

## **HUMAN CAPITAL AND DEVELOPMENT IN AFRICA: ECONOMETRIC MODELS AND EVOLUTION, 1950-2002**

GUISAN, Maria-Carmen\*

EXPOSITO Pilar

---

### ***Abstract***

During the period 1950-2002 Africa has experienced a lower degree of economic development than Asia, due to several circumstances, and particularly to the low educational levels of population in many African countries. In this article we present the estimation of some econometric models of African countries, which show the positive role that human capital has in development and the negative consequences for many African countries if their educational gap is not overcome on the next years. We also analyse some models which have into account the role of industrial investment and foreign trade in the development of Africa.

*JEL classification:* C51, L6, O1, O11, O14, O15, O55

*Keywords:* Human Capital, Africa, Economic Development.

---

### **1. Introduction**

Here we analyse the role of human capital on economic development of African countries. In section 2 we present a summary of the main features of human capital and economic development in Africa for the period 1950-2002. In section 3 we present the estimation of two econometric models, for a pool of African countries, which show the important role of human capital to diminish fertility rates and to increase income per inhabitant. In section 4 we present the estimation of other cross-country models which try to measure the positive impact of industrial development

---

\*Maria-Carmen Guisan is Professor of Econometrics at the Faculty of Economics of the University of Santiago de Compostela, Spain, e-mail: eccgs@usc.es, and Pilar Exposito, is Associate Professor of Econometrics at the same university, e-mail: piliexpo@lugo.usc.es

and trade in African development. Finally in section 5 we present the main conclusions.

## 2. A general view of economic development in Africa, 1950-2002

Economic development in Africa during the 20<sup>th</sup> century has evolved at an average rate of only 1% per year, clearly below world average of 1.56%. Although a few African countries have had a better evolution, it is clear that there have been failures in developing policies and international cooperation in many African countries. Data in table 1 shows that the main cause of this failures is not an small increase in real Gross Domestic Product (Gdp), but an excessive average rate of population growth. than in other areas.

Table 1. Exponential Rates, ER, of growth in the 20<sup>th</sup> century  
(average percentage of increase per year)

Area	ER Gdp	ER Pop	ER Gdph	Factor
Western Europe	2.40	0.47	1.93	6.89
USA and w.o.s	3.14	1.25	1.89	6.62
Japan	4.21	1.05	3.16	23.57
Asia excl. Japan	3.32	1.53	1.79	5.99
Latin America	3.75	2.16	1.59	4.90
East Europe and Eurasia	1.91	0.66	1.25	3.49
Africa	3.12	2.12	1.00	2.72
World	2.97	1.40	1.56	4.76

Fuente: Guisan et al.(2001b), based on figures from Maddison(2001) for 1913-1998, and World Bank for year 2000. The group USA and w.o.s (western off-springs in Maddison), includes the USA, Canada, Australia and New Zealand. Gdp is Gross Domestic Product at constant prices, Pop is Population and Gdph is Gdp per inhabitant. Last column shows the number of times that real Gdph was multiplied since 1900 to year 2000.

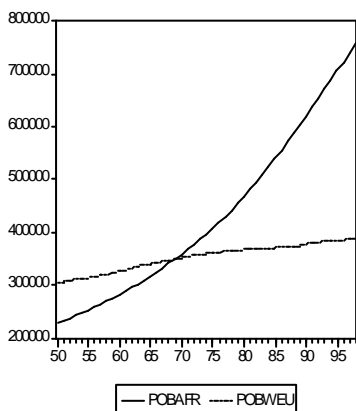
Population has growth at a rate higher than Gdp during the period 1990-2002 in Sub-Saharan Africa: while its real Gdp grew from 831 to 1096 billion of dollars, at 1995 prices and Purchasing Power Parities (Bn \$95PP), what amounts an average rate of increase of 2.31% per year, in the same period its population increased from 510 to 688 million of inhabitants, growing at an average rate of 2.49%,

As a consequence the average rate of growth of real Gdph was negative,  $-0.18\%$  per year, and Gdph was in 2002 of only 1.59 thousand dollars, clearly under the world average of 6.98.

