The environment in the dynamics and interactions between economic growth and openness to international trade.

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Introduction

The importance of economic growth and development always interested economists. Sustainable growth is the result of more and better quality of human resources, natural capital, as well as technological advances that improve productivity and enabling the economic growth along a sustainable path.

In recent years many economists asked if, among the variables that impact on economic growth, openness[1] to trade could contribute to it significantly.

Although several studies have shown more open trade regimes are beneficial for economic growth due to export expansion that raises the total factor productivity (Dar and Amirkhalkhali, 2003), there are studies that focus attention on the fact that greater openness generates deterioration in social and environmental conditions raising, for example, inequality between the incomes and the emissions of greenhouse gases (and Fraunholz Baten, 2004; Manage, 2004).

Usually, studies on economic growth and openness to trade consider, as a parameter of economic growth, the GDP.

However, the GDP can not be considered the only indicator of economic growth (because growth is not only productivity) nor the economic well-being (Stockhammer et al, 1997).

Beginning with the seminal work of Daly et al. (1989) there have been several attempts to develop alternative national income accounting systems that address these deficiencies. Collectively, these systems measure what is commonly referred to as green GDP. The first objectives of these green GDP accounting systems are to provide a more accurate measure of welfare and to gauge whether or not an economy is on a sustainable time path (Hanley, 2000). Two of the most popular green GDP systems are the Index of Sustainable Economic Welfare (ISEW) and the Genuine Progress Indicator (GPI)[2].

Empirical analysis

This section examines the structural factors that may impact on economic growth measured in terms of green GDP (using the ISEW index).

Therefore, we propose a panel data (unbalanced) in which the observations are grouped cross section observations for a period of 30 years (1970 - 2000) for 10 countries: Australia, Belgium,

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[1] The proliferation of indexes to measure the degree of trade openness of a country leads us to think that there is not a clear and precise definition about what the real meaning of trade to international markets (or openness), because in the literature there is not a precise and widely definition. We could generally grouped opening measures into two broad categories: first, those based on the orientation of trade policies, ie on the choice of tax rates, on the other hand, those focused on the effects of trade policies, ie the volumes of goods exchanged, regardless of the tariff policies adopted. Iin this work we will refer to openness as the ratio (imports + exports) / GDP, as indicated by the World Bank.

[2] For many information about these indicators, see the studies of Daly and Cobb (1989), Lawn (2003) , Lawn and Sanders (1999), Neumayer (2000) et other authors.

China, Finland, Japan, New Zealand, Netherlands, United Kingdom, United States, Thailand. We start with a linear regression of growth and then test the same with fixed effects. In the second analysis we showed the results of applying a dynamic estimator.

The growth models are specified as following:

$$GGDPgreen_{it} = \beta_0 + \beta_1 G(GFCF)_{it} + \beta_2 G(ADR)_{it} + \beta_3 G(O)_{it} + \beta_4 G(O^2)_{it} + \beta_5 (FDI)_{it} + \beta_6 G(INF)_{it} + \beta_7 G(PS)_{it} + \gamma_{it} \qquad (1)$$

$$GGDPgreen_{it} = \beta_0 (GGDPgreen)_{it-1} + \beta_1 G(GFCF)_{it} + \beta_2 G(ADR)_{it} + \beta_3 G(O)_{it} + \beta_4 G(O^2)_{it} + \beta_5 (FDI)_{it} + \beta_6 G(INF)_{it} + \beta_7 G(PS)_{it} + \gamma_{it} \qquad (2)$$

A model of green GDP growth

As in Talberth and Bohara (2005), the hypothesis is that the level of green GDP can be explained by a variant of a standard model of growth in which the real output is a function of the stock of physical capital, labor, and influenced by other factors which may affect the productivity of these inputs such as economic openness .

In general notation, we have:

$$GDPgreen_t = f(K_t, L_t, O_t), \qquad (3)$$

where GDPgrn is per capita green GDP at time t as measured by the ISEW or GPI indices, K is a measure of a nation's capital stock at time t, L is a measure of labor input at time t, and O is an index of economic openness at time t. Following Mankiw et al. (1992) this relationship can be expressed in terms of a Cobb-Douglas type aggregate production function of the form:

$$GDPgreen_t = \delta_0 K_t^{\alpha} O_t^{\beta} L_t^{(1-\alpha-\beta)} e^{ut}, \qquad (4)$$

Which can be represented in a log – linear form as:

$$GDOgreen_t = \delta + \alpha K_t + \beta O_t + (1 - \alpha - \beta) L_t + u_t, \qquad (5)$$

Where all variables are logged, α is the constant and u the error term.

