SELECTED READINGS ON ECONOMETRICS METHODOLOGY, 2001-2010: CAUSALITY, MEASURE OF VARIABLES, DYNAMIC MODELS AND -ECONOMIC APPROACHES TO GROWTH AND DEVELOPMENT,

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Abstract

In this survey we analyze some main problems often found on international studies of econometric applications, particularly those related with the measurement of variables, dynamic specification of models, analysis of causality and co-integration, the role of demand and supply approaches in macro-econometric studies and the role of education and other main factors on economic development. Here we present a synthesis of several articles, written for the period 2001-2010, which throw light on those problems and provide solutions to some difficulties often found by researchers. The questions included are related with: 1) the right conclusions from the analysis of causality and cointegration, 2) measurement of variables, avoiding to mix rates, ratios and per capita variables in comparisons, when the hypotheses that would allow the mix of rates and ratios do not hold, 3) the importance of the right selection of the functional form in dynamic models, and 4) utility of international pools and cross-section samples in order to diminish multicollinearity and reach interesting conclusions about economic approaches to economic growth and socio-economic development.

JEL Codes: C5, C52, C82, E2, F1, F4, I2, O1, O5, O57

Keywords: Causality tests in empirical studies, econometric methodology, macro-econometric models, selection of functional form in dynamic models, supply and demand approaches to growth, inter-sectoral relationships, education and economic development.

1. Introduction

From a wide experience, of many decades, as researcher, reviewer, member of Editorial Boards and Editor of several international journals I have had the opportunity to read hundreds of articles on applications of Econometrics to growth and development. From that experience I have realized that it is important to avoid frequent errors in the interpretation of econometric results, when authors try to accept or reject hypothesis of causality (or other ones), with a partial view, based on the automatic application of one or more tests, without mention some features of their data, models and methods, which present problems that do not support the apparently clear conclusions of their studies.

Here we present some selected readings, published for the period 2001-2010, with throw light on several of those important questions: Section 2 analyzes the interpretation of causality and cointegration tests. Section 3 shows a frequent problem of inadequate mixing of variables measured as rates, ratios and per capita values. Section 4 presents empirical evidence on the selection of demand and supply approaches to growth models. Section 5 refers to the role of education and other socio-economic factors. The conclusions are present in each section and in a final summary in the Annex.

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2. Causality and cointegration: problems and interpretation

Note: In the following tables AEID is "Applied Econometrics and International Development". IJAEQS is "International Journal of Applied Econometrics and Quantitative Studies, and RSES is "Regional and Sectoral Economic Studies": Available at https://www.usc.es/economet/eaat.htm

Table 1. Some selected readings on causality and co-integration

Journal	*Article*
Ijaeqs 2004	*Guisan (2004). A Comparison of Causality Tests Applied to the Bilateral Relationship Between Consumption and GDP in the USA and Mexico.Vol-1-1.*
Ijaeqs 2005	*Guisan and Aguayo (2005). Employment, Development And Research Expenditure In The European Union : Analisys Of Causality And Comparison With The United States, 1993-200. Vol. 2-2.*
Ijaeqs 2005	*Guisan and Exposito(2005) Industry And Foreign Trade In India, China, And OECD Countries: An Analysis Of Causality, 1960-2002. Vol. 2-3.*
Aeid 2001	*Guisan(2001). Causality and Cointegration between Consumption and GDP in 25 OECD countries: Limitations of Cointegration Approach, vol. 1-1.*

Some important conclusions of our studies of causality with Granger tests are: 1) Granger test is interesting but it may present several limitations due to the effects of missing variables and multicollinearity. In order to diminish multicollinearity the modified version of Granger test suggested by Guisan(2004) usually improves the results. 2) Besides we may find that application of the test with a pool leads to better results, due to the diminution of multicollinearity, as in the following example of Guisan and Aguayo(2005) applied to the bilateral relationship between real Gross Domestic Product per head (Gdph) and Research and Development Expenditure per head (Rdh) in 16 OECD countries, for the period 1993-2003.

