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Michele Bagella – Leonardo Becchetti –
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Research Department
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The anticipated and concurring effects of the EMU: exchange rate volatility, institutions and growth

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The views expressed are those of the authors and do not necessarily reflect the views of the Bank of Finland.

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The anticipated and concurring effects of EMU: exchange rate volatility, institutions and growth

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Michele Bagella – Leonardo Becchetti – Iftekhar Hasan
Research Department

Abstract

Reduced exchange rate volatility and higher and less heterogeneous quality of institutional rules and macroeconomic policies are two of the main (anticipated and concurring) effects expected from a currency union.

In this paper we measure the magnitude of these two effects on the Euro area countries, looking at real effective exchange rates (REER) and at different indicators of quality of institutional rules and macroeconomic policies (QIRMP). We find that the first effect is much stronger than the second when we compare relative changes on Euro area countries and the rest of the world in the relevant period.

We further evaluate the impact of both effects on economic growth on a larger sample of countries. Our findings show that both have significant impact on levels (more robust) and on rates of growth (weaker) of per capita GDP.

Key words: real exchange rate, volatility, institutional rules, macroeconomic policy

JEL classification numbers: F15, F31

Euroopan rahaliiton vaikutukset valuuttakurssivaihteluun, instituutioihin ja taloudelliseen kasvuun

Suomen Pankin keskustelualoitteita 15/2004

Michele Bagella – Leonardo Becchetti – Iftekhar Hasan
Tutkimusosasto

Tiivistelmä

Vakaa valuuttakurssi sekä aiempaa yhtenäisempi talouspolitiikka ja institutionaalinen säännöstö ovat ne kaksi keskeistä vaikutusta, joita rahaliitolta tavanomaisesti odotetaan. Tässä tutkimuksessa näiden kahden vaikutuksen voimakkuutta Euro-euroalueella arvioidaan yhtäältä tutkimalla reaalisen efektiivisen valuuttakurssin (REER) käyttäytymistä ja toisaalta tulkitsemalla erilaisia talouspolitiikan ja institutionaalisten sääntöjen laatua (QIRMP) mittaavia indikaattoreita. Tulosten mukaan ensimmäinen näistä vaikutuksista on paljon voimakkaampi kuin jälkimmäinen, kun verrataan euroalueen maiden välisiä reaalisen valuuttakurssin muutoksia vertailuryhmään kuuluvien maiden vastaaviin.

Tutkimuksessa myös arvioidaan näiden tekijöiden vaikutusta taloudelliseen kasvuun laajemmasta maajoukosta koostuvassa aineistossa. Tulosten mukaan reaalisen valuuttakurssin stabiloituminen ja talouspolitiikan yhdenmukaistuminen kasvattavat henkeä kohden laskettua bruttokansantuotetta ja nopeuttavat sen kasvuvauhtia. Näistä jälkimmäinen tulos on kuitenkin enemmän riippuvainen mittaustavasta.

Avainsanat: reaalinen valuuttakurssi, heilahtelut, institutionaaliset säännöt, talouspolitiikka

JEL-luokittelu: F15, F31

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1 Introduction

A nice synthesis of the challenges posed by global integration is in the formulation of a well known trilemma (Summers, 1999). The trilemma synthetically expresses the difficulties, or the impossibility, of pursuing at the same time the following three goals – greater economic integration, proper public policy management and national sovereignty – against the possibility of pursuing any of the two at the expenses of the third. The three potential alternatives left for the partial solution of the trilemma are resumed as being those of: i) 'traditional conservative economists' (according to Summers definition) pursuing economic integration and national sovereignty at the expenses of freedom on public policy management; ii) modern protectionists advocating limits to economic integration to favor 'free hands' on public policy management and national sovereignty and, finally, iii) advocates of Monetary Unions intended as means to promote economic integration and proper public policy management at the expense of national sovereignty (Summers, 1999).

In this perspective the rise of Monetary Unions appears therefore as one of the possible responses to the trilemma which makes compatible the first two goals at the expense of the third.

Originally, within the more general approach of the optimal currency areas (Mundell, 1961), one of the most sound economic rationales for the EMU came from the theoretical observation that simple fixed exchange rate parities could not be enough for the partial solution of the trilemma given that, in absence of a common currency, exchange rate stability cannot coexist with divergences in fiscal and monetary policies (Giavazzi and Pagano 1994, Obstfeld and Rogoff 1995). In this framework a country whose monetary policy is relatively more expansionary than that of the fixed exchange rate partner is likely to suffer from an appreciation of real exchange rates. This appreciation worsens its relative competitiveness and therefore makes necessary a devaluation, thereby generating further currency instability. The awareness of such problems led economist and policymakers in the eighties and in the nineties to affirm that *'fixed exchange rates now seem much less effective as means to price stability than many of us thought before. Therefore, monetary stability and credibility has to be built at home with other means'* (Svensson 1994, p. 467).

On the basis of this theoretical pillar, the EU started a process of convergence in fiscal policies, inflation and institutions which was going to prepare the introduction of a common currency.

One of the undiscussed advantages of the process leading to the common currency was the elimination of exchange rate volatility among members (Buiter et al 1998, Devereux et al 1998). This was generally considered a beneficial effect given the perception that *'unpredictable volatility can inflict damage'* ...[and

that]… *'Although the associated costs have not been quantified rigorously, many economists believe that exchange rate uncertainty reduces international trade, discourages investment and compounds the problems people face in insuring their human capital in incomplete asset markets.'* (Obstfeld and Rogoff 1995).

Since exchange rates are a forward looking financial variable whose movements are driven by expectations and anticipate the occurrence of real events, the most, if not all the positive effects of the process of convergence toward the common currency in terms of real exchange rate volatility materialized well before that event.[1] This fact may create the illusion that the introduction of the common currency did not generate any benefit.

A deeper look at the institutional background may help to illustrate the point of the strict consequentiality between policy and institutional changes promoted by the Treaty and the Stability and Growth Pact and the stage of the single currency. On a chronological point of view, consider that, even though the Euro was technically born on December 31, 1998, it had a eight-year gestation which closely followed the time-table and modalities agreed upon in December 1991 in Maastricht (Corsetti and Pesenti 1999). The Maastricht Treaty, and, subsequently, the Stability and Growth Pact, established prerequisites needed to qualify for MU membership which include complying with the convergence criteria in terms of inflation, fiscal stance and interest rates, as well as appropriate reforms to prepare central banks to be integrated into the new European system.[2] More specifically on this point, Gali and Perotti (2003) remember that compliance with budgetary discipline (established by art. 104 of the Treaty) and price stability was among the criteria on which the decision of admission to stage III of the EMU was taken in July 1998. Furthermore, the same EEC rules explicitly exclude the same consequentiality for countries which are not candidates to the Monetary Union. Regulation 1467/97 states that fiscal discipline does not apply to the UK unless it moves to the stage of Monetary Union. Both Denmark and the UK are explicitly exempted from requirements of paragraph 9 and 11 of Art. 104 relative to European Council penalties for countries with deficit exceeding the 3% threshold (Gali and Perotti 2003).

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[1] Van Foreest and de Vries (2002) provide results in support of this hypothesis linking relate exchange rate instability to the instability of macroeconomic policies. The authors show that, irrespective of the foreign exchange rate regime, countries with high monetary volatility have lower relative output growth. The interpretation is that, due to the forward looking nature of foreign exchange markets, exchange rate stability hinges on the stability of the institutional structure within which monetary and fiscal policies are formulated.

[2] Dwyer and Lothian (2003) and Afxentiou (2000) argue that convergence criteria created conditions for a change in monetary and inflation environments which greatly reduced the skepticism toward the Euro, emphasising another important link between convergence and Euro adoption.