Data and coefficients expected signs

Data on the dependent variable, the "green" GDP, are related to studies on Australia (Hamilton, 1999, Lawn, 2008), Japan (Makino, 2006), UK (Jackson et al., 2006), Thailand (Clarke and Islam, 2005), Belgium (Bleys, 2008), Holland (Bleys, 2007), USA (Talberth et al, 2007), China (Lawn, 2008), New Zealand (Lawn and Clarke, 2008) and Finland (Hoffren, 2008). For all countries the observations are complete with respect to the time series. All data expressed were converted into U.S. dollars at the constant rate of 2000 using the exchange rates published in the Penn World Tables.

The variable expression of physical capital is represented by the ratio of gross fixed capital formation (GFCF) to GDP as, for example, use Moudatsou (2003). The labor input is the age

dependency ratio (ADR) defined as the ratio of no working age population (<15 and> 64) to the working age population. The importance of this variable in growth models has long been known as a larger presence of dependent population may limit investments to improve productivity (Holtz - Eakin et al., 2004).

Variable O is the openness to international trade. Here, the method of calculation of this variable is closely related to the measure used by Summers and Heston (1991) using data from Penn World Table. In particular, we refer to openness for the year t as the ratio (IMP + EXP) / GDP.

The preliminary observation on data regarding openness leads us to consider that there is a tendency for larger countries (respect to population) to be less open and this seems to be in line with the statement made by Frankel and Romer (1996). In our example, we find that the Spearman correlation coefficient between openness and size (population) is negative and high. It should, however, noted that the variations in terms of openness that we find within countries reflect not only differences in size but also differences in location and economic policies (Dar and Amirkhalkhali, 2003).

As a result, the ratio of trade to GDP has not a monotonically increasing relationship to size, and the openness and the dimensions are not perfectly correlated.

Compared to the theoretical model in which the variables were only three (capital, labor and openness), in the estimation phase we added other variables deemed relevant in order to assess more fully what are the components of growth in line with the choices made by several empirical works proposed.

These variable are: PS that is the expression of public expenditure that government devotes to education. The choice of this variable is justified by the fact that, in endogenous growth models, the State can wield a positive impact on economic growth promoting the so called productive public spending that performs a positive function of externalities in the growth process (Barro, 1990).

Considering the openness as the only measure of international trade could be insufficient as into the countries considered there are also countries which, although not considered "open" in a very strict way for years (openness levels lower than other countries considered in this dataset), this evidence does not mean they conducted a different openness policy based on investment. For this reason we consider also the variable foreign direct investment (FDI).

Among the variables considered interesting and impacting on sustainable growth, we also introduce the inflation (INF) which may lead to a slowdown in the production[3].

Data for these three variables are from World Bank database.

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[3] For a detailed summary on the relationship between growth and inflation, see Chari et all (1995). The authors suggest, empirically, the possibility that there is a trade-off between growth and inflation.

Framework of the explanatory variables and coefficients expected signs

| Variable	Theory intuition	Expected signs
ADR	High dependent population may limit economic growth	Negative (-)
GFCF	It is the portion of new value added invested in the economy and not consumed	Positive (+)
O	Openness to economic growth (measured by a green Gdp indicator) has a negative effect on the growth	Negative (-)
FDI	Foreign direct investment is positively related to the economic growth only when the host country has a great capacity in human capital and financial depth	Positive (+)
INF	Inflation in the economy will cause production to slow down since products are produced at higher prices.	Negative (-)
PS	Public spending in education as importance of human capital in a nation.	Positive (+)

In this model we are assuming that there is a linear relationship between openness and growth of green GDP. However if we observe the following figures, we can see there are at least 6 countries with a non linear relationship; for three there are a positive correlation; for New Zealand, instead, the correlation is clearly negative.

