growth high rate.

2. DATABASE AND METHODOLOGY USED

2.1. Database

We retained two countries to compare to the French case since1950: Japan and the United States. We chose these two countries because we want to confront the case of France with two countries with different levels of wealth, of culture and of development. For this reason, we chose the United States, first world power illustrating countries "close to the technological border" and Japan in prolongation of our study on the engine of the Japanese economic growth before the second world war (Diebolt & Jaoul, 2004c), because of the specificity of this country.

For each one of them, we seek to characterize the relationship between the growth rate of the GDP and the growth rate of the number of students thanks to a VAR model. The data result from:

- For the GDP, Maddison from 1950 to 1994 and Eurostat from 1994 to 2000;
- For students, Diebolt (1997, 1998) for Japan, US Department for Education for the United States.

Series concerning France used here, (GDP, Manpower of higher education) result from work of Quantitative History of Diebolt (1997), and were supplemented, for the most recent part, using statistics of OECD and Eurostat figures. The growth rate of the GDP is noted GDPJAP for Japan (respectively the USA for the United States and FRA for France); the growth rate of manpower of higher education is noted SUPJAP for Japan (respectively the USA for the United States and FRA for France).

2.2. Methodology

The objective is to cancel/ to confirm, contributions of endogenous growth theories and to highlight the assumption formulated by Aghion & Cohen (2003). For this purpose, two tools are privileged: the cointegration (long run stable linear relationship between variables) and causality (short term relationship). This involves the use of VAR (Vector Auto-Regressive) modelling that enables us to envisage all causal relations between two variables without *a priori* exogenising one of them.

Proposed in the 1980s by Sims, VAR modelling was initially opposed by 'classic' econometricians (in favour of the formalisation generated by the Cowles Commission). Indeed, the latter category tended to favour theory, constructed their models on theoretical bases and considered that it was essential to put forward hypotheses concerning relationship between variables. Those in favour of the empirical approach considered that the model should be based on solid statistical results, making it possible to reveal the structure of markets.

Advantages of VAR modelling over classic modelling are first that it allows better dynamic analysis of systems, taking into account the intrinsic structure[5] of series and dynamic

[5]The intrinsic structure of the series is related to its identification in the ARIMA classification (Box and Jenkins, 1976).

effects between variables and secondly because it makes it possible to envisage all causal relationships between two variables without any *a priori* assumptions with regard to the exogeneity of any one of them.

VAR models nevertheless have their limits. The first is the problem of the number of variables to be included in the model and the resulting estimation problem. The number of variables to be included in the model brings the problem of vanishing degrees of freedom. Indeed, considering 20 variables and 4 delays leads to estimate 80 coefficients per equation and the number of unknown coefficients often approaches the size of the sample analysed.

Another criticism often aimed at VAR models is the small amount of theory to which they refer, describing them as "a-theoretical" models. This 'theory versus measurement' debate had already opposed economists in the 1920s following the work of Mitchell (1913)[6] and appeared again in the 1980s with that of Sims. However, this debate is far from settled, and if VAR models are criticised for their lack of theory, theoretical models supported by the Cowles Commission are also criticised for their lack of flexibility (Lucas, 1976)[7]. Face to these differences of opinion, our cliometric approach (research in quantitative history structured by economic theory and fed by econometric methods) proposes the reconciliation of theory and measurement in proportions providing both the theoretical and empirical debate required in economics.

In these models, each equation of the model describes the evolution of a variable in function:

- of its past values;
- of past values of other variables of the system[8].

The analysis proceeds in several stages (cf. in particular Diebolt & Litago, 1997).

The use of this type of modelling implies to test several assumptions. First of all, it is necessary to work with stationary variables[9]. Then, an essential phase of construction of a model VAR is the selection of the optimal lag. It is that also which causes divergences

[6]The 'theory versus measurement' debate started in the analysis of Mitchell cycles (1913) that laid the empirical foundations of modern macroeconomic theory.