Based on this evidence, it is hard to believe ex post that a process of institutional and monetary and fiscal policy convergence would have occurred without the final goal of the MU.

This is why we argue in this paper that the likely benefits of a common currency must be evaluated starting from the beginning of the convergence process leading to the Euro. Our approach for measuring them is in two steps. In the first we compare real effective exchange rate volatility and, level and variance of QIRMP between Eurozone members and other representative groups of countries before and after the currency union. In the second we evaluate the impact of these variables on economic growth.

The paper is divided into six sections (including introduction and conclusions). In the second section we shortly illustrate theoretical and empirical arguments of the literature on the relationship between exchange rate volatility and growth. In the third section we describe the approach followed to build a real effective exchange rate (REER) risk indicators in order to measure the effects of convergence toward the Euro on exchange rate volatility. In the fourth and fifth section we respectively describe our econometric specification and present findings which evaluate the statistical and economic impact of REER volatility and of quality of institutional rules and macroeconomic policies (QIRMP) on economic growth.

2 The relationship between REER and growth

The main channel though which volatility is expected to affect growth is investment but theoretical evidence on the relationship between investment and volatility is mixed (Caballero and Corbo 1989. Baum et al 2001, Froot and Kemplerer 1989, Serven 2000). Theoretical predictions on the relationship between exchange rate volatility and investment depend on assumptions on market competitiveness, symmetry/asymmetry of investment adjustment costs and entrepreneurial attitudes toward risk.

Cavallero and Corbo, (1989) predict a positive effect of volatility on investment under perfect competition, risk neutrality and symmetric costs of capital adjustment. The positive effect arises from the convexity of the profit function implying that potential losses for insufficient investment in good states are higher than potential costs for excess capacity in bad states and therefore lead firms to overinvest when the exchange rate volatility is higher.

This result, though, disappears under more realistic assumptions such as the departure from risk neutrality and symmetric costs of capital adjustment. The existence of sunk costs implies per se that costs of downward are higher than those of upward adjustments (Dixit and Pindick 1994). Serven (2000) shows that

irreversibility must be accompanied by imperfect competition and decreasing returns to scale to change the sign (from positive to negative) of the relationship among uncertainty, investment and growth. The direction of the link between investment and volatility definitely changes (and becomes negative) if we also introduce risk aversion.

Theoretical papers analyzing the direct relationship between exchange rate volatility and growth find mixed results. Baum et al (2001) use a signal extraction framework to investigate the effects of permanent and transitory components of exchange rates on firms' profitability under imperfect information. They find that the variances of these components have indeterminate effects on profits growth, but predictable effects on its volatility. Froot and Kemplerer (1989) observe in an oligopolistic framework that, when market shares matter, exchange rate volatility may affect price and quantity of trade in both directions, regardless of risk preferences.

More clear evidence is provided on the empirical side by Serven (2000) who finds that a GARCH-based measure of real exchange rate volatility has a strong negative impact on investment, larger in countries with highly open economies and less developed financial systems.[3]

On the methodological side, the empirical research on the relationship between exchange rate volatility and growth has followed different methodological paths: bilateral exchange rate volatility, ARCH–modeled volatility, real effective exchange rate volatility and volatility of the exchange rate misalignment with respect to a 'fundamental' value (Razin and Collins 1997).

Empirical findings seem consistent with the above mentioned theoretical approach which considers the role of asymmetric sunk costs and finds a negative relationship among exchange rate volatility, investment and growth (Cottani et al 1990, Dollar 1992, Ghura and Grennes 1993, Darby et al 1999).

None of these papers devises a real effective (trade weighted) exchange rate (also called REER) and tests the hypothesis of a negative relationship between REER and growth.[4] The value added of using a REER is that this measure crucially incorporates volatility induced by trading partners and its difference with bilateral exchange rate volatility may be substantial leading to erroneous interpretations of the exchange rate volatilities associated with different exchange rate regimes.

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[3] A likely explanation is that economies of these countries are more exposed to export portfolio risk and dispose of less financial instruments to hedge it.

[4] The only example in this direction is provided by Bleaney and Greenaway (2001) examining the effect of the level and volatility of the terms of trade and the real effective exchange rate on investment and growth in a panel of 14 sub-Saharan African countries over the 1980–1995 period. The authors find that growth is negatively affected by terms of trade instability, while investment by real exchange rate instability. Both growth and investment increase when the terms of trade improve and real exchange rate overvaluation is eliminated.

Kent and Naya (2002) illustrate this point showing that, in a set of countries with low and stable inflation and stable growth rates from 1978 to 1994, the REER is only twice as volatile under floating regimes as under fixed regimes. But this result is likely to be influenced by a few countries which experienced periods of hyperinflation and high volatility. Although this difference is statistically significant, results within such countries show that for most countries there was no significant increase in effective REER volatility when moving to more flexible exchange-rate regimes. Surprisingly, there are even some countries for which volatility is lower under more flexible exchange-rate regimes.

These are the reasons for using REER volatility to evaluate first the effect of the convergence toward a MU on exchange rate instability and, after that, the impact of exchange rate instability on growth.

3 The definition of the Real effective exchange rate risk

Our REER-based approach at evaluating exchange rate risk hinges on the idea that a country may be conceived as having a portfolio of assets represented by its relationships with trade partners.

More formally, if the i–th country has trade relationships with j (j = 1,..,N) partners, the variance of its portfolio $\sigma^2_{p,i}$ may be written as

$$\sigma^2_{p,i} = \sum_j x_j^2 \sigma_j^2 + 2\sum_{h<k} x_h x_k \sigma_{hk}$$

where σ^2_j is the variance of the return of the j–th asset, ie the rate of return of the bilateral exchange rate with the j–th partner, x_j is the share of export to the j–th partner out of the i–th country total export, σ_{hk} is the covariance between bilateral exchange rate returns of the i–th country with partners h and k.

Our measure of effective exchange rate variance is therefore a ‘portfolio variance’. It includes the volatility of each bilateral exchange rate and their covariances weighted for their relative trade shares.

The REER variable has two main advantages with respect to a simple bilateral exchange rate with a leading currency (ie the dollar). First, it includes neighbours’ (or trade partners’) externalities in the evaluation of the effects of exchange rate volatility on growth. This inclusion is fundamental because a country may have good governance and good macroeconomic policies (and, therefore, may be likely to have a low bilateral exchange rate volatility with a leading currency, say, the dollar) but may import instability via variability of governance and economic

policies of its trade partners. Individual country stability is therefore insufficient if it is not framed into regional stability and this is why the export portfolio risk variable is more likely to measure the costs of missing regional integration.[5]

Second it takes into account that favorable and unfavorable exchange rate movements with different trade partners may compensate each other, thereby dampening the negative effects of individual bilateral exchange rate volatility on growth (Quian and Varangis 1994). This effect is incorporated in our export portfolio risk measure which conveniently takes into account the potential impact of trade diversification on export risk.

When building the REER index we consider that, as far as export shares of a given trading partner get lower, their contribution to the REER becomes negligible.

For this reason, and in order to avoid to include in the analysis trade partners with very small shares, we consider the following three constraints: i) no more than 7 partners, ii) a cumulative export share not higher than 60 percent, iii) an individual partner share not smaller than 2 percent. When one of these constraints is hit we do not include additional trade partners in our REER measure.[6]

4 Descriptive statistics on the REER dynamics for Eurozone and non Eurozone countries

In Table 1 (and in Figures 1 and 2) we show the dynamics of REER volatilities per macroareas between 1980 and 2001.[7]

The inspection of the dynamics of the export portfolio risk variable in the EUROZONE countries (column 2, Table 1) shows a sharp rise in volatility between 1983 and 1985, a period of high regional exchange rate instability because of the frequent realignments among currencies in the European Monetary

[5] A typical example for illustrating this point is that the inspection of the volatility of the bilateral dollar-Argentinean peso exchange rate would suggest low nominal (and slightly higher real) effective exchange rate volatility before the Argentinean crisis, while our measure of real effective exchange rate volatility would have been higher in the same period including the volatility generated by the devaluation of the currency of one of its main trade partners (such as Brazil).