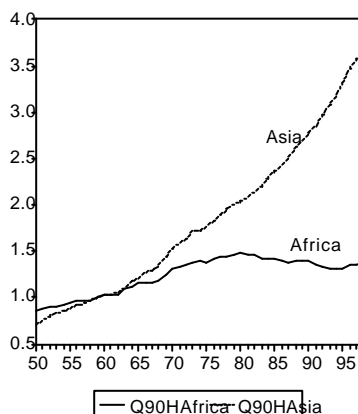
Northern African countries have experienced a better evolution than Sub-Saharan average during the period 1990-2002 with an average increase of real Gdp per inhabitant and per year of  $0.14\%$  in Algeria,  $1.90\%$  in Egypt,  $0.72\%$  in Morocco, and  $3.00\%$  in Tunisia. As it may be seen in table 2 Northern Africa presents higher educational level and lower average fertility rates than Sub-Sahara.

Graph 1 presents the evolution of population in Africa and Western Europe, during the period 1950-1998 and graph 2 compares the evolution of real Gdp per inhabitant in Africa and Asia, in thousand dollars at 1990 prices and Purchasing Power Parities, PPPs.

Graph 1. Population in Africa and Western Europe, 1950-98



Graph 2. Real Gdp per inhabitant in Africa and Asia, 1950-1998



Source: Guisan and Exposito(2001) with data from Maddison(2001).

The high value of fertility rates in many African countries is mainly due to the low value of the average educational level of population. Table 2 shows the important differences of many African areas and world averages, regarding education and fertility. Northern Africa is the African area with a better situation, converging towards world

averages, while other areas, and Africa as whole, is in a poor situation, clearly worse than world average.

Table 2. Education and Fertility in African Areas.

Area	Tyr99	Eduh	Fer00
1. Northern Africa	4.8	237	3.3
2. North West Africa	2.8	29	5.7
3. Sahel+África Central	2.5	21	6.6
4. North East África	2.2	26	6.7
5. Estearn África	3.1	44	5.7
6. Southern África	4.9	152	5.0
Total África	3.4	87	5.4
World	5.8	258	2.8

Source: Guisan and Exposito(2001) from Maddison(2001), Guisan(1997), Barro and Lee(1997) and other sources. Eduh is public expenditure on education per inhabitant in 1994 (dollars)

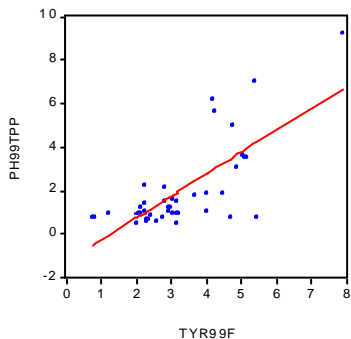
Guisan et al.(2001a) and Neira and Guisan(2002) show that the main positive effects of human capital on economic development are: 1) Moderation of the rates of natural growth of population, and increase in real value of Gdp per inhabitant, Gdph, for a given level of Gdp. 2) The increase of investment and consumption per inhabitant, and other positive effects on Gdph: increase on industrial investment per head, productivity per worker, quality of institutions and political systems, freedom, peace and other factors which favours development. Some effects depend not only on education but also on other socio-economic factors, as seen in Guisan and Aguayo(2004).

Graph 3 shows the positive relationship, for 38 African countries, between Gdp per inhabitant, expressed in thousand dollars per inhabitant in 1999, at prices and purchasing power parities of that year (Ph99tpp), and the educational level of population measured by the variable Total Years of Schooling (Tyrf).<sup>1</sup>

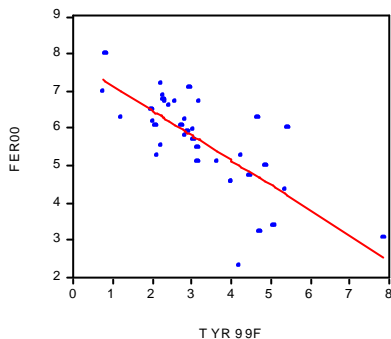
<sup>1</sup> Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Central African Rep., Chad, Congo R.D., Congo R., Côte d'Ivoire, Egypt, Eritrea, Ethiopia, Ghana, Guinea, Kenya, Lesotho, Madagascar, Malawi,

Graph 4 shows the important impact of Education on the diminution of excessively high fertility rates in this group of 38 African countries, being Fer00 the average fertility rate of year 2000 and Tyr99f the average value of total years of education per adult, accordingly to data by Barro and Lee and provisional estimations.