For this, we decided to include in the model a variable of squared openness.
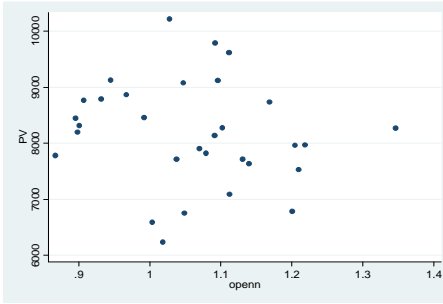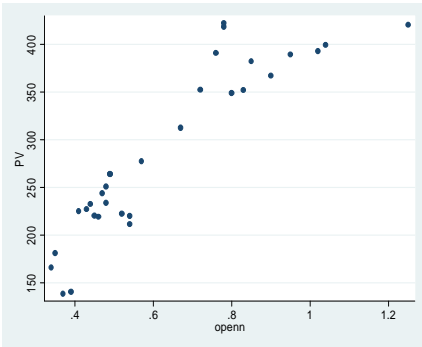
Fig.1. *per capita* **green GDP and** *openness*
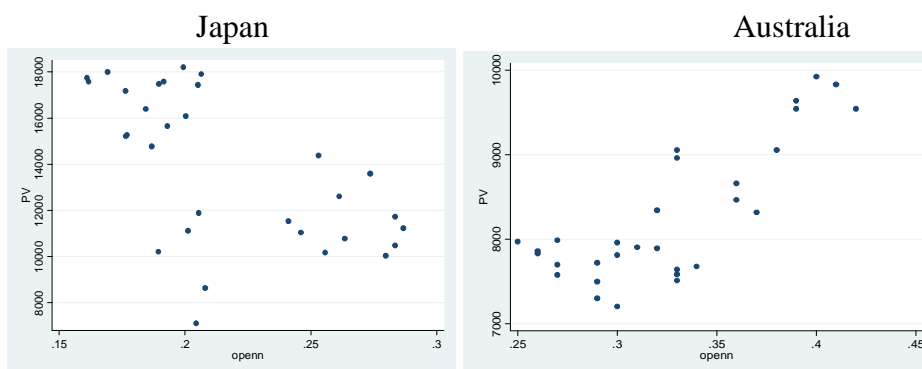
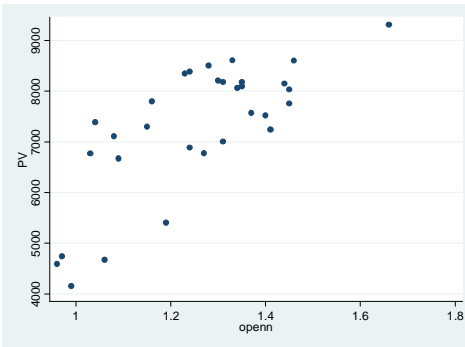## United Kingdom
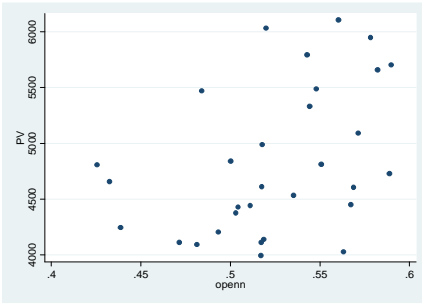
Netherlands
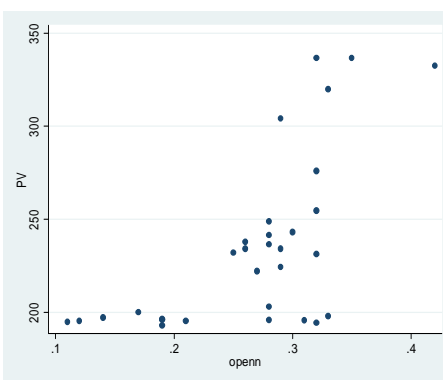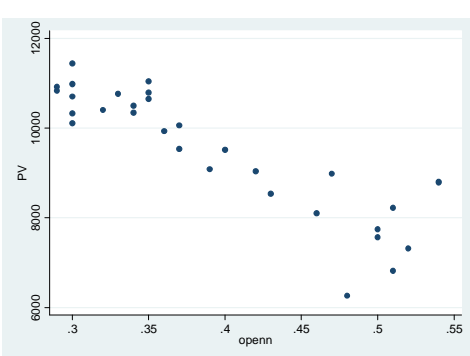