[6] Since we are interested in the effects of the historically realised REER on growth and not in the investigation of its law of variation we prefer the above mentioned way of calculating it to ARCH or GARCH measures of volatility.

[7] The considered macroareas are: i) EUROZONE countries: Belgium, Germany, Spain, France, Ireland, Italy, Luxembourg, Netherlands, Austria, Portugal, Finland and Greece, ii) EU non EUROZONE countries: Denmark, Sweden, United Kingdom, iii) OECD non EU and non developping countries: Australia, Canada, Japan, Iceland, Norway, New Zealand, Switzerland, United States.

System and another smaller peak between 1991 and 1993. After 1993 we assist to a sharp decline in volatility for Eurozone countries. At the end of 2001 the export portfolio variance in the EUROZONE countries is more than four times smaller than at the end of the 1993. This descriptive finding does not contradict the hypothesis of the sensible effects of the European Monetary Union on the reduction of real effective exchange rate volatility of its members in the previous years and after the third and last step of the EMU.

In the three EU non EUROZONE countries volatility is always smaller than EUROZONE volatility (except for the 2001), it does not show the peak of the EUROZONE members at the end of 1985, while the peak between 1991 and 1993, even though significant, is smaller (column 3, Table 1).

The path for OECD non EU countries is quite different and their volatility is always bigger than that of EUROZONE countries (column 4, Table 1).[8] The peak between 1981 and 1985 is less significant with respect to the other areas (Figure 1). In the analysis within the area it is three times smaller with respect to the peak between 1993 and 1995.[9]

Some interesting considerations may be drawn from these descriptive statistics. The advantage of the medicine (a common currency) in terms of reduction of exchange rate volatility is primarily for those countries having ex ante a 'more severe pathology' (higher level of such variable). This determines for them a higher incentive to follow the therapy. It is not surprise therefore that those joining the common currency have a REER which is up to three times higher than EU countries which did not join. A second consideration is that MU may have generated positive externalities for non participating EU countries which benefited from a reduction of REER volatility due to the adjustment of MU candidates.

[8] In this group we exclude from OECD countries newcomers, Mexico and Korea given that with our classification we want to identify non EU non developing countries.

[9] The extremely high REER volatility during this period partially depends on Canada. Given that 75% of canadian exports are toward the US and the absence of trade diversification increases the export and exchange rate risk.

5 Descriptive statistics on the quality and heterogeneity of economic policies and institutional indicators for Eurozone and non Eurozone countries

The other potential source of benefits from MU is the expected change and harmonization in the institutional and policy environment. Durlauf and Quah (1998) identify 87 different proxies of variables enhancing growth in a survey of the related literature. Among them the quality of institutions (Rodrik 2000, Barro-Sala-i-Martin 1995, 1996, 2002), financial institutions (Pagano 1993, King and Levine 1997) appear together with human capital (Mankiw and Romer and Weil 1992), the government sector (Hall and Jones 1997), social and political stability (Alesina and Perotti 1994), corruption (Mauro 1995), social capital (Knack and Keefer 1997),[10] income inequality (Persson and Tabellini 1994, Perotti 1996) and many others. In evaluating the relative weight of each of these variables, Sala-y-Martin (2002) finds that institutional quality is one of the most robust.

Other contributions specify why we expect institutions to play an important role. Rodrik (1999, 2002) and Frankel (2002) argue that market based economies, to be successful, crucially need good institutions and, more specifically, institutions to protect property rights, to fight corruption, to support macroeconomic stabilization and to promote social cohesion. Klein and Luu (2003) find that that technical efficiency is positively related to policies supporting laissez-faire and political structures that promoting policy stability. Esfahani and Ramirez (2003) find that good institutions support the creation of infrastructure needed to promote growth.

In this perspective we observe that the convergence toward a currency union unequivocally generates changes in governance of the member states. One of its effects is the partial devolution of economic and political power from national to European institutions.

To evaluate the direction of changes in average quality and homogeneity of governance we analyse the dynamics of the economic freedom indicators of the Frazer Institute for different groups of countries. The indicators being part of the different governance factors and the calculation approaches are described in the legend of Table 2. Given the way these indicators are formed we consider the aggregate index as a proxy of the quality of institutional rules and macroeconomic policies (QIRMP), when we do not refer more specifically to some of them composing the aggregate index.

[10] According to these authors financial institutions improve the screening and monitoring of investment projects, provide mobilisation and aggregation services to savings and enhance opportunities for risk management and liquidity.

The main general result in this table is that EU eurozone countries exhibit: i) a higher relative improvement with respect to EU non eurozone and other OECD non eurozone in the 'access to sound money indicators', ii) quite surprisingly a lower relative improvement in the general QIRMP indicator and in the specific indicators of credit and labour market regulation; iii) a sharply lower within group variability in all the considered indicators.

6 The econometric specification

To test the impact of exchange rate risk and governance quality on levels and growth per capita GDP consider the standard MRW (1992) production function taking into account the role of human capital

$$Y_t = F(k, H, AL) = K_t^{\alpha} H_t^{\beta} (A_t L_t)^{1-\alpha-\beta} \quad \text{with } \alpha + \beta < 1 \tag{6.1}$$

where H is the stock of human capital, while L and K are the two traditional labour and physical capital inputs and A is a labour augmenting factor.

Physical and human capital follow the standard laws of motion.

$$\dot{K} = s_K Y - \delta K \tag{6.2}$$

and

$$\dot{H} = s_H Y - \delta H \tag{6.3}$$

where s_k and s_h are the fractions of income respectively invested in physical and human capital. The exogenous growth of the labour input is expressed as

$$L_t = L_0 e^{nt} \tag{6.4}$$ [11]

Differently from MRW (1992), we test whether the variable resuming the effect of the residual factors affecting productivity includes REER volatility and institutional factors affected by the convergence toward the monetary union.

[11] The exogeneity of labour force growth is a restrictive assumption which can be accepted considering that changes in per capita income on fertility affect labour force with lags which go beyond the time interval considered in our estimate (especially panel estimates). Moreover, we may also assume that with migration and partial international mobility of labour the effect of domestic fertility on the labour force is limited.

We therefore model labour augmenting technological progress as formed by two components

$$A_{(t)} = A_{KP(t)} A_{V(QIRMP,REERV,...)(t)} \tag{6.5}$$

with

$A_{V(QIRMP,\ REER,\ ...)(t)} = A_{V(0)} e^{gV(t)}$ and $A_{KP(t)} = A_{KP(0)} e^{gKP(t)}$

$A_{KP(t)}$ is the contribution to technological progress of the stock of weightless infinitely reproducible knowledge products and g_{KP} its rate of growth, whereas A_V is a measure of all factors different from the former affecting the capacity of labour productivity of affecting per capita GDP (and, among them, the quality of governance and of macroeconomic policies (QIRMP) and REER volatility) and g_V its rate of growth.[12]

By rewriting the production function in terms of output per efficiency units as $y = k^{\alpha} h^{\beta}$ we can obtain the two standard growth equations

$$\dot{k}_t = s_k y_t - (n + g + \delta) k_t \tag{6.6}$$

$$\dot{h}_t = s_h y_t - (n + g + \delta) h_t \tag{6.7}$$

where

$g = g_{EPR} + g_{QI} + g_{KP}$

If we set the growth of physical and human capital equal to zero in the steady state we get

$$k^* = \left(\frac{s_k^{1-\beta} \cdot s_h^{\beta}}{n + g + \delta} \right)^{\frac{1}{1-\alpha-\beta}} \tag{6.8}$$

$$h^* = \left(\frac{s_k^{\alpha} \cdot s_h^{1-\alpha}}{n + g + \delta} \right)^{\frac{1}{1-\alpha-\beta}} \tag{6.9}$$

[12] For simplicity these two factors are modelled here as augmenting the productivity of labour, even though only some of their features may be strictly considered as such (ie quality of institutions regarding restriction of labur and credit markets, exchange rate induced effects on competitiveness of domestic labour force, etc.)