[7]Lucas (1976) used strong theoretical bases to argue that these models are fundamentally imperfect for assessing the consequences of the results of political alternatives. He puts forward the reason that, for example, their functioning plans little advice for political managers with regard to predicting changes of effect in economic policy because it is improbable that the parameters of the models remain stable under alternative economic policies.

[8] That is to say still while formalizing:

$$\begin{bmatrix} Y_{1,t} = \Phi^1_{11}.Y_{1,t-1} + ... + \Phi^p_{11}.Y_{1,t-p} + ... + \Phi^1_{1n}.Y_{n,t-1} + ... + \Phi^p_{1n}.Y_{n,t-p} + \varepsilon_{1t} \\ ... \\ ... \\ ... \\ Y_{n,t} = \Phi^1_{n1}.Y_{1,t-1} + ... + \Phi^p_{n1}.Y_{1,t-p} + ... + \Phi^1_{nn}.Y_{n,t-1} + ... + \Phi^p_{nn}.Y_{n,t-p} + \varepsilon_{nt} \end{bmatrix}$$

with N the number of variables and p the number of delays.

[9] A Xt process is known as stationary if all its moments are invariants for any change of the origin of time. There are two types of non stationary processes: the TS processes (Trend Stationary Processes) which present non stationnarity of the deterministic type and the DS processes (Difference Stationary Processes) for which non stationnarity is due to a random type. These processes are respectively stationnarised by a deviation from the deterministic trend and with a differences filter. In this last case, the number of filters indicate the order of integration of the variable. A variable is integrated of order "D" if it is necessary to differentiate it "D" times to make it stationary.

between the econometricians. If there is not criterion to determine the lag, econometricians agree on the fact that, theoretically, this number must be sufficiently large so that residues of the various equations of the model are white noise. Being based on the concept of entropy (measurement of the informational contents of a series), various existing criteria (Akaike, 1970, 1974; Hannan-Quinn, 1973; Schwartz, 1979) are based on the maximization of the logarithm of the function of "log-probability". The model selected will be that which has a minimal value of these criteria. In our analysis we will retain the BIC criterion of Schwartz (1978), considered to be completely consistent (Diebold and Sharpe, 1990).

Once given optimal lag, the analysis can take two non exclusive orientations: the study of the dynamics of the model on the one hand and the study of causal relationship then. The latter concerns the long term analysis via the concept of cointegration and the study of causality relationship (short term).

The term “cointegration” first appeared in 1964 in Sargan's work but only received true theoretical coverage in 1987 by Engle and Granger. Cointegration encompasses the idea that two or more series evolve together in time and generate statistical equilibrium in the long term, whereas the variables may move in different directions in the short term. However, if they continue to move far from each other in the long term, economic forces such as a market mechanism or government intervention makes it possible to bring them towards each other.

Analysis of the cointegration presented by Engle and Granger (1983, 1987) permits to identify the true relation[10] between two variables by seeking the possible existence of a vector of integration and by removing its effect.

A necessary condition of cointegration between 2 series x_t and y_t is that they are have the same order of integration “D”.

Within the framework of VAR modelling, the presence of cointegration requires a correction of the model (Vector Error Model Correction, VECM) which takes into account this relationship in order to avoid the risk of spurious regressions (Granger and Newbold, 1974). Indeed, when two series are cointegrated, there is a difficulty in the estimation and the good statistical quality of the model is generally due to the non stationarity.

In addition to the identification of the generating process of each variable of the model with unit roots tests, the finality of a model VAR is the identification of causal relationships between variables. The description of causal relationship between the economic variables allows a better comprehension of economic phenomena and consequently, a better implementation of the economic policy. The definition of causality is given by Granger (1969): the variable y_{2t} causes the variable y_{1t} if the prediction of the latter is improved when one incorporates information concerning y_{2t} in the analysis. There are two approaches of causality: Granger (1969) and Sims (1980). Granger causality relates to the propagation of deterministic impulses like structural changes. On the contrary, Sims analysis is based on the propagation of stochastic impulses representative of "surprises". Although these two approaches are generally equivalent (Bruneau, 1996), we choose here a test of Granger, because we consider that it is legitimate to associate the relationship between higher education and economic growth to a non stochastic context.