Table 2. Granger´s Causality test for Gdph and Rdh, in 16 countries,1993-2003

Country	**F_1**	**p_1**	**F_2**	**p_2**
Austria	6.5983	0.0541	11.535	0.0218
Belgium	1.5376	0.3196	0.2590	0.7837
Denmark	24.927	0.0055	10.640	0.0250
Finland	27.633	0.0045	6.6091	0.0539
France	2.1596	0.2311	2.6451	0.1853
Germany	1.1570	0.4013	2.0451	0.2444
Greece	1.5556	0.3163	22.539	0.0066
Ireland	8.1492	0.0388	0.7281	0.5374
Italy	5.0944	0.0794	0.5161	0.6318
Luxembourg	0.4411	0.6661	1.0407	0.4188
Netherlands	0.5890	0.5967	0.5755	0.6030
Portugal	3.7230	0.1221	14.547	0.0146
Spain	0.4357	0.6742	0.1639	0.8542
Sweden	26.346	0.0049	0.1454	0.8690
UK	9.8949	0.0282	1.7192	0.2891
USA	6.8386	0.0512	0.1574	0.8593
Pool of 16	**675.82**	**<0.001**	**230.68**	**<0.001**

Note: F_1 is the F-statistic to test H_1: "Gdph does not cause Rdh" in (1) and F_2 corresponds to H_2 :"Rdh does not cause Gdph" in (2), while p_1 and p_2 are the significance levels for 2 lags. Source: Guisan and Aguayo(2005), based on OECD statistics.

Non-causality is rejected at the 10% level of significance in only 8 cases for F_1 and in 5 cases for F_2. Source: Guisan and Aguayo(2005) using data from OECD statistics.

Granger´s test with the 144 observations of the pool of 16 countries, shows that both variables have a bilateral relationship, with the following results for the F statistics of (1) and (2), with coefficients which are highly significant:

$$F_1 = (\Delta SCE_1/2)/(SCE_1/(144-4)) = 675.82 > F\alpha; \quad F_{0.05}(2,140) = 3.07 \qquad (1)$$
$$F_2 = (\Delta SCE_2/2)/(SCE_2/(144-4)) = 230.68 < F\alpha; \quad F_{0.05}(2,140) = 3.07 \qquad (2)$$

In order to analyse the possible existence of contemporaneous relationship between both variables we present in table 3 the estimated coefficients for the period 1993-2003 of the following mixed dynamic model:

$$RDH = C(11)*RDH(-1) + C(21)*D(GDPH) \qquad (3)$$
$$GDPH = C(12)*GDPH(-1) + C(22) *D(RDH) \qquad (4)$$

Table 3. Estimation of (3) and (4), with 160 observations, 1994-2003

Method	C(11)	C(21)	C(12)	C(22)
LS, White	1.0264 (151.27)	0.0131 (4.36)	1.0198 (500.44)	6.4447 (4.31)
TSLS	1.0308 (206.43)	0.0088 (2.34)	1.0228 (463.96)	2.8815 (1.51)

Note: terms between parentheses are the t-statistics. All the coefficients, but C(22) in TSLS are significant at 5% level.

Results of table 3 show that a contemporaneous relationship holds for relation (3) but that one or more lags are usually needed to show the impact of Rdh on Gdph. We deem that it is not necessary to apply Hausman tests, or other proofs, as the relation is unilateral contemporaneous (Rdh usually depends contemporaneously on Gdph) and bilateral non contemporaneous (contemporaneous value of Rdh usually may not have an inmediate impact on Gdph in year t, but in future periods (for example may lead to take a decision on patents, investment or other choices that imply a positive effect on economic development of future periods).

3) Granger test may fail to detect causality, in causal and important relationhips, due to the effect of missing variables, particularly the lack of contemporaneous relationship. As shown in Guisan(1997), and in the Annex 1, the effect of missing some relevant variables, with some degree of linear relationship with the included explanatory variables, affects to the parameters and estimator and to the random shock. In the case of the Granger test, Guisan and Exposito(2005) analyze those effects as follows:

"There are important effects of missing explanatory variables on the estimation and significance of parameters in a VAR model, particularly those due to the values of relevant contemporaneous variables, which may affect to the sign and significance of the coefficients of the Granger´s causality test:nY1=Industrial Value-Added, Y2=Non-Industrial Value-Added, Y3=Imports

In the Annex we analyze effects of missing relevant values, particularly the case of contemporaneous explanatory variables.