Substituting h* and k* into the production function and taking logs we obtain

$$\frac{Y}{L} = Af(k^*, h^*) = Ak^{*\alpha}\ h^{*\beta} = A_{KP(0)}e^{g_{KP}t}A_{V(0)}e^{gVt}A_{QI(0)}e^{gQIt}k^{*\alpha}\ h^{*\beta} \tag{6.10}$$

and

$$\ln\left(\frac{Y_t}{L_t}\right) = c + \gamma_1[\ln(A_{QIMP}) + g_{PIMP}t] + \gamma_2[\ln(A_{REERV}) + g_{REERV}t]$$
$$\frac{\alpha}{1-\alpha-\beta}\ln(s_k) + \frac{\beta}{1-\alpha-\beta}\ln(s_h) + -\frac{\alpha+\beta}{1-\alpha-\beta}\ln(n+g+\delta) \tag{6.11}$$

where $c = \ln(A_{KP(0)}) + g_{KP}t$ is the quasi-public good component of knowledge products and is therefore assumed constant across countries and $[\ln(A_{QIMP}) + g_{PIMP}t]$, $_2[\ln(A_{REERV}) + g_{REERV}t]$ are two specific components (quality of institutional rules and macroeconomic policies and real effective exchange rate volatility) of the country specific factors augmenting the effects of labour input on levels and growth of real per capita GDP when we interpret $A_{V(QI,\ REERV,\ ...)}$ as $A_V = \gamma_1 A_{QIMP}{*}\gamma_2 A_{REERV}{*}\gamma_3 Ar$ where Ar captures all additional factors affecting the labour augmenting component. In this augmented MRW model, the possibility that all countries have the same steady state level of per capita income depends not only on the levelling of their rate of population growth and of their physical and human capital investment rates, but also on REER and quality of rules and macroeconomic policies.

Given the production function specified in 1 it is possible to show that, in the proximity of the balanced growth path, y converges to y* at the rate $(1 - \alpha - \beta)(n + g) \equiv \lambda$ since the solution of the differential equation[13]

$$\frac{d\ln(y)}{dt} = -\lambda[\ln(y) - \ln(y^*)] \tag{6.12}$$

is

$$\ln(y_t) - \ln(y^*) = e^{-\lambda t}[\ln(y_0) - \ln(y^*)] \tag{6.13}$$

If we add $\ln(y^*) - \ln(y_0)$ to both sides we get an equation explaining the rate of growth

[13] This obviously implies that the speed of convergence differs across countries and is crucially influenced by the pace of labour augmenting A-factors.

$$\ln(y_t) - \ln(y_0) = -(1 - e^{-\lambda t})[\ln(y_0) - \ln(y^*)]$$

Replacing ln(y*) with our solution we get

$$\begin{aligned}\ln(y_t) - \ln(y_0) = {} & (1 - e^{-\lambda t})\frac{\alpha}{1-\alpha-\beta}\ln(s_k) + (1 - e^{-\lambda t})\frac{\beta}{1-\alpha-\beta}\ln(s_h) \\ & + -(1 - e^{-\lambda t})\frac{\alpha+\beta}{1-\alpha-\beta}\ln(n+g+\delta) - (1 - e^{-\lambda t})\ln(y_0)\end{aligned} \tag{6.14}$$

or

$$\begin{aligned}&\ln((Y/L)(t)) - \ln((Y/L)(0)) = c' + g_v t + \gamma_1[\ln(A_{QIMP}) + g_{PIMP} t] \\ &+ \gamma_2[\ln(A_{REERV}) + g_{REERV} t] + (1 - e^{-\lambda t})c_1 \ln(s_k) + c_2 \ln(s_h) + c_3 \ln(n+g+\delta) \\ &+ c_4 \ln((Y/L)(0))\end{aligned} \tag{6.16}$$

To interpret our model, and, especially, findings from the growth estimate in (6.16) remember that, while the MRW estimation framework was adopted by the authors originally to test the (human capital augmented) Solow exogenous growth model, Bernanke and Gurkaynak (2001) show that such estimation framework is consistent with any growth model that admits a balanced growth path and therefore is compatible also with suitable endogenous growth models.

More specifically, Bernanke and Gurkaynak propose an example of such observationally equivalent model in which total factor productivity is determined by education.

The exogenous/endogenous growth issue has special interest when we interpret the results of our growth equation, given that the interpretation under the two perspectives is quite different.

The validity of the MRW framework in the augmented Solow model perspective, implies that growth is determined by transitional dynamics, leading to the steady state equilibrium level of per capita GDP (the latter being affected by country fundamentals which include human capital investment). Growth from this perspective is uniquely determined by exogenous changes in the labour augmenting A-factor.

The same empirical finding would imply, in the endogenous growth perspective, that human capital investment directly affects growth and not just equilibrium levels of per capita GDP.

However, since we introduce REER volatility and quality of institutions and economic policies as determinants of the A-factor, the traditional distinction between exogenous/endogenous growth models in terms of the role of economic policy as a growth stimulus fades away.

By arguing that REER volatility and quality of institutions and economic policies proxy important components of the A-factor which augments labour productivity and is uniquely responsible of further growth from the equilibrium point, we implicitly introduce the importance of institutions and policies also in the exogenous growth framework.[14]

7 The choice of regressors

Variables for our empirical analysis are taken from the World Bank (WB) database. The dependent variable Y/L is the real gross domestic product per working-age person, L is the working age population (population aged between 15–64). s_k is gross domestic investment over GDP and is calculated using values taken from Penn World Tables or, alternatively, World Bank data.[15]

In our empirical estimate we use basically three different types of human capital proxies.

The first is represented by measures of school enrollment ratios at different educational levels. School enrollment data are reported to the UNESCO Institute for Statistics by national authorities.[16]

The use of gross enrolment ratios as proxies of human capital investment, even tough used in most empirical growth papers, has been subject to severe criticism (Wossmann, 2003). Current enrollment ratios represent the investment of future and not current workers and, even if we lag this variable, it is very difficult to relate it exactly with the human capital investment of current workers. This is why average schooling years are considered a superior proxy when measuring the investment in human capital of the current labour force.

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[14] Dowrick and Rogers (2002) implicitly share our view by arguing that 'the Solow-Swann steady state is a moving target which grows at different rates in each country' and by adding that such growth depends on technical progress which 'may well reflect unobserved policy and institutional differences'.

[15] Penn World Tables are the result of a United Nation International Comparison Project whose aim is to create information for consistent cross-country comparisons in time and space starting from price surveys of identical sets of good and services in different countries. To find a detailed discussion of the methodology and of the critical issues of PWTs see Heston-Summers (1988, 1991 and 1996).

[16] Usually we find measurs of gross and net school enrollment ratios. The first is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education shown, the second is the ratio of children of primary school age who are enrolled in school. Although the net enrollment ratio is more precise because excludes overage students in an attempt to capture more accurately the system's coverage, we use the gross enrollment ratio because of the scarcity of data available for the net ratio.

As a proxy of average schooling years we use ten-year data calculated by Barro and Lee (2000). Barro and Lee apply basically the same methodology based on census and survey data on educational attainment levels, but they extend the coverage of countries and years.