Graph 3. Gdph and Education in Africa, 1999

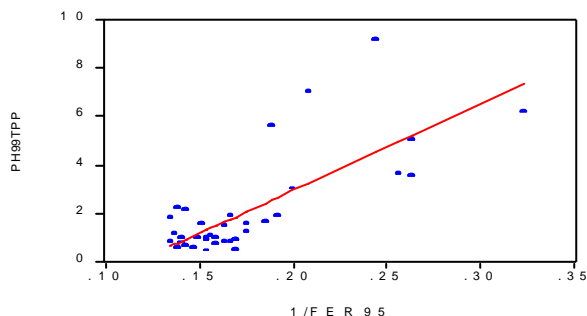


Graph 4. Fertility and Education in Africa, 1999-2000



Graph 5 shows the relationship between Gdph in 1999 and the inverse of Fertility in the previous years ( $1/\text{Fer}95$ ), in the same group.

Graph5. Gdp per inhabitant and inverse of Fertility in Africa




---

Mali, Mauritania, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, South Africa, Tanzania, Togo, Tunisia, Uganda, Zambia and Zimbabwe.

During the last decades only few economic researchers and many teachers have shown serious concern about the scarcity of financing to foster the educational level of population in Africa, but nowadays there is a more general concern on this question, among researchers and policy makers, and we could expect an increase on international cooperation addressed to overcome the educational gap.

### 3.- Econometric models of education and fertility in Africa

Here we present the estimation of two models between Fertility and Education, one in levels, Model 1, and another one as a mixed dynamic model, Model 2, with a cross-section of 38 African countries: Fer00 is the fertility rate in year 2000, measured by the average number of children expected per woman along her life, Fer95 is the corresponding value in 1995. Tyr99f and Tyr95f are the averages of total years of schooling per adult in 1999 and 1995.

Accordingly to Model 1, the average Fertility rate would be 7.81 in case of a null value in the educational variable, and Fertility would decrease in 0.66 per one unity on increase in the explanatory variable. In Model 2 this effect would be approximately equal to 1 per year of schooling. The coefficient of the level of education (Tyr) is significant in both models and the goodness of fit is higher in Model 2.

Model 1. Fertility and Education in Africa: Model in levels

Dependent Variable: FER00				
Method: Least Squares. Included observations: 38				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	7.813952	0.353268	22.11902	0.0000
TYR99F	-0.666816	0.098585	-6.763880	0.0000
R-squared	0.559633	Mean dependent var		5.623158
Adjusted R-squared	0.547401	S.D. dependent var		1.292264
S.E. of regression	0.869377	Akaike info criterion		2.609116
Sum squared resid	27.20938	Schwarz criterion		2.695305
Log likelihood	-47.57320	F-statistic		45.75007
Durbin-Watson stat	2.129820	Prob(F-statistic)		0.000000

**Model 2. Fertility and Education in Africa: Mixed dynamic model**

Dependent Variable: FER00				
Method: Least Squares. Included observations: 38				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
TYR99F-TYR95F	-1.008305	0.315556	-3.195325	0.0029
FER95	0.989781	0.020715	47.78007	0.0000
R-squared	0.830094	Mean dependent var		5.623158
Adjusted R-squared	0.825374	S.D. dependent var		1.292264
S.E. of regression	0.540015	Akaike info criterion		1.656756
Sum squared resid	10.49818	Schwarz criterion		1.742944
Log likelihood	-29.47836	Durbin-Watson stat		1.103406

Both models are interesting to show the important role that the educational level of population has to moderate the average fertility rate. Accordingly to international studies, as in Guisan et al.(2001a), the coefficient of education seems to have a higher effect on the diminution of fertility rates when these rates are very high, and the effect lowers down until to reach stabilization of the average fertility rate, around or below 2, in countries with high educational level.