[10] If two variables are cointegrated, that comes from the presence of a common stable trend in the long run; the analysis of the cointegration consists in removing this common trend and then studying the relation between the variables, called here "true relation".

3. RESULTS

Unit root test (Elliott, Rothenberg & Stock, 1996) reveal that variables GDPUSA and SUPFRA are stationary. Variables GDPJAP, GDPFRA and SUPUSA are stationnarised by deviation from a deterministic trend. Lastly, variable SUPJAP is taken in the first differences. For each country, the necessary condition of cointegration is not met so the analysis can be made with the use of a VAR model.

1. THE CASE OF FRANCE

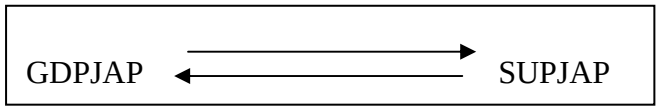
Whereas over the two last centuries, the general tendency seems to go in the direction of dominant theories with higher education which support the economic growth, (Jaoul, 2004b), over the last half-century, we don't observe a relationship between higher education and economic growth. This lack of coordination between the economic growth and higher educational system over the contemporary period could be due to the problem of France to adapt consequently its education system in particular its higher educational system to the economic development, (Aghion & Cohen, 2003).

2. THE CASE OF JAPAN

The studied model is a VAR(5) of the form:

$$\begin{bmatrix} GDP_t \\ SUP_t \end{bmatrix} = [Ao] + \begin{bmatrix} A_1 & B_1 \\ C_1 & D_1 \end{bmatrix} \begin{bmatrix} GDP_{t-1} \\ SUP_{t-1} \end{bmatrix} + \begin{bmatrix} A_2 & B_2 \\ C_2 & D_2 \end{bmatrix} \begin{bmatrix} GDP_{t-2} \\ SUP_{t-2} \end{bmatrix} + \ldots + \begin{bmatrix} A_5 & B_5 \\ C_5 & D_5 \end{bmatrix} \begin{bmatrix} GDP_{t-5} \\ SUP_{t-5} \end{bmatrix} + [\varepsilon_t]$$

The causality analysis shows a retroactive loop between the GDP and the number of students. So, higher education appears as engine of growth but it is also determined by the level of economic growth (see figure).



The dynamic analysis of the system confirms this idea; indeed, after a shock, if two variables find again their long run balanced path, they are sensitive to a variation of the other variable. Thus, a shock on higher education has an impact on the GDP, initially negative (approximately 5-6 years) then positive. On the other hand, a shock on the GDP has a negative impact on students, but in a shorter duration (3 years); this influence becomes positive then attenuates (Figure 1).

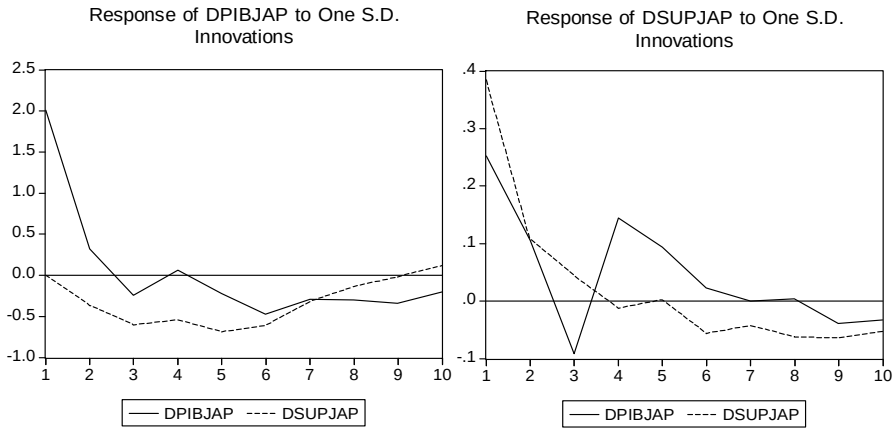
The variance analysis shows that this double influence is more important for higher education. Indeed, variations of the GDP depend to 25 % on variations on higher education,

whereas variations of higher education are influenced with height of 41 % by variations of the GDP (Table 1).