There is a mayor criticisms that render years of schooling a poor proxy for the human capital stock. Specifying human capital by average year of schooling implicitly gives the same weight to any year of schooling acquired by a person regardless of the efficiency of the educational system, of the quality of teaching, of the educational infrastructure, or of the curriculum. The indicator should therefore be weighted according to the quality of the education system in which it has taken place.

To encompass this problem we use as a third proxy of human capital, the Hanushek and Kimko's (2000) educational quality index, conveniently normalized by Wossmann (2003) for each country relative to the measure for the United States.

8 Empirical findings

We test the significance of institutional quality and REER volatility on real per capita GDP in levels and on per capita GDP growth in cross sectional and panel estimates.

Results on the determinants of real GDP levels in 4(interval)*5-year panel data[17] are quite robust and consistent with the theory (Tables 3.1–3.2).[18]

Coefficients pass several tests on restrictions imposed by the model, such as those on i) diminishing returns on physical and human capital, ii) nonzero physical and human capital shares and iii) equality between the sum of the physical and human capital coefficients and the coefficient on the variable summing rates of change in population and in technological process plus depreciation. The hypothesis of the joint insignificance of fixed effects is always rejected and the model performs better when explaining variability between countries than within the same country in moments of time.

In most estimates confidence intervals suggest that the human capital share, even though lower in mean than what expected, is not significantly different from

[17] The relative advantage of panel over cross-sectional estimates is that the former avoid the cross-sectional constant critique, or the assumption that the part of the labour augmenting component unexplained by our regressors is the same for each country (Islam 1995, Temple 1999).

[18] Sensitivity analysis on our results shows that they are robust to the use of the three different proxies of human capital, to the use of WB or PWT investment in physical capital and also to the adoption of beginning of period or of average period regressors. Results are omitted for reasons of space and are available upon request.

the lower bound indicated by MRW in their paper (1/3).[19] The physical capital share is lower than expected, consistently with results obtained by the same authors as well. Coefficients of A-factors added to the estimates (QIRMP and REER) have the expected sign and are lower than one confirming our hypothesis that the two factors contribute to explain only part of the overall labour augmenting component. A major problem though is that REER volatility and quality of institutions are highly correlated variables (around .5). Therefore their coefficients tend to be unstable when they are both present in the estimate. This is why we propose estimates with, alternatively, one of them present.

In level panel estimates we have an interesting alternative to evaluate the anticipated effects of EMU on our estimates. The last two spells of our 4(interval)*5-year panel coincide with the period in which we identified that anticipated effects of convergence toward monetary union materialised in terms of reduced REER and improved institutional quality. We may therefore directly estimate the impact of convergence toward the EMU by introducing a dummy for Eurozone countries covering the last two five year periods. Our results (Tables 3.1–3.2) show that the UME dummy effect is quite significant in level estimates both when we introduce it in a simple MRW estimate and when we add to physical and human capital one of the two above considered variables affected by EMU convergence (REER and institutional quality). Since we estimate a fixed effect model, the impact of the UME dummy cannot be confused with country specific constant characteristics which positively affect levels of per capita GDP. The effect of the dummy therefore captures a positive impact on the dependent variable for the MU countries in the period of the Stability and Growth Pact (even though not necessarily due to the Pact), independent from other unobserved MU country specific factors which are invariant in time.

Level cross-sectional estimates (Table 4) give results which are not substantially different from those of panel estimates, even though the sharp reduction of degrees of freedom seems to limit the set of regressions which satisfy all our hypotheses on coefficient magnitudes and parameters restrictions.

For growth estimates we report both cross-sectional and panel results (Tables 5–6.2). As expected, it is difficult that all hypotheses of conditional convergence be respected in short time intervals such as those considered in our panel estimates. The model proves to weaker in the repeated five year interval of panel estimates than in the larger twenty year sample period of cross-sectional estimates, especially when we look at human capital investment which is not significant in panel growth estimates, consistently with Islam (1995) results. Both cross sectional and panel convergence estimates support our hypothesis on the relevance of REER and institutional quality indicators.

[19] Tests of this hypothesis are omitted for reasons of space and are available upon request.

Results, presented in tables 3.1–6.2 are confirmed (with some exceptions) when we use bootstrap standard errors and are therefore robust to changes in sample composition and independent from the assumption of a specific functional form for the dependent variable.[20]

Summing up, we find that the REER variance effect is statistically significant both in panel and cross-sectional level and growth estimates. When looking at the economic significance of the REER variance effect in the five year horizon of the panel interval we find that a doubling of the REER variance generates a change of 1–2 percent (0.5 percent) in levels (rates of growth) of real per capita GDP. In cross-sectional estimates which cover a longer time horizon the same change in the REER variance generates an effect on levels up to 9 percent and on rates of growth is around 4.5 percent.

Presentation of results consistent with the model (tables 3.1–6.2) with more estimates for panel levels and less for panel convergence) also outline the 'robustness borders' of our results (superior robustness of panel estimates in levels) and try as far as possible to tackle the two well known problems of heterogeneity[21] and endogeneity (in using long lags for the regressors), aware of the trade-off between MRW model requirements (which imply using sample period averages of regressors) and econometric problems (which require lagged or instrumented regressors to reduce endogeneity).

9 Conclusions

In the trilemma generated by global integration Monetary Unions are considered as an optimal way to pursue at least two of the three desirable goals at stake (economic integration and proper public policy management) at the expense of the third (national sovereignty) or as a subregional partial solution to the trilemma when lack of more broader consensus for the loss of sovereignty exists.

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[20] Bootstrapping provides an alternative way of estimating standard errors which does not rely on any a priori given distributional form (Efron 1979, Efron and Stein 1981, Efron and Tibshirani 1986). More specifically, in each trial of the bootstrapping procedure we draw with replacement N observations from the N observation dataset (therefore in each trials some countries may have higher weight and other countries may not be included in the sample). We perform two thousands of trials and for each of them we calculated the coefficient magnitude. The estimate of the standard error os that statistics then depends on the variability of the estimate in the different trials. In this sense, and given that in each trial of the bootstrapping procedure we draw with replacement N observations from the N observation dataset, bootstrapping measures the sensitivity of the result to changes in the number of observations.

[21] The sensitivity of our results to different weights on countries/observations is implicitly tested the drawing with replacement approach of bootstrap estimates.

We measure in this paper whether such solution has testable consequences on levels and growth of real per capita GDP consistently with the title of the agreement establishing the path for convergence toward the EMU (the Stability and Growth Pact).

We start with a short institutional background documenting the strict consequentiality between the Maastricht Treaty and the Stability and Growth Pact, on the one side, and the target of the MU, on the other side, showing how EU-non Eurozone countries had weaker obligations in the convergence period. We therefore argue that effects of MU are anticipated and must be evaluated starting from the convergence process.

In principle, and on the basis of theoretical and simply rational grounds, we expect that the anticipated and concurring effects of the EMU should materialize in terms of reduced REER volatility and of higher quality and reduced within group variability of institutional rules and economic policies. When comparing relative changes in these variables of EU Eurozone countries with a control sample we find with surprise that, while the REER volatility reduction effect is strong and confirmed, the positive change in quality of institutional rules and economic policies is not higher than that in EU non Eurozone and in other non OECD countries.

In a second step we test in different ways whether these two effects have significant impact on levels and growth of per capita GDP. We find a robust effect on levels for both institutional quality and reduction of REER volatility, confirmed and reinforced by a direct positive effect of Eurozone countries during the convergence period. We also find a weaker and less robust positive effect on growth of the two variables in cross-sectional and panel estimates.