#### **4. Econometric models of industry, trade and development**

The positive role of industry and foreign trade in economic development has been had into account in some econometric models. In the case of Africa, Uebe(2005) present a review of interesting macro-econometric models some of which have into account the positive role of oil production and trade on economic growth and development, and other relevant variables. Among those interesting models there several that have into account the important role of production by sector from the supply side, as in the study by Mukela(1993) for Zaire and Kidane and Kockläuner(1985) for Ethiopia. Another studies have into account the positive role of imports and exports on economic growth as in the model of Subramanian(1996) for Cameroon, from demand and supply sides, and some models, as in the study by Morrisson et al.(1993), have into account many socio-economic variables such as strikes, demonstrations, popularity policies, and other ones. Of course there

are also several interesting models which have into account the role of demand side, from a Keynesian perspective, and the impact of monetary policies and other variables. Human capital usually lead to increase the level of manufacturing development per head, and contributes to increase real value added per inhabitant in other sectors. In this section we present some models which have into account the relations between industry, foreign trade and Gdp.

There have been many interesting studies during the last years focused to analyse the impact of foreign trade on economic development and the factors which contribute to increase this trade. Trade is positively related with industrial development, being the need to develop foreign trade per inhabitant usually higher in small size countries because they usually have less opportunities to develop internal trade than biggest countries, due to the limitations of its territory and production. Table 3 presents a reference to some models of foreign trade in Africa.

Table 3. Gravitational models of foreign trade in Africa

Autor	Descripción
Fontagne, Pajot and Pasteels(2001)	Foreign trade among 75 countries (developed and developing).
Asefa y Leni(2002)	Trade relationships of Ethiopia with African countries. Includes cultural, political and linguistic variables.
Chauvin and Gaulier(2002)	Exports for 30 developing countries (19 African countries). It includes dummies for free trade agreements and frontier effects.
Geda and Kibret(2002)	Exports and Imports for the group of COMESA (Djibouti, Egypt, Eritrea, Ethiopia and Sudan)
Exposito and Mohedano(2004)	Exports and Imports of CEMAC: Cameroon, Central African Republic, Chad, Congo R, Gabon, Guinea Equatorial

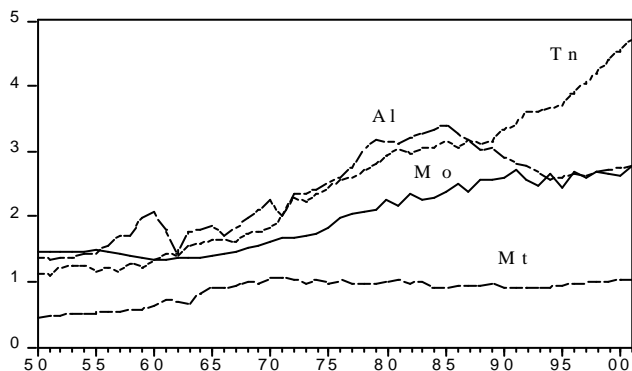
Source: Exposito and Mohedano(2004).



In Exposito and Mohedano the log-linear relationship for Exports from country  $i$  to country  $j$ , includes the following explanatory variables: Gdp of countries  $i$  and  $j$  (both with positive coefficients, Distance among both countries (with negative coefficient), and several dummies which take account of several circumstances which influence trade: common border (positive), illiteracy (negative), oil production (positive), trade relation with Asia and EU (positives). Imports of country  $i$  from country  $j$  are explained also by Gdp of both countries (with positive coefficients), common border (positive), common language (positive), road infrastructures (positive) and other variables. The differences among countries of this area are very high, with a value of exports per inhabitant between 2400 and 4000 dollars in 2002, for the case of Guinea and Gabon, which are oil producers and exporters, and the very low value of Chad with only 8 dollars per inhabitant in exports and 58 dollars in imports.

Guisan and Exposito(2004) analyse economic trends and fluctuations in 4 countries of Magreb, by means of econometric models. Graph 6 shows the evolution of real Gdp per head in those countries.

Graph 6. Evolution of real Gdp per head in four countries of Magreb (thousand of dollars at 1990 prices and PPPs)



Source: Guisan and Exposito(2004) from international statistics.  
Gdp of Algeria (Al), Mauritania (Mt), Morocco (Mo) and Tunisia (Tn).

Tunisia is the most advanced country of this group. Regarding Egypt, (not included in this graph), the increase in Gdp has been very important during the period 1950-2002, from 15.2 to 170.0 Bn \$1990PP., but the growth of Gdph has been more moderate, from 718 to 2388 dollars of 1990 per inhabitant, according to our provisional estimations for year 2002 (there are important disparities in population data for this country from different statistical sources which require a further analysis).