Tableau 1 - Variance decomposition– Case of Japan

Variance Decomposition of PIBJAP:			
Period	**S.E.**	**PIBJAP**	**SUPJAP**
1	2,009844	100,0000	0,000000
2	2,068787	96,80944	3,190561
3	2,168664	89,34653	10,65347
4	2,237173	84,03406	15,96594
5	2,351886	**76,93620**	**23,06380**
6	2,475021	73,08965	26,91035
7	2,512886	72,25076	27,74924
8	2,534113	72,42544	27,57456
9	2,557428	72,91911	27,08089
10	2,568027	72,91811	27,08189
Variance Decomposition of SUPJAP:			
Period	**S.E.**	**PIBJAP**	**SUPJAP**
1	0,459902	30,00946	69,99054
2	0,484040	31,82844	68,17156
3	0,494559	33,92238	66,07762
4	0,515472	39,11667	60,88333
5	0,523929	**41,06529**	**58,93471**
6	0,527515	40,69736	59,30264
7	0,529272	40,42764	59,57236
8	0,533018	39,86814	60,13186
9	0,538353	39,59610	60,40390
10	0,541969	39,44524	60,55476

Figure 1 – Impulse response function : the case of Japan.

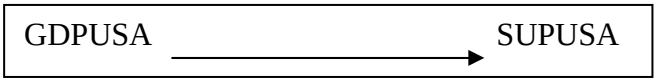


3. THE CASE OF USA

The model relating to the analysis of United States is a VAR (1) such as:

$$\begin{bmatrix} GDP_t \\ SUP_t \end{bmatrix} = [Ao] + \begin{bmatrix} A_1 & B_1 \\ C_1 & D_1 \end{bmatrix} \begin{bmatrix} GDP_{t-1} \\ SUP_{t-1} \end{bmatrix} + [\varepsilon_t]$$

Unlike Japan, for the United States, there is only one relation of causality going from the GDP to higher education. This unilateral relation is in contradiction with dominant theories (see graphic below) because it is the level of growth reached by the country which determines the development of the education. However, that goes in the direction of our working hypothesis, which says that the United States reached a level of economic development near to the technological border, and that they adapt their higher educational system to maintain their competitiveness on a high level.



The dynamic analysis (Figure 2) and the variance decomposition (Table 2) confirm this observation. Higher education is more sensitive to variations of the GDP (4,3 %) that the GDP is sensitive to variations of higher education (0 %); a shock on the GDP initially affects higher education in a fall, then in a rise before attenuating. On the other hand, a shock on higher education has a weak positive impact on the GDP which attenuates.

Figure 2 – Impulse response function: case of USA.

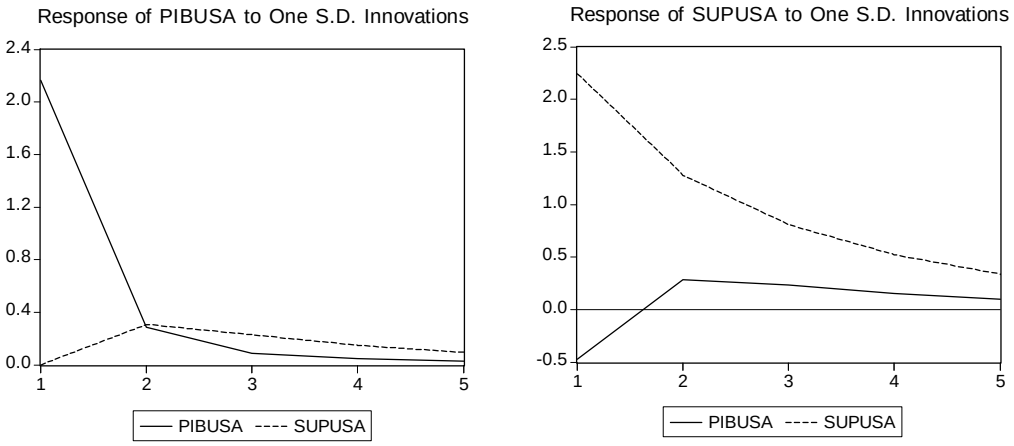


Tableau 2 - Variance Decomposition – case of USA.