3. Measuring variables: Rates, ratios and per capita variables

Table 4. Readings on the problem of mixing rates, ratios and per capita variables

Journal	*Article*
Ijaeqs 2009	*Guisan,M.C. (2009). Rates, Ratios And Per Capita Variables In Cross-Section Models Of Development, Investment And Foreign Trade: A Comparative Analysis Of OECD Countries, 1961-9. Vol. 6-2.*

Very often there is a wrong mix of variables, for example comparing rates and shares, in order to detect causality between two or more variables. In many applications to macro-econometric models, this problem is present with negative consequences. As pointed out by Guisan(2009): "*Many contradictions among different econometric studies, which analyze the role of investment and foreign trade on economic development in international comparisons, are due to specification problems in models which include a relationship between the rates of growth of real GDP per head and ratios of Investment, or other variables, on real GDP, in cases where that relationship does not hold or it is only very weak. This type of problems creates some degree of confusion and weakens the social trust on the capacity of econometric research to improve economic policy recommendations. Here we present a comparison of several specifications related with the role of investment and foreign trade on the explanation of real GDP, and recommend to use relationship based on per capita values of these variables, instead of relating rates and ratios, in international comparisons. The analysis of 25 OECD countries for the period 1961-1995 shows a clear support for this conclusion*" (Guisan (2009).

In section 2 of Guisan (2009) we present a comparison of several relationships between investment, foreign trade and real production based on the mix of rates and ratios which appear very often published in econometric studies, in comparison with rate to rate and per capita to per capita relationships. While the former only hold in particular circumstances (rate to ratio), the rate to rate and per capita per capita seem clearly more general and interesting for international comparisons.

Section 3, of the same study, analyzes the bilateral relationship between investment and real GDP and between foreign trade and real GDP.

Table 5 shows that a very important relationship between Investment and GDP, with a correlation of 91.12% in per capita terms (PC), may be much lower with less adequate options (Rates with 69.46% of correlation, Rate/Share (or Rate/Ratio) with only 25.67% of correlation) or with inadequate sign and value in the worst of the options of this table (-8.69% with option PC/share).

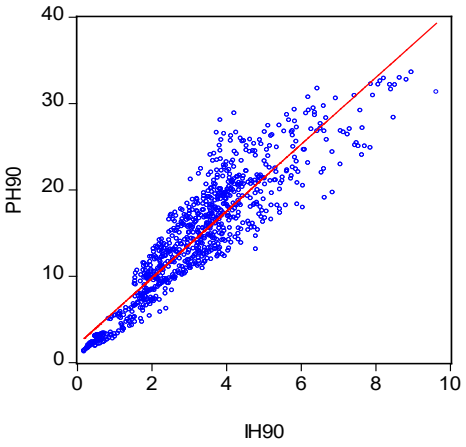
Table 5. Correlations of GDP per capita with Investment, Exports and Imports

	(1) PC/PC	(2) Rate/Rate	(3) Rate/Share	(4) PC/Share
IH90	0.9112	0.6946	0.2767	-0.0869
XH90	0.6768	0.3647	-0.0323	0.3975
MH90	0.6500	0.6023	-0.0058	0.2976

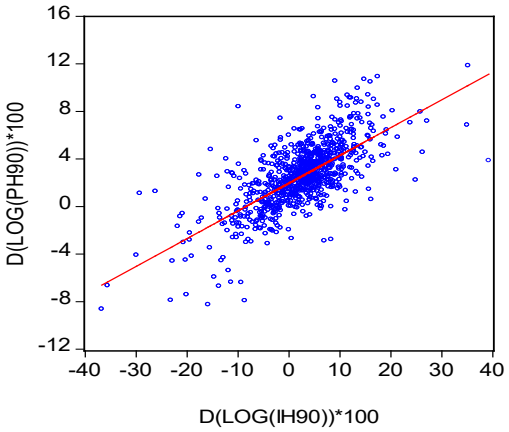
Source: Guisan(2009) based on OECD statistics. Data of 25 countries 1961-1995.

Graph 1, shows the great differences among the (4) options of table 5. The main conclusion is that the option (1) is the best one, while option (2) is not so good, because underestimation although it is not wrong, and the options (3) and (4) are usually inadequate, particularly option (4).

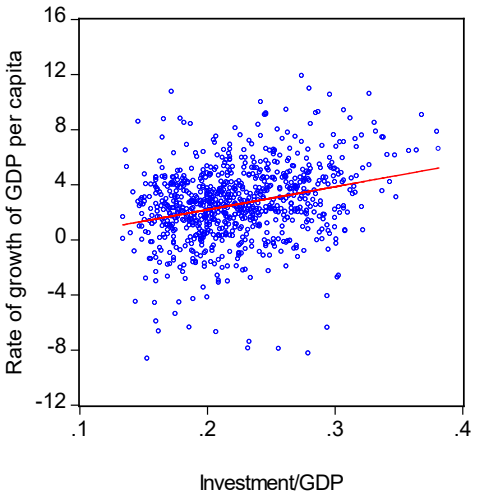
Graph 1. Relationship between Gdp and Investment, with the comparisons of table 5.