Thailand

Belgium
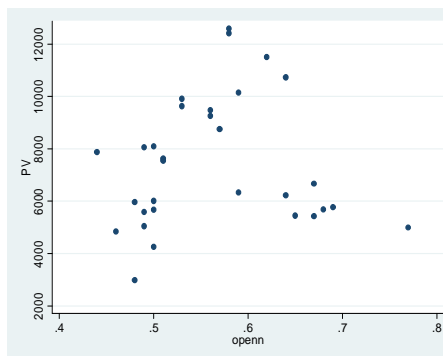

United States
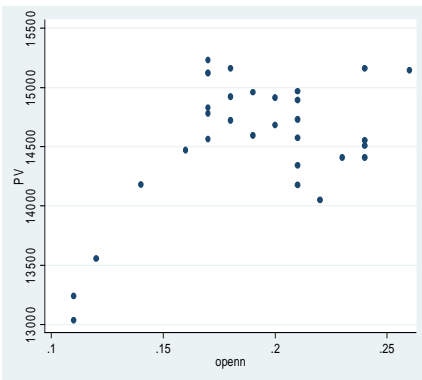
China

New Zealand

Finland

Estimation Methodology

To start off our analysis we perform the panel unit roots test that our chosen macroeconomic variables are stationary and, hence, our correlations are not spurious.

A persistent concern in the literature is to what degree these "level" models result in spurious regression due to the presence of unit roots. A time series is said to contain a unit root if contains a long-term trend and is, thus, non-stationary.

Using classical ordinary least squares (OLS) estimation techniques when unit roots are present can give misleading inferences and lead to spurious regression (Bhattacharya and Sivasubramanian, 2003).

To test the presence of unit roots the Dickey-Fuller unit root test is used (Dickey e Fuller, 1979). For each series in a given model, this test involves fitting a regression of the form:

$$\Delta y_t = \alpha + \beta\, y_{t-1} + \pi\, t + \delta_1\, \Delta y_{t-1} + \delta_2\, \Delta y_{t-2} + \dots + \delta_k\, \Delta y_{t-k} + \varepsilon_t, \qquad (6)\,,$$

and then the null hypothesis $H_0: \beta = 0$. If the null cannot be rejected, unit roots are present and the series is nonstationary.

The test is included in the software package used for this analysis (*Stata Intercooled Version 10.0*).

Once the presence of unit roots have been confirmed, converting level GDP models to growth rate according to very popular growth models testing the effect of openness (Dar e Amirkhalkhali, 2003).

Using a OLS pooled regression, the individual effects not observed respect to each countries are not Testable and, thus, as in Bevan and Danbolt (2004), the heterogeneity (a consequence of these not considered effects) can influence the measurement of estimated parameters.

Using, instead, a fixed effects panel, you can control these non-observable individual effects on the estimated parameters.

To test the relevance of non-observable individual effects we use the LM (Lagrange Multiplier) test. It tests the null hypothesis of non-relevance of non-observable individual effects, against the alternative hypothesis of significance of individual effects not observed.

Furthermore, in order to test the feasibility of a fixed effects estimator against one of random effects, the Hausman test is proposed.

We first used a methodology panel with simple OLS and then we compared the results with a fixed effects methodology, in which the dependent variable is per capita green GDP measured by ISEW or GPI indicator, while the independent variables are those stated above (see equation 1). The fixed effects are preferred to random effects because it is possible to assume directly into equational form the existence of structural differences (stable over time) between different countries, in addition to those identified with the explanatory variables.

The estimation of the model is complicated by the characteristics of the data. It refers to characteristics of countries that are stable over time, and low variability does not help the quality of the estimation. In particular, the explanatory variables have less variability. The coefficient of variation (standard deviation relative to average) is generally quite low. The functional form to estimate is described by the following equation:

When we include the lagged dependent variable in the growth regression (1), the Generalized Method of Moments (GMM) estimation is used. This is to avoid the problems of inconsistent and biased OLS estimators. Arellano and Bond (1991) introduced a method of first differencing. One disadvantage of using this first differences method is that it may become less informative in the presence of persistent effects within the data. A new estimator is then introduced by Arellano and Bover (1995) and Blundell and Bond (1997) to solve for biased estimates. This is a combination of

first differencing and taking the regressions in levels by transforming the data using orthogonal deviation.

So here we estimated the following equations:

$$GGDPgreen_{it} = \beta_0 + \beta_1 G(GFCF)_{it} + \beta_2 G(ADR)_{it} + \beta_3 G(O)_{it} + \beta_4 G(O^2)_{it} + \beta_5(FDI)_{it}$$
$$+ \beta_6 G(INF)_{it} + \beta_7 G(PS)_{it} + \gamma_{it} \qquad (1)$$

$$GGDPgreen_{it} = \beta_0(GGDPgreen)_{it-1} + \beta_1 G(GFCF)_{it} + \beta_2 G(ADR)_{it} + \beta_3 G(O)_{it} +$$
$$\beta_4 G(O^2)_{it} + \beta_5(FDI)_{it} + \beta_6 G(INF)_{it} + \beta_7 G(PS)_{it} + \gamma_{it} \qquad (2)$$

The term β_0 represents the constant intercept and the γ represents the stochastic error term. The subscript "it" denotes the number of cross-sections and time period. The "G" prefix means that all the variables are converted into growth rate.