Variance Decomposition of PIBUSA:			
Period	**S.E.**	**PIBUSA**	**SUPUSA**
1	2,165611	**100,0000**	**0,000000**

2	2,205502	98,08526	1,914743
3	2,218379	97,09555	2,904450
4	2,223628	96,67974	3,320261
5	2,225789	96,50856	3,491442
6	2,226679	96,43810	3,561901
7	2,227047	96,40907	3,590932
8	2,227198	96,39710	3,602901
9	2,227260	96,39216	3,607837
10	2,227286	96,39013	3,609872
Variance Decomposition of SUPUSA:			
Period	**S.E.**	**PIBUSA**	**SUPUSA**
1	2,291868	**4,228612**	**95,77139**
2	2,639678	4,349360	95,65064
3	2,770148	4,668732	95,33127
4	2,822223	4,801795	95,19820
5	2,843425	4,854906	95,14509
6	2,852124	4,876413	95,12359
7	2,855704	4,885211	95,11479
8	2,857180	4,888827	95,11117
9	2,857788	4,890317	95,10968
10	2,858039	4,890930	95,10907

CONCLUSION: TOWARDS A NEW MODEL?

Whereas France does not present a relationship between higher educational system and the economic growth, Japan and the United States present a relationship between these two aggregates. In order to try to explain these differences from a country to another, we consider higher education as an investment.

For the United States, the relationship goes from the economic system to the educational system, what can be interpreted like a strategy of innovation (Aghion &Cohen, 2003): the level of economic growth is such as it conditions the organization and the development of higher education. In this case, higher education can be apprehended as an infrastructure investment. Education then becomes a condition for the effectiveness of material means.

The case of Japan is more complex since a double relation is highlighted. We can think that Japan is in a transitive stage. After a strategy of imitation (Aghion &Cohen, 2003) in order to reach the technological border -period where an influence of education on GDP was observed (Diebolt & Jaoul, 2004c) -, this country whose growth exploded in particular during the Thirty Glorious, has now a strategy of innovation similar to that of the United States. It adapts its research and its educational system to the economic level. Contrary to the previous case, higher education seems to be first a material investment and then an investment of infrastructure. In the first case, the possibility of development induced by such an investment is uncertain: the material investment is considered as a driving force of economic growth because it is undertaken with a view to production for which there should be outlets. It is not certain that a similar forecasting calculation can be made for education.

This problem of the adaptation of higher education to the economy's capacity of absorption, is also found if we consider higher education as an investment of infrastructure, whether it has a driving role or a role of accompaniment.

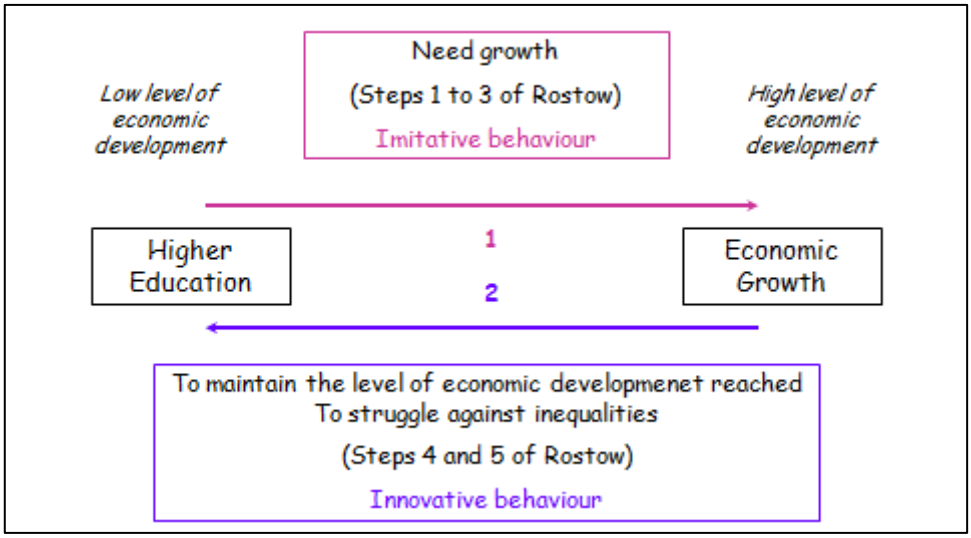
Concerning material investment, this leads to advocate a scholastic structure (levels and types of education) corresponding to a desired level of economic growth.