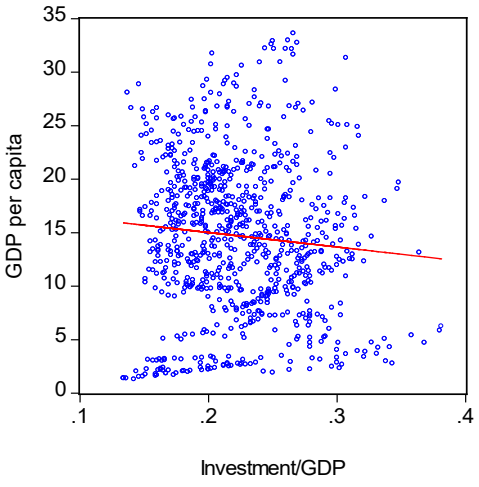
(1) Gdp per capita and Investment per capita: PC and PC



(2) Rate of growth of GDP per capita and rate of growth of Investment: Rate and Rate



(3) Rate of growth of GDP per capita and Investment Share: Rate and Share



(4) Gdp per capita and Investment Share: PC and Share

Source: Based on Guisan(2009) with OECD statistics of 25 countries for 1961-1995.

. In section 5 we analyse, from a disequilibrium approach, the relationship between investment and production, unilateral or bilateral depending on some circumstances. Authors that mix rates and shares, or per capita values and shares, should be advised that an inadequate mixing of the measures of variables, may lead to wrong conclusions about the causality relationship between variables.

4. Dynamic functional form: the role of mixed dynamic models

Table 6. Readings on the functional form of dynamic models.

Ijaeqs (2007)	*3- 2*	*Guisan, M.C.(2007) Dynamic Models in Econometrics: Classification, Selection and the Role of Stock Variables in Economic Development*

Here we focus particularly in the functional form of Dynamic relationships in three types: levels (both explained and explanatory variables in levels), first differences (all the variables in first differences) and mixed dynamic models (explained variable and its lagged value in levels, other explanatory variables in first differences). The mixed dynamic model converges to a first difference model in the special case of coefficient of the lagged value equal to unity. In the Annex 2, we include table 1 of Guisan(2007) with a classification of causal dynamic models with contemporaneous relationships. Table A2, in the Annex, shows the results of estimation a relationship between Consumption and Gross Domestic Product in the United States for the period 1961-2003. Other studies cited in the Annex, present similar results for employment equations or other variables. In Guisan(2009), and in other studies, the mixed dynamic model usually provides the best option, regarding goodness of fit and for forecast accuracy. Besides the mixed dynamic leads to cointegration that might not appear clearly in other options.

4. Economic Approaches to Macro-econometric Models: Supply, Demand, Industry, Investment and Trade

Table 8. Readings on Supply and Demand approaches to Macro-econometric models

Ijaeqs 2006	*Guisan, M.C.(2006).Industry, Foreign Trade And Development: Econometric Models Of Europe And North America, 1965-2003*
Ijaeqs 2008	*Guisan, M.C. (2008) Industry, Foreign Trade and Development: Econometric Models of Africa, Asia and Latin America 1965-2003*
Rses 2008	*Guisan(2008). Manufacturing and Economic Development: Inter-sectoral relationships in Europe, America, Africa and Asia-Pacific, 1999-2006, V 8-2.*
Aeid 2001	*Cancelo, Guisan and Frias(2001). Supply and Demand on Manufacturing Output in OECD countries: Econometric Models and Specification tests, Vol. 1-2.*
Aeid 2002	*Guisan and Cancelo(2002). Econometric Models of Foreign Trade in OECD Countries. Vol. 2-2.*
Aeid 2004	*Guisan(2004). Human Capital, Trade and Development in India, China, Japan and other Asian Countries, 1960-2002: Econometric Models and Causality Tests, V 4-3.*
Aeid 2005	*Guisan and Aguayo(2005). Industry and Economic Development in Latin America, 1980-2002, Vol. 5-3.*

To analyze the role of consumption, investment, wages, trade, or other ones, as explanatory variables on production and employment, it is important to have a wide view of demand and supply and not only limit the analysis to a particular test of causality or cointegration between two variables. In the Annex we present a summary of features and conclusions of the studies listed in table 8 and in other studies there cited. The main conclusion from these empirical studies is that the effects of many variables may be direct and indirect and depend on demand and supply.