The transformed equation (2) uses instrumental variables to estimate parameters in the context of a GMM estimator and to obtain consistent estimates under the assumption that there is no second order serial correlation between errors. In particular, the assumption that the error term in the level equation is not serially correlated has two implications empirically testable by first differences equation.

In the Arellano-Bond (1991) estimator, the Sargan test for evaluating restrictions on over-identification and a robust version of the first stage of the Arellano-Bond estimation are included to test the "goodness" of the specification and the robustness of estimated parameters in terms of inference.

Results

The results of the correlation matrix are presented in Appendix, Table No. 3.

According to Aivazian and others (2005), when the coefficients of correlation between explanatory variables are not more than 30%, the problem of collinearity is not particularly relevant. Looking at the coefficients of correlation between the explanatory variables, we verify that they, among all the variables are well below 30%.

The Dickey - Fuller test for each series of the panel data tests the null hypothesis of nonstationarity for each series against the alternative hypothesis of stationarity. The null hypothesis of nonstationarity can not be rejected in 9 out of 10 cases for the series on the green GDP, in 10 out of 10 for the series for the variable K, in 5 out of 10 for the series for the variable L (age dependency ratio), 10 out of 10 variables for openness and openness to the square, 3 out of 10 for foreign investment and in 10 out of 10 panel for the variables inflation and public spending in education. So we convert each series in terms of growth rate because the predominance of non-stationary series. The test is repeated considering the variables in terms of first differences and the results allow us to reject the null hypothesis of nonstationarity for each series, in most cases.

Using the LM test we cannot reject the null hypothesis, therefore we can conclude that the not observable individual effects are not relevant so the pooled OLS regression would be an appropriate way to conduct an assessment of the determinants of growth measured by GDP green. However, as earlier, the panel was subjected to an estimation method using a fixed effects estimator, which results will be compared with the OLS estimation.

As shown in the Table 4, a variable has significance at 1%, and it's openness, two variables are significant at 5% and three are 10%.

In our model the variable openness shows the greatest significance in all three estimation hypothesis. The impact of this variable on growth is much higher than the other variables considered into the model.

We observe that the expected signs for the variables openness and age dependency ratios are met as are negative as expected and consistent with the main economic theory (in the second case). The variable INF refers to inflation does not show the expected signs and presents an almost bland contribution in our model with a significance level that increases when we consider the fixed effects model.

According to the endogenous growth theory, we would expect that investment in human capital have positive impact on growth, but the not significant coefficient on public spending on education denies the expectations. This could be due to the choice of the variable rather generic compared to other variables that would have been more immediately related to human capital but unfortunately were not taken into account because the difficult to find data on the time series considered in this area.

Gross fixed capital formation has, as expected, positive sign.

Probably the coefficient significance on the FDI variable is unexpected as selected countries are "suffering" investments from other countries (and is denoted by the negative data for almost all the countries considered),because many of them are stable economies. We also assume that this small contribution to the growth of this variable measured by the green GDP is due to the lack of observations for the country China (as said the panel is unbalanced).

Equation (2) is estimated with Generalized Method of Moments (GMM) as well as first differences as that orthogonal deviations. In this case we used the lagged value of the dependent variable - growth measured by green GDP indicator - as one of the regressors. The coefficient for openness is still strongly negative and significant with respect to economic growth. In the GMM estimation with first differences, except for the foreign direct investment, all variables have the expected signs. However, with orthogonal deviations, the variable of public spending in education has a negative effect. The rest of the variables still have signs identical to those of the GMM estimates with first differences.

The results of the Sargan and Hansen test, tell us we can not reject the null hypothesis of no second order autocorrelation. So for the validity of the instruments and the absence of second-order autocorrelation, we can conclude that the dynamic estimators are considered efficient and robust.

Conclusions

This work is part of a very current and interesting discussion concerning the possibility of using alternative indicators to estimate GDP growth in terms of sustainability. The aim of the work was not to diminish the value of GDP, a certainly important index of measuring productivity growth but to take this opportunity to highlight that this indicator has limits due to the difficulty to represent a multidimensional concept - the growth seen in a perspective of welfare.