If we consider the infrastructure investment as a simple accompanying investment, the objective is to define the infrastructure required by the prospects of economic growth related to directly productive investments. In this case, the infrastructure investment follows the productive investment and it is modulated by the latter. Applied to higher education, this means to adapt the flow of the educational system to the foreseeable future demand of manpower of various types and with various qualifications as it is the case for Japan.

These various results seem to confirm Aghion & Cohen's hypothesis (2003) which is the starting point of this study.

So, in a first time, the "qualitative" favoured the "quantitative", and in a second time, the "quantitative" goes into service with the "qualitative" (Perroux, 1960). Indeed, Perroux distinguishes the growth (quantitative phenomenon) from the development (qualitative phenomenon), even if these two aspects are linked. Indeed, on the one hand, development explains growth, and on the other hand, the growth goes into service with the development. So there would be a vicious circle between economy and higher education.

On the one hand, for the purpose of growth, countries will develop higher education in order to favour economic growth (phenomenon number 1); it's a stage of verification of the theory of the human capital with countries which adopt imitative behavior. Once they have reached a certain threshold of economic development, to invest in higher education does not improve economic growth. Countries whose economic situation have evolved, will seek after struggle against inequalities inside the country. This will have a repercussion on higher education. Indeed, the level of economic development reached by the country implies a modification of higher education: thus the reverse phenomenon is observed because it's the level of economic growth which determines the development of higher education. Then, countries have an innovative behavior (see diagram below).



Following this, we propose a new model which takes into account the conjunction of the two phenomena. We assume that:

- the phenomenon number 1 always precedes the phenomenon number 2, that is to say that education is in a first time an engine for growth and after, growth becomes a condition for the education development

- the duration of the phenomenon number 1 varies according to the country.

If we consider two variables representing respectively economic growth (ECO) and higher education (SUP), over a period $t \in [1 ; n]$, linked by a VAR model like those used in our analysis :

$$\begin{bmatrix} ECO_t \\ SUP_t \end{bmatrix} = [Ao] + \begin{bmatrix} A_1 & B_1 \\ C_1 & D_1 \end{bmatrix} \begin{bmatrix} ECO_{t-1} \\ SUP_{t-1} \end{bmatrix} + \begin{bmatrix} A_2 & B_2 \\ C_2 & D_2 \end{bmatrix} \begin{bmatrix} ECO_{t-2} \\ SUP_{t-2} \end{bmatrix} + ... + \begin{bmatrix} A_p & B_p \\ C_p & D_p \end{bmatrix} \begin{bmatrix} ECO_{t-p} \\ SUP_{t-p} \end{bmatrix} + [\varepsilon_t]$$

The parameters of the model change according to the phenomenon observed:

- for $t \in [1 ; q]$, $Bi \neq 0$ and $Ci = 0$, $\forall i$; education causes economic growth ;
- for $t \in [q+1 ; n]$, $Ci \neq 0$ and $Bi = 0$, $\forall i$; economy causes education.

According to Rostow, the periods [1 ; q] and [q+1 ; n] seem to correspond to the various stages of economic growth. Indeed, the stages 1 to 3 of Rostow (Traditional society ; Preparation to the take off ; Take off) correspond to the period [1 ; q] during which the qualitative development is favourable to growth ; the stages 4 and 5 (Maturity ; Mass consumption) representing the period [q+1 ; n], when the growth goes into service with development.

Thus, at the macroeconomic level, like at the microeconomic one (Jaoul, 2004), the influence of higher education on economic system doesn't go in an unilateral way and depends on various factors, especially, the level of economic development reached by the country.

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