5. International development: education, poverty eradication and quality of life

Table 9. Reading on education, quality of life and development

Ijaeqs 2009	*Guisan, M.C. (2009). Indicators Of Social Well-Being, Education, Gender Equality And World Development: Analysis Of 132 Countries, 2000-2008*
Rses 2009	*Guisan(2009). Education, Health and Economic Development: A Survey of Quantitative Economic Studies, 2001-2009.*
Aeid 2001	*Guisan, Aguayo and Exposito. Economic growth and cycles: Cross-country models of Education, Industry and Fertility and International Comparisons.V.1-1.*
Aied 2006	*Guisan and Neira(2006). Direct and Indirect Effects of Human Capital on World Development, 1960-2004, Vol. 6-3.*
Aeid 2007	*Guisan and Exposito. Education, Development and Health Expenditure in Africa: A cross-section model of 39 countries in 2000-2005, Vol. 7.2*
Aeid 2009	*Guisan(2009). Government Effectiveness, Education, Economic Development and Well-Being: Analysis of European Countries in Comparison with the United States and Canada, 2000-2007. vol. 9-2*

These articles, and other ones included in Table A4 in the Annex, show the important role of education, industry and international cooperation on world development.

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Guisan, M.C., Aguayo, E. (2005). Employment, Development And Research Expenditure In The European Union : Analisys Of Causality And Comparison With The United States, 1993-200. *International Journal of Applied Econometrics and Quantitative Studies*, Vol. 2-2.

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Annex (updated on 2nd January 2022).

Annex 1. Effects of missing explanatory variables.

Following the approach of chapter 5 by Guisan(1997) on the effects of missing relevant variables, we include this short Annex 1, to the interpretation of the significance or not significance of the coefficient of an explanatory variable in an econometric model. We remember the contents of this Annex in other publications because it is very important for the right interpretation of many econometric models.

Suppose that Y(t) is explained by three explanatory variables (X1, X2, X3).

$$Y(t) = \beta_1 X1(t) + \beta_2 X2(t) + \beta_3 X3(t) + \varepsilon1(t) \quad (1)$$

Now suppose that X3 is highly correlated, by direct or indirect causality realtions, with X1 and X2, by means equation (2)

$$X3(t) = \alpha_1 X1(t) + \alpha_2 X2(t) + \varepsilon2(t) \quad (2)$$

Then the substitution of (2) into (1) gives equation (3):

$$Y(t) = (\beta_1 + \beta_3 \alpha_1) X1(t) + (\beta_2 + \beta_3 \alpha_2) X2(t) + (\varepsilon1(t) + \beta_3 \varepsilon2(t)) \quad (3)$$

$$Y(t) = \beta_1^* X1(t) + \beta_2^* X2(t) + \varepsilon3(t) \quad (4)$$

Where $\beta_1^* = \beta_1 + \beta_3 \alpha_1$; $\beta_2^* = \beta_2 + \beta_3 \alpha_2$; $\varepsilon3(t) = \varepsilon1(t) + \beta_3 \varepsilon2(t)$

The variance of the random shock will increase when X3 is missing from the equation, depending on the values of the variance of $\varepsilon2(t)$ and β_3^2.The lowest the value of the varianza of $\varepsilon2(t)$ it is expected a better lower variance of $\varepsilon3(t)$ and higher goodness of fit of equation (4).

The significance of β_2^* does not always imply the significance of β_2. If the coefficients of the other included variables have signs and values as expected and the goodness of fit is high, then it is frequent that the significance of β_2^* also implies the significance of β_2. The no significance of β_2^* nos always imply that $\beta_2=0$.