In this work we used a recently developed indicator (ISEW and GPI in its latest version) which is precisely the empirical translation of what are the criticisms made over the past year to GDP. It is built taking into account the aspects that, while not counted in GDP, contributing both positively and negatively to economic growth. The analysis suggests that the use of the "correct" GDP (defined as green GDP), measured in terms of ISEW (or GPI that is the last version of ISEW) is a useful tool to review the factors that influence the growth rate.

We find that the results obtained from the empirical study are robust and interesting and this leads us to justify its use and at the same time they contradict the previous empirical work where the correlation between openness and growth (measured by GDP) is positive. We observe, in this case, that openness is significantly associated with a reduction in growth rates of green GDP. These results provide an interesting empirical support in according to the point of view that greater

openness is associated with a high environmental degradation, an increase in income disparity and a less quality of life.

This study uses a set of explanatory variables, in accord with the current growth theory; with the openness, there are the most important factors that have affected the economic growth of ten economies in the period 1970 to 2000. Using alternative estimation methods for the proposed panel, we show that the openness and dependence on age (age dependency ratio) had a strong negative influence on growth, compared with other variables, however, in line with the results reported in the literature that use the GDP as the dependent variable of growth, have positive impact on the same.

In addition, we found similar results using the GMM estimation in a model that incorporates the role of the first level of growth as a dependent variable. The GMM helps us to control the problem of correlation of error terms that other methods are not able to verify.

Our results don't want to suggest policy measures about trade choices but rather to highlight the fact that, using alternative instruments of measurement, the results can be quite different as measured in a different perspective and therefore be appropriate that there are always comparisons between different metrics of measurement in order to achieve more realistic results both in research then in the decision-making.

Certainly the model deserves an extension that could, on the one hand, concern the understanding of what are the determinants of the gap existing between the traditional values of GDP and the correct green GDP, and the other would be interesting to work on two separate panel data: the first covers the period 1960-1980 and a second from 1981 to 2000 in order to verify if indeed we find the openness impact is negative on growth only in the second period (as assumed in both this paper), or it is true for all period.

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Appendix

Tablen.1   Countries

country	Abbreviation used
Australia	Aus
Belgium	Bel
China	Cin
Finland	Fin
Japan	Jap
New Zealand	New
Netherlands	Net
United Kingdom	Uk
United States	Usa
Thailand	Tai

Source: own

Table n.2 Variable Explanations

Variable	Description and construction	source
ADR	Age dependency ratio: (number of people aged 0 to 14 and those aged 65 and over)/number of people aged 15 -> 65	World Bank Development Indicators
GFCF	Gross fixed capital formation as percentage of GDP	World Bank Development Indicators
O	Openness: (Exports + Imports) / GDP	World Bank Development Indicators
FDI	Foreign Direct Investment: (FDI / total trade); where total trade is (exports + imports)	World Bank Development Indicators
INF	Inflation: Percentage	World Bank Development Indicators
PS	Public spending in education	World Bank Development Indicators

Source: own

RESULTS OF THE DIFFERENT MODELS

Table n. 4 Models of static panel

Modello Variabile	OLS	Effetti Fissi
crGFCF	0.3170689	0.3023683
crADR	-0.3863356**	-0.7417477
crO	-1.014716***	-1.016925***
crFDI	0.0002662*	0.0001587***
crINF	0.0072415*	0.006719**
crPS	0.0178891*	0.0089346*
crO^2	0.836557	0.7949272
const	0.0464521	0.0500582
R^2 Adj R^2 Obs.	0.8028 0.7974 265	Within= 0.8135 Between =0.3765 overall = 0.8004 265

Notes: (*,**,***) denotes the level of significance levels at 10%, 5% and 1%, respectively.

Table n.5 Dynamic models -> GMM regression models

Model Variable	First Differences	Orthogonal Deviations
crPILverde _1	-0.0184743***	0.0133835*
crGFCF	0.2341227	0.1515647**
crADR	-0.743347***	-1.541477***
crO	-0.947403	-0.8763116***
crFDI	0.0001589*	-0.0005654*
crINF	0.0078071**	0.0018069*
crPS	0.0066202*	-0.0051358
crO^2	0.7150641	0.5928131

Notes: (*, **, ***) denotes the level of significance levels at 10%, 5% and 1%, respectively.