Table 1. **The relative dynamics of export portfolio volatility across macroareas**

	World	Eurozone	Eu No Eurozone	OECD No EU
1981/12	1.000	0.0306	0.0054	0.1776
1983/12	3.451	0.0169	0.0098	0.2161
1986/12	>100	0.0316	0.0039	0.2841
1987/12	22.917	0.0104	0.0041	0.1109
1989/12	>100	0.0187	0.0028	0.1728
1991/12	1.572	0.0235	0.0021	0.2589
1993/12	4.230	0.0261	0.0127	0.2536
1995/12	1.197	0.0071	0.0026	0.9582
1997/12	0.232	0.0046	0.0031	0.1114
1999/12	0.363	0.0068	0.0027	0.1660
2001/12	0.432	0.0065	0.0096	0.0525

(monthly REER variance is calculated as two-year moving average of REER monthly returns. World December 1981=1)

The Export portfolio risk or real effective exchange rate (REER) variance for the i–th country having trade relationships with j (j = 1,..,N) partners, $\sigma^2_{p,i}$, may be written as

$$\sigma^2_{p,i} = \sum_j x_j^2 \sigma_j^2 + 2\sum_{h<k} x_h x_k \sigma_{hk}$$

where σ_j^2 is the variance of the return of the j–th asset, ie the rate of return of the bilateral exchange rate with the j–th partner. x_j is the share of export to the j–th partner out of the i–th country total export, σ_{hk} is the covariance between bilateral exchange rate returns of the i–th country with partners h and k.

When building the REER index we consider that, as far as export shares of a given trading partner get lower, their contribution to the REER becomes negligible.

For this reason, and in order to avoid to include in the analysis trade partners with very small shares, we consider the following three constraints: i) no more than 7 partners; ii) a cumulative export share not higher than 60 percent; iii) an individual partner share not smaller than 2 percent. When one of these constraints is hit we do not include additional trade partners in our EPR measure.

Figure 1.

Dynamics of export portfolio volatility in EU and OECD no EU countries

(monthly REER variance is calculated as two-year moving average of REER monthly returns. World December 1981=1)

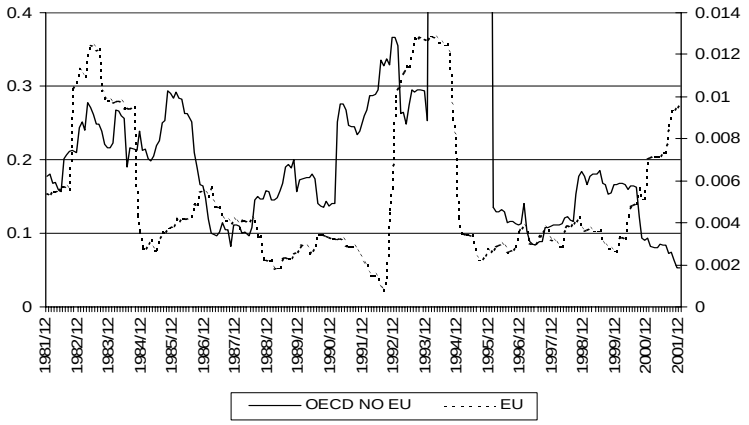

Figure 2.

Dynamics of export portfolio volatility in EUROZONE countries and EU NO EUROZONE countries

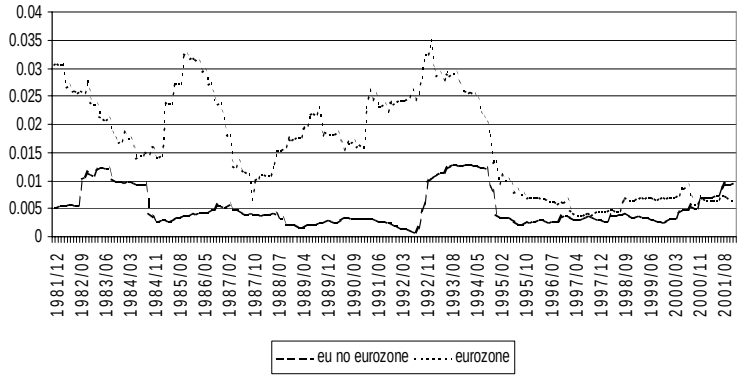

Table 2. **Changes in real effective exchange rates (REER) and in quality of institutions and policies**

Countries	Real effective exchange rate (2001 value / 1993 value)	Quality of institutions and of economic policies (2001 value / 1993 value)	Regulation of Credit, Labor, and Business (2001 value / 1993 value)	Access to Sound Money (2001 value / 1993 value)	Sigma convergence Quality of institutions and of economic policies (2001 s.d. / 1993 s.d.)	Sigma convergence Regulation of Credit, Labor, and Business (2001 s.d. / 1993 s.d.)	Sigma convergence Access to Sound Money (2001 s.d. / 1993 s.d.)
Eurozone	0.660	1.071	1.102	1.179	0.718	1.119	0.075
UE non Eurozone	0.895	1.079	1.124	1.145	1.085	1.309	0.311
OECD non EU	1.478	1.049	1.116	1.088	0.867	1.476	0.259
Non OECD	1.744	1.260	1.156	2.743	0.801	0.753	0.795

Legend: REER: real effective exchange rate (see Table 2 legend) QIRMP: index of the quality of institutions and of economic policies. It is measured as a simple average of the following composed indicators. **1 Size of Government: Expenditures, Taxes, and Enterprises.** A) General government consumption spending as a percentage of total consumption; B) Transfers and subsidies as a percentage of GDP; C) Government enterprises and investment as a percentage of GDP; D) Top marginal tax rate (and income threshold to which it applies); i) Top marginal tax rate (excluding applicable payroll taxes); ii) Top marginal tax rate (including applicable payroll taxes). **2 Legal Structure and Security of Property Rights**. A) Judicial independence. the judiciary is independent and not subject to interference by the government or parties in disputes; B) Impartial court. A trusted legal framework exists for private businesses to challenge the legality of government actions or regulation; C) Protection of intellectual property; D) Military interference in rule of law and the political process; E) Integrity of the legal system. **3 Access to Sound Money**. A) Average annual growth of the money supply in the last five years minus average annual growth of real GDP in the last ten years; B) Standard inflation variability in the last five years; C) Recent inflation rate; D) Freedom to own foreign currency bank accounts domestically and abroad. **4 Freedom to Exchange with Foreigners**. A) Taxes on international trade; i) Revenue from taxes on international trade as a percentage of exports plus imports; ii) Mean tariff rate; iii) Standard deviation of tariff rates; B) Regulatory trade barriers; i) Hidden import barriers. No barriers other than published tariffs and quotas; ii) Costs of importing. The combined effect of import tariffs, licence fees, bank fees, and the time required for administrative red-tape raises the costs of importing equipment; C) Actual size of trade sector compared to expected size; D) Difference between official exchange rate and black market rate, E) International capital market controls; i) Access of citizens to foreign capital markets and foreign access to domestic capital markets; ii) Restrictions on the freedom of citizens to engage in capital market exchange with foreigners index of capital controls among 13 IMF categories. **5 Regulation of Credit, Labor, and Business.** A) Credit Market Regulations; i) Ownership of banks. percentage of deposits held in privately owned banks; ii) Competition. Domestic banks face competition from foreign banks; iii) Extension of credit. percentage of credit extended to private sector; iv) Avoidance of interest rate controls and regulations that lead to negative real interest rates; v) Interest rate controls. Interest rate controls on bank deposits and/or loans are freely determined by the market; B) Labor Market Regulations; i) Impact of minimum wage. The minimum wage, set by law, has little impact on wages because it is too low or not obeyed; ii) Hiring and firing practices. Hiring and firing practices of companies are determined by private contract; iii) Share of labor force whose wages are set by centralized collective bargaining; iv) Unemployment Benefits. The unemployment benefits system preserves the incentive to work; v) Use of conscripts to obtain military personnel; C) Business Regulations; i) Price controls. Extent to which businesses are free to set their own prices; ii) Administrative conditions and new businesses. Administrative procedures are an important obstacle to starting a new business; iii) Time with government bureaucracy. Senior management spends a substantial amount of time dealing with government bureaucracy; iv) Starting a new business. Starting a new business is generally easy; v) Irregular payments. Irregular, additional payments connected with import and export permits, business licenses, exchange controls, tax assessments, police protection, or loan applications are very rare.