In the case of a mixed dynamic model where Y(t) dependens on its lagged value Y(t-1) and the increase of one or more exogenous variables (for example X(t)), then the actual model is:

$$Y(t) = \beta_1 Y(t-1) - \beta_2 X(t-1) + \beta_2 X(t) + \varepsilon1(t) \quad (5)$$

when we perform Granger´s test, which does not include the contemporaneous value of the exogenous variable, there is a problem of missing variable (X3(t)=X(t)), and the included predetermined variables are X1t=Y(t-1) anad X2t=X(t-1). If the missing variable is related with its lagged value, as $X3(t) = \alpha_2 X2(t) + \varepsilon2(t)$, then we can express:

$$Y(t) = \beta_1 Y(t-1) + \beta_2 (\alpha_2-1) X(t-1) + (\varepsilon1(t) + \beta_2 \varepsilon2(t)) \quad (6)$$

Then, if α_2 is close to 1, then $\beta_2^* = \beta_2 (\alpha_2-1)$ may be close to zero, and the acceptance of the nullity of this parametros does not imply the nullity of β_2. The conclusion is that in a model that includes Y(t-1) the inclusion of X(t-1) may not be relevant but the inclusion of D(X1t) may be highly relevant.

Annex 2. Dynamic models: 4 classifications.

Table A1. Causal dynamic models: lags, levels and 1st differences, direction of causality and persistence

Criteria	*Types of models*
1. Lagged Regressors (explicit and implicit)	*a) with explicit lags in y_t: causal autoregressive* *b) with explicit lags in one explanatory variable* *c) without explicit lags in the regressors but with implicit ones: stock variable*
2. Models in levels or first differences	*a) levels: Y and X in levels* *b) simple dynamic: Y and X in first differences* *c) mixed dynamic models: Y in levels X in differences* *d) ECM: long term in levels, short term in differences*
3. Direction of causality	*a) one dynamic equation and unidirectional causality* *b) one dynamic equation and bidirectional causality* *c) two dynamic equations and unidirectional causality* *c) two dynamic equations and bidirectional causality*
4. Persistence of propagation effect	*a) declining* *b) constant,* *c) increasing*

Note: the models of this table are causal models and thus they include at least one exogenous variable, well in the context of a single equation model or in a multiple equation system

Table A2 shows the % of Root of Means Square error in sample and forecasting period for the relationship between Private Consumption and Gross Domestic Product in the United States for 1961-2003.

Table A2. Relation between of C90 with GDP90, US, 1961-2003

Model	Regressors and AR terms	Coeff. gdp90	Coeff. c90(-1)	%RMSE sample	%RMSE forecast	RS	*RF*
Mixed Dynamic and AR(1)	D(gdp90) c90u(-1)	0.4793	1.0111	0.70	2.74	1	1
Mixed Dynamic	D(gdo90) c90(-1)	0.4994	1.0101	0.72	3.71	2	2
Levels with lag	c gdp90 c90(-1)	0.4350	0.4202	0.92	3.84	5	3
Levels without lag	c gdp90	0.7330	-	1.26	4.17	5	4
Levels with ar(1)	c gdp90 AR(1)	0.7307	-	0.87	4.41	3	5
First differences	D(gdp90)	0.6634	1	0.89	4.83	3	5

Note: %RMSE is the Percentage of the Root of Mean Square Error on the mean of the explained variable. RS and RF are, respectively, the ranking positions of each model in sample and forecasting period of best estimations. Source: Guisan(2007).

The percentage of RMSE, among the different specifications varied between the minimum 0.70, of the mixed dynamic model (with correction of autocorrelation), and the maximum 1.26 of the model in levels without the lagged dependent variable as regressor. For the forecasting period, %RMSE varied between the minimum 2.74% for the mixed dynamic model (with correction of autocorrelation), and the maximum of 4.83 for first differences.

Annex 3. Readings on Econometric Models of Industry, Foreign Trade and Development

Table A3 in the Annex: Industry, Foreign Trade and Development

Ijaeqs 2006	*Guisan, M.C.(2006).Industry, Foreign Trade And Development: Econometric Models Of Europe And North America, 1965-2003*
Ijaeqs 2008	*Guisan, M.C. (2008) Industry, Foreign Trade and Development: Econometric Models of Africa, Asia and Latin America 1965-2003*
Rses 2006	*Guisan and Exposito(2006). Production by sector in China, India and OECD countries, 1985-2005. Vol. 6-2.*
Rses 2007	*Guisan an Aguayo(2007). Production by Sector in the European Union: Analysis of France, Germany, Italy, Spain, Poland and the United Kingdom, 2000-2005. V, 7-1.*
Rses 2007	*Guisan and Exposito(2007). Production by sector in Africa, 2000-2005, Vol. 7-2.*
Rses 2008	*Guisan(2008). Manufacturing and Economic Development: Inter-sectoral relationships in Europe, America, Africa and Asia-Pacific, 1999-2006, V 8-2.*
Aeid 2001	*Cancelo, Guisan and Frias(2001). Supply and Demand on Manufacturing Output in OECD countries: Econometric Models and Specification tests, Vol. 1-2.*
Aeid 2002	*Guisan and Cancelo(2002). Econometric Models of Foreign Trade in OECD Countriea. Vol. 2-2.*
Aeid 2004	*Guisan(2004). Human Capital, Trade and Development in India, China, Japan and other Asian Countries, 1960-2002: Econometric Models and Causality Tests, V 4-3.*
	Guisan and Aguayo(2005). Industry and Economic Development in Latin America, 1980-2002, Vol. 5-3.