Model 3 presents the results of the estimation of a mixed dynamic model with a pool of these 4 Northern African countries, and shows the positive impact of real Gdp of manufacturing, QM90, on the evolution of non manufacturing sectors, QNM90.

Model 3. Manufacturing and Non-Manufacturing Value-Added in 4 countries of Magreb. GLS estimation of a mixed dynamic model

GLS: Dependent Variable: QNM90?. White Heteroskadiscity				
Sample(adjusted): 1981 2001. Cross sections 4. Panel 75 obs.				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(QM90?)	1.612278	0.820651	1.964633	0.0535
QNM90?(-1)	1.018575	0.006598	154.3856	0.0000
R-squared	0.996281	Mean dependent var		39415.65
Adjusted R-squared	0.996012	S.D. dependent var		25690.22
S.E. of regression	1622.403	Sum squared resid		1.82E+08
Log likelihood	-657.6684	F-statistic		3697.105
Durbin-Watson stat	2.381840	Prob(F-statistic)		0.000000

Model 4 presents the relationship between real Value Added of Services and the sum of real value-added of Agriculture and Industry in 30 African countries with a pool of data for the years 1980, 1990 and 2000.<sup>4</sup> The explained variable QS is real Gdp of Services, and the

<sup>4</sup> Algeria, Angola, Benin, Burkina Faso, Congo R.D., Congo R., Côte d'Ivoire, Egypt, Ethiopia, Gabon, Ghana, Guinea, Kenya, Madagascar, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, South Africa, Tanzania, Tunisia, Uganda, Zambia and Zimbabwe.

explanatory variables are the increases of real Gdp in Agriculture, QA, and Industry, QI, and the lagged value value of QS. The lagged values are indicated with an L at the end (10 years lag).

#### Model 4. Gdp of Services in Africa: sectoral relations

Pooled Least Squares. Dependent Variable: QS? 1980, 1990, 2000				
Total observations: 74. 30 countries. White-consistent				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
QA?-QA?L	0.561810	0.427063	1.315520	0.1926
QI?-QI?L	0.630322	0.180805	3.486198	0.0008
QS?L	1.236655	0.015736	78.58887	0.0000
R-squared	0.993084	Mean dependent var		7488.797
Adjusted R-squared	0.992890	S.D. dependent var		16498.30
S.E. of regression	1391.198	Sum squared resid		1.37E+08
Log likelihood	-639.0763	F-statistic		5097.758
Durbin-Watson stat	1.593542	Prob(F-statistic)		0.000000

Besides we have found that the capacity to import, mainly given by the capacity to export, plays a positive role for economic development, as it may be seen in Model 5 where QS in year 2000 is explained as a function of its lagged value in 1990 and the increases, in 1990-2000, of QAI (Agriculture and Industry) and Imports.

#### Model 5. Gdp of Services in Africa: sectoral relations and imports

Dependent Variable: QS00				
Method: Least Squares. Sampl 1 30. Included observations 28				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
QAI00-QAI90	0.341542	0.072523	4.709403	0.0001
IMP00-IMP90	0.243680	0.104367	2.334846	0.0279
QS90	1.202112	0.026885	44.71358	0.0000
R-squared	0.997648	Mean dependent var		8748.536
Adjusted R-squared	0.997460	S.D. dependent var		19474.39
S.E. of regression	981.5514	Akaike info criterion		16.71710
Sum squared resid	24086081	Schwarz criterion		16.85984
Log likelihood	-231.0394	Durbin-Watson stat		1.544723

Similar results were found in econometric studies of other areas of the world, as in those cited in Guisan(2004). The impact of imports

of intermediate and capital goods is also very important to foster industrial development although in many African countries this effect is not easy to measure due to the low level of their industrial development.

## **5. Conclusions**

The main challenge for world development at the beginning of the 21<sup>st</sup> century is to moderate fertility rates in countries with average rates over world average. This challenge is particularly important in many poor countries of Sub-Saharan Africa, which have at the same time very low levels of income per inhabitant and rates of population growth higher than their rates of growth of Gdp. The best way to deal with the problem of poverty in those countries is to increase the educational level of population, and thus international cooperation should be increased and more focused to help poor countries in this regard. We recommend to improve cooperation from industrialized countries, and particularly from European Union, with African development, mainly on educational and industrial development. Africa has an important challenge to evolve culturally and socio-economically in order to increase income, employment, and improve the socio-economic well-being of their population.