Table 3.1 **The determinants of levels of real per capita GDP (panel estimates): the effect of REER volatility and of quality of institutional rules and macroeconomic policies (five year spells between 1980–2001)**

	MRW	Estimates augmented with REER variance and QIRMP variables			
Lngcapform (1)	0.167 **	0.198 **	0.112 **	0.144 **	0.240 **
	[0.176]	[4.480]	[2.370]	[3.000]	[4.900]
Lnaverschol (2)	0.340 **	0.311 **	0.339 **	0.290 **	0.442 **
	[8.480]	[7.880]	[5.580]	[4.660]	[6.610]
Lnngd (3)	–0.333 **	–0.330 **	–0.467 **	–0.582 **	–0.610 **
	[–3.110]	[–3.160]	[–3.970]	[–5.700]	[–5.920]
LnREERV			–0.017 **		
			[–3.430]		
LnQIRMP				0.410 **	
				[6.550]	
Lncredlabbus					0.542 **
					[6.400]
Ume		0.288 **	0.202 **	0.180 **	0.179 **
		[5.120]	[4.570]	[4.110]	[3.970]
Constant	7.618	7.708 **	7.122 **	6.494 **	6.054 **
	[25.490]	[26.380]	[21.740]	[23.820]	[20.380]
H_0: Joint insignificance of fixed effects	115.79	117.54	141.91	127.17	126.26
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
R^2 overall	0.5694	0.5755	0.6694	0.6642	0.6712
R^2 between	0.5542	0.5765	0.711	0.6781	0.6816
R^2 within	0.1558	0.2006	0.2508	0.3579	0.3924
α	0.111	0.131	0.077	0.101	0.143
β	0.226	0.206	0.234	0.202	0.263
H_0: (1)+(2) = –(3)	1.84	2.62	0.01	1.28	0.28
	(0.4662)	(0.1062)	(0.9046)	(0.2592)	(0.5990)
H_0: β=0	69.11	86.21	51.24	34.26	75.76
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Countries	101	101	81	91	89
Obs	608	608	383	443	417

Legend: lngcapform: log of gross capital formation over GDP (WB data); lnaverschol average schooling of the working population; lnngd: log of the sum of the rate of growth of population, stock of capital depreciation and technological progress; LnQIRMP: Quality of institutional rules and of macroeconomic policies (see table 3 legend), lncredlabus log of the index on Regulation of Credit, Labor, and Business (see table 3 legend); LnREERV: real effective exchange rate variance (see Table 2 legend); UME: dummy for Eurozone countries in the 1992–2001 period.

All regressors are calculated as four year averages excluding the final year of the five year time spell. T-stats are in square brackets. ** 95 percent significance with bootstrap standard errors, * 90 percent significance with bootstrap standard errors (percentile and bias corrected approach with 2000 replications).

Table 3.2 **The determinants of levels of real per capita GDP (panel estimates): the effect of REER volatility and of quality of institutional rules and macroeconomic policies (five year spells between 1980–2001)**

	MRW	Estimates augmented with REER variance and QIRMP variables			
Lngcapfis (1)	0.185 **	0.190 **	0.161 **	0.111 **	0.139 **
	[5.870]	[6.200]	[4.310]	[3.190]	[3.850]
Lnaverschoolqua (2)	0.292 **	0.267 **	0.280 **	0.215 **	0.316 **
	[7.500]	[6.980]	[5.210]	[4.580]	[6.180]
Lnngd (3)	–0.545 **	–0.516 **	–0.382 **	–0.480 **	–0.466 **
	[–4.840]	[–4.710]	[–3.300]	[–4.670]	[–4.320]
LnREERV			–0.011 **		
			[–2.280]		
ume		0.229 **	0.200 **	0.180 **	0.184 **
		[4.930]	[4.730]	[4.400]	[4.400]
Lncredlabbus					0.395 **
					[4.620]
LnQIRMP				0.385 **	
				[6.350]	
Constant	7.339 **	7.453 **	7.713 **	6.980 **	6.857 **
	[24.240]	[25.270]	[23.540]	[24.770]	[22.550]
H_0: Joint insignificance of fixed effects	113.770	116.01	134.430	116.37	111.15
		(0.00)		(0.00)	(0.00)
R^2 overall	0.691	0.700	0.724	0.733	0.755
R^2 between	0.693	0.711	0.746	0.747	0.760
R^2 within	0.216	0.263	0.272	0.366	0.362
α	0.125	0.130	0.112	0.084	0.096
β	0.198	0.183	0.194	0.162	0.217
H_0: (1)+(2) = –(3)	0.30	0.25	0.19	1.56	0.01
	(0.5822)	(0.6194)	(0.6646)	(0.2130)	(0.9308)
H_0: β=0	86.22	72.23	42.60	30.59	62.48
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Countries	87	87	75	83	81
Obs	476	476	356	414	389

Legend: lngcapfis: log of gross capital formation over GDP (PWT data); lnaverschoolqua: log of average schooling of the working population corrected for quality following Hanushek and Kimko (2000); lnngd: log of the sum of the rate of growth of population, stock of capital depreciation and technological progress; LnQIRMP: Quality of institutional rules and of macroeconomic policies (see table 3 legend), lncredlabus log of the index on Regulation of Credit, Labor, and Business (see table 3 legend); LnREERV: real effective exchange rate variance (see Table 2 legend).

All regressors are calculated in the first of the five year time spell. T-stats are in square brackets. ** 95 percent significance with bootstrap standard errors, * 90 percent significance with bootstrap standard errors (percentile and bias corrected approach with 2000 replications).

Table 4. **The determinants of levels of real per capita GDP (cross-sectional estimates): the effect of REER volatility and of quality of institutional rules and macroeconomic policies**

	MRW	Estimates augmented with REER variance and QIRMP variables				
Lncapfis (1)	0.593 **	0.350 **	0.519 **	0.535 **	0.660 **	0.747 **
	[2.580]	[1.640]	[2.030]	[1.990]	[2.550]	[3.030]
Lnschooltertgro (2)	0.746 **	0.794 **	0.814 **	0.759 **	0.661 **	0.741 **
	[7.660]	[8.520]	[9.210]	[8.780]	[6.680]	[8.130]
Lnngd (3)	–1.637 **	–1.376 **	–1.890 **	–2.010 **	–2.003 **	–2.224 **
	[–2.050]	[–1.980]	[–2.870]	[–3.510]	[–3.600]	[–3.600]
LnREERV		–0.145 **	–0.096 **	–0.062 *		
		[–3.390]	[–2.650]	[–2.330]		
LnQIRMP				1.644 **	2.095 **	
				[3.040]	[4.350]	
Lncredlabbus			1.704 **			2.472 **
			[3.380]			[4.860]
Constant	7.542 **	6.830 **	3.370 *	3.339 *	3.117 *	2.171 *
	[3.640]	[3.870]	[1.570]	[1.810]	[1.710]	[1.060]
R^2	0.699	0.767	0.803	0.826	0.789	0.769
α	0.253	0.163	0.223	0.233	0.284	0.300
β	0.319	0.370	0.349	0.331	0.285	0.298
H_0: (1)+(2) = –(3)	0.15	0.11	0.60	1.24	1.15	1.14
	(0.7017)	(0.7380)	(0.4423)	(0.2699)	(0.2876)	(28.80)
H_0: β=0	34.01	41.35	40.71	39.17	30.14	38.30
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
obs	94	84	74	75	82	82

Legend: lngcapfis: log of gross capital formation over GDP (PWT data); lnschooltergro: log of tertiary school gross enrolment ratio; lnngd: log of the sum of the rate of growth of population, stock of capital depreciation and technological progress; LnQIRMP: Quality of institutional rules and of macroeconomic policies (see table 3 legend), lncredlabus log of the index on Regulation of Credit, Labor, and Business (see table 3 legend); LnREERV: real effective exchange rate variance (see Table 2 legend).