Annex 4. Readings on Econometric Model, of Education and Quality of Life

Table A4. Education, Health care, Poverty diminution, Gender Equality and Development

Ijaeqs 2006	*Guisan, M.C. and Exposito, P.(2006). Health Expenditure, Poverty And Economic Development In Africa, 2000-2005*
Ijaeqs 2007	*Guisan and Aguayo(2007). Health Expenditure, Poverty and Economic Development in Latin America 2000-2005*
Ijaeqs 2009	*Guisan, M.C. (2009). Indicators Of Social Well-Being, Education, Gender Equality And World Development: Analysis Of 132 Countries, 2000-2008*
Rses 2004	*Guisan (2004) Education, Research and Manufacturing in EU25: An Inter-Sectoral Econometric Model of 151 European Regions, 1995-2000. Vol. 4-2.*
Rses 2009	*Guisan(2009). Education, Health and Economic Development: A Survey of Quantitative Economic Studies, 2001-2009.*
Aeid 2001	*Guisan, Aguayo and Exposito(2001). Education and World Development in 1900-1999: A General View and Challenges for the Near Future , Vol.1-1*
Aeid 2001	*Guisan, Aguayo and Exposito. Economic growth and cycles: Cross-country models of Education, Industry and Fertility and International Comparisons.V.1-1.*
Aeid 2005	*Guisan and Exposito(2005). Human Capital and Economic Development in Africa: An Econometric Analysis for 1950-2002, Vol. 5-1*
Aied 2006	*Guisan and Neira(2006). Direct and Indirect Effects of Human Capital on World Development, 1960-2004, Vol. 6-3.*
Aeid 2007	*Guisan and Exposito. Education, Development and Health Expenditure in Africa: A cross-section model of 39 countries in 2000-2005, Vol. 7.2*
Aeid 2008	*Konya and Guisan(2008). What Does the Human Development Index Tell Us about Convergence?, Vol. 8.1*

Aeid 2009	*Guisan(2009). Government Effectiveness, Education, Economic Development and Well-Being: Analysis of European Countries in Comparison with the United States and Canada, 2000-2007. vol. 9-2*

Annex 5. The importance of Supply and Demand

It is important to have into account that not only de primary inputs supply (Q^{s1}) and demand approach (Q^{d}) are relevant for the specification of causal relationships in macro-econometrics. There is also an important role of supply side of intermediate inputs (Q^{s2}), which usually imply direct and indirect effects of industry and foreign trade con macro-econometric models.

The studies listed in table 8 are readings suggested to point to the direct and indirect effects of many variables from this wide approach. Some of the articles deal with the question of models selection by means of specification tests, as it is the case of Guisan and Cancelo(2002). In spite of the empirical evidence that shows the important role of the three approaches, there are a lot of models that only focus on one primary inputs (Q^{s1}) or on demand (Q^{d}).

In order to understand properly the direction of causality it is important to have into account that real GDP (Q) is usually related with the minimum of the three values (Q^{s1}, Q^{s2}, Q^{d}). This disequilibrium approach provides great important to industry and foreign trade on macroeconometric analysis of causality. The main direction of causality between Investment and Production, may change, because investment is of uppermost importance to explain production in the neoclassical regime (Q^{s1}), but it is mainly a consequence of economic growth when the restriction to growth comes from Q^{s2} o from Q^{d}.

Some types, in dynamic models in levels, may appear lack of cointegration between two variables so closely related as Consumption and Production. In those cases, the failure in cointegration should not be interpreted as an spurious or non causal relationship but simply as an small problem with the choice of functional form: just specifying the right functional form usually will lead to show causality and cointegration.

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