Sovereign debt markets in the new digital era

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ABSTRACT: We investigate the role of Information and Communication Technologies (ICTs) as a possible determinant of credit risk ratings and cost of debt, using for the first time in such a context and as a comprehensive proxy of ICTs' usage and diffusion, the Network Readiness Index. The empirical analysis of a panel of 65 countries between 2001-2010, by a modified random effects approach that allow us to distinguish between short and long run effects, confirms that ICTs are a significant long-run determinant of credit ratings and lending costs, especially for non-OECD countries.

Keywords: NRI index; E-readiness; Credit ratings; Sovereign debt
JEL Codes: C23, E43, E44, F34, G15, G24, H63, O33

1. Introduction

Policy and academic research has established the importance of Information and Communication Technology (ICT) as a driver of economic growth and development. This comes as no surprise as ICT is recognized widely as a development that is at par with the Industrial Revolution, steam power, electricity and fossil fuels (Alierta, 2011). Furthermore, as stated by Robert Greenhill (2011, p. V), Chief Business Officer of World Economic Forum, *"the last decade has seen