All regressors are calculated in the first year of the sample period. T-stats are in square brackets. ** 95 percent significance with bootstrap standard errors, * 90 percent significance with bootstrap standard errors (percentile and bias corrected approach with 2000 replications).

Table 5. **The determinants of rates of growth of real per capita GDP (panel estimates): the effect of REER volatility and of quality of institutional rules and macroeconomic policies**

	MRW	Estimates augmented with REER variance and QIRMP variables	
Lngdpwr0	–0.152 **	–0.181 *	–0.157 *
	[–7.840]	[–5.500]	[–5.110]
Lngcapform (1)	0.108 **	0.058 **	0.061 **
	[5.180]	[2.060]	[2.250]
Lnaverschool (2)	–0.026 **	0.059 *	0.027 *
	[–1.260]	[1.550]	[0.720]
Lnngd (3)	–0.252 **	–0.162 **	–0.160 *
	[–5.110]	[–2.300]	[–2.650]
LnREERV		–0.006 **	
		[–1.990]	
LnQIRMP			0.066 *
			[1.740]
Constant	0.919 **	1.162 *	0.964 *
	[4.490]	[3.850]	[3.860]
H_0: Joint insignificance of fixed effects	3.80	2.18	2.39
	(0.00)	(0.00)	(0.00)
R^2 overall	0.0014	0.0007	0.0055
R^2 between	0.0048	0.0113	0.0245
R^2 within	0.2054	0.1113	0.0840
α	0.099	0.052	0.056
β	–0.024	0.053	0.024
H_0: (1)+(2) = –(3)	10.35	0.31	0.90
	(0.0014)	(0.5795)	(0.3427)
H_0: β=0	1.53	2.69	0.54
	(0.2171)	(0.1023)	(0.4620)
Countries	99	81	91
Obs	593	378	440

Legend: lngdpwr0: log of real per capita GDP in the first year of the sample period; lngcapform: log of gross capital formation over GDP (WB data) (moving average of the sample period excluding the final year); lnaverschol average schooling of the working population (moving average of the sample period excluding the final year); lnngd: log of the sum of the rate of growth of population, stock of capital depreciation and technological progress; LnREERV: log of one year variance of REER monthly returns (for the calculation of the REER see table 2 legend) (moving average of the sample period excluding the final year); LnQIRMP: Quality of institutional rules and of macroeconomic policies (see table 3 legend).

T-stats are in square brackets. ** 95 percent significance with bootstrap standard errors, * 90 percent significance with bootstrap standard errors (percentile and bias corrected approach with 2000 replications).

Table 6.1. **The determinants of rates of growth of real per capita GDP (cross-sectional estimates): the effect of REER volatility and of quality of institutional rules and macroeconomic policies**

	MRW	Estimates augmented with REER variance and QIRMP variances		
Lngdpwr0	–0.131 *	–0.183 **	–0.225 **	–0.249 **
	[–2.090]	[–3.300]	[–3.430]	[–4.1200]
Lncapfis (1)	0.260 **	0.198 **	0.337 **	0.297 **
	[3.000]	[2.300]	[3.150]	[2.9600]
Lnschoolsecgro (2)	0.141 *	0.242 **	0.277 **	0.387 **
	[1.560]	[2.660]	[2.8300]	[4.1300]
LnREERV (3)		–0.045 **		–0.035 **
		[–2.830]		[–1.9300]
Lnmngd	–1.227 **	–0.977 **	–0.899 **	–0.719 **
	[–3.890]	[–2.750]	[–3.0700]	[–2.1800]
LnQIRMP			0.690 **	0.369 **
			[2.8900]	[1.8700]
Lncredlabbus				
Constant	–1.309 *	–0.546 *	–0.496 *	–0.470 *
	[–1.690]	[–0.610]	[–0.620]	[–0.590]
R^2	0.281	0.442	0.405	0.540
α	0.186	0.137	0.209	0.177
β	0.101	0.168	0.171	0.230
H_0: (1)+(2) = –(3)	7.11	2.07	0.90	0.01
	(0.0091)	(0.1544)	(0.3456)	(0.9209)
H_0: β=0	2.93	9.44	11.22	28.04
	(0.0902)	(0.0030)	(0.0013)	(0.00)
Obs	93	80	82	74

Legend: lngdpwr0: log of real per capita GDP in the first year of the sample period; lncapfis: log of gross capital formation over GDP (PWT data); lnschoolsecgro: log of secondary school gross enrolment ratio; lnngd: log of the sum of the rate of growth of population, stock of capital depreciation and technological progress; LnREERV: log of one year variance of REER monthly returns (for the calculation of the REER see table 2 legend) (moving average of the sample period excluding the final year); LnQIRMP: Quality of institutional rules and of macroeconomic policies (see table 3 legend), lncredlabus log of the index on Regulation of Credit, Labor, and Business (see table 3 legend).

T-stats are in square brackets. ** 95 percent significance with bootstrap standard errors, * 90 percent significance with bootstrap standard errors (percentile and bias corrected approach with 2000 replications).

Table 6.2 **The determinants of rates of growth of real per capita GDP (cross-sectional estimates): the effect of REER volatility and of quality of institutional rules and macroeconomic policies**

	MRW	Estimates augmented with REER variance and QIRMP variables	
Lngdpwr0	–0.152 **	–0.181 *	–0.157 *
	[–7.840]	[–5.500]	[–5.110]
Lngcapform (1)	0.108 **	0.058 **	0.061 **
	[5.180]	[2.060]	[2.250]
Lnaverschool (2)	–0.026 **	0.059 *	0.027 *
	[–1.260]	[1.550]	[0.720]
Lnngd (3)	–0.252 **	–0.162 **	–0.160 *
	[–5.110]	[–2.300]	[–2.650]
LnREERV		–0.006 **	
		[–1.990]	
LnQIRMP			0.066 *
			[1.740]
Constant	0.919 **	1.162 *	0.964 *
	[4.490]	[3.850]	[3.860]
H_0: Joint insignificance of fixed effects	3.80	2.18	2.39
	(0.00)	(0.00)	(0.00)
R^2 overall	0.0014	0.0007	0.0055
R^2 between	0.0048	0.0113	0.0245
R^2 within	0.2054	0.1113	0.0840
α	0.099	0.052	0.056
β	–0.024	0.053	0.024
H_0: (1)+(2) = –(3)	10.35	0.31	0.90
	(0.0014)	(0.5795)	(0.3427)
H_0: β=0	1.53	2.69	0.54
	(0.2171)	(0.1023)	(0.4620)
Countries	99	81	91
Obs	593	378	440

Legend: lngdpwr0: log of real per capita GDP in the first year of the sample period; lncapfis: log of gross capital formation over GDP (PWT data); lnaverschoolqua average schooling of the working population corrected for quality; lnngd: log of the sum of the rate of growth of population, stock of capital depreciation and technological progress; LnREERV: log of one year variance of REER monthly returns (for the calculation of the REER see table 2 legend) (moving average of the sample period excluding the final year); LnQIRMP: Quality of institutional rules and of macroeconomic policies (see table 3 legend), lncredlabus log of the index on Regulation of Credit, Labor, and Business (see table 3 legend).

T-stats are in square brackets. ** 95 percent significance with bootstrap standard errors, * 90 percent significance with bootstrap standard errors (percentile and bias corrected approach with 2000 replications).

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