The econometric models here presented show the important impact of the educational level of population to lower average fertility rates in Africa, and the positive impact that industrial development and foreign trade have to increase real income per inhabitant.

## **Bibliography**

Asefa, S. and Leni, A. (2002). "Challenges to African Regional Integration in the Global Economy: Implications for Ethiopia". African Development Bank, <http://www.adb.com>

Barro, R. and Lee, J.W.(1997). "Schooling Quality in a Cross-section of Countries". *NBER Working Papers Series* n° 6198.

Chauvin, S. and Gaulier, G.(2002). “Regional Trade Integration in Southern Africa”. Working Paper no. 2002-12, CEPII, Paris.

Exposito, P. and Mohedano, I.(2004). Procesos de integración en el Magreb y Africa Subsahariana. *Estudios Economicos de Desarrollo Internacional*, Vol.4-2 (Spanish).<sup>1</sup>

Fontagne, L., Pajot, M. and Pasteels, J.M.(2001). “Potentiels de commerce entre économies hétérogènes: un petit modèle d’emploi des modèles de gravité”. Centre du Commerce Internationale COMTRADE (French).

Geda, A. and Kibret, H.(2002). “Regional Economic Integration in Africa: A Review of Problems and Prospects with a Case Study of COMESA”. Working Paper no. 125, SOAS, University of London.

Guisan, M.C.(2004). “Human Capital, Trade and Development in India, China, Japan and other Asian Countries, 1980-2002: Econometric Models and Causality Tests”. *Applied Econometrics and International Development*, Vol. 4-3, pp. 125-138.<sup>1</sup>

Guisan, M.C. and Aguayo, E.(2004). “Economic Growth and Cycles in Poland, Hungary, Czech Republic, Slovakia and Slovenia: A Comparison with Spain, Austria and Other EU Countries, 1950-2002”. Working paper of the series *Economic Development*, no. 79.<sup>1</sup>

Guisan, M.C., Aguayo, E. and Exposito, P.(2001a). “Economic Growth and Cycles: Cross-country Models of Education, Industry and Fertility and International Comparisons”. *Applied Econometrics and International Development*, Vol. 1-1, pp. 9-37.<sup>1</sup>

Guisan, M.C., Aguayo, E. and Exposito, P. (2001b). “Education and World Development in 1900-1999. A General View and Challenges for the Near Future”. *Applied Econometrics and International Development*, Vol. 1-1, pp. 101-110.<sup>1</sup>

Guisan, M.C. and Exposito, P.(2001). Education, Industry, Trade and Development of African Countries in 1980-1999. *Applied Econometrics and International Development*, Vol. 2-2, pp. 85-107.<sup>1</sup>

Guisan, M.C. and Exposito, P.(2004). "Econometric Models and Causality Relationships Between Manufacturing and Non-Manufacturing Production in Morocco, Tunisia and Other Northern African Countries, 1950-2000". *Economic Development*, no. 78.<sup>1</sup>

Kidane, A. and Kockläuner, G.(1985). "A Macro-econometric Model for Ethiopia: Specification, Estimation, Forecast and Control". *Eastern Africa Economic Review*, Vol.1-1, pp.1-12.

Maddison, A.(2001). The World Economy. A millennial perspective. Development Centre Studies. OECD, Paris.

Morrison, C., Lafay, J.D. and Dessus, S.(1993). "La faisabilite politique de l'ajustement dans les pays africaines". *Documents Techniques* no. 88, OECD, Paris.

Mukela, L.A.(1993). "Econometric Model for Zaire's Macro-economic Policy". *The Economic Science*, Nagoya University, Japan.

Neira, I. y Guisán, M.C.(2002). Modelos econométricos de capital humano y crecimiento económico: Efecto Inversión y otros efectos indirectos. Documento nº 62 de la serie *Economic Development* (Spanish). English version forthcoming 2005.<sup>1</sup>

Uebe, G. (2005). Macro-Econometric Models, <http://www.unibw-hmaburg.de/uebe/zuhane.eng/html>.

World Bank(2005). World Development Indicators. World Bank, Washington.

<sup>1</sup>More information on line at: <http://www.usc.es/economet/ea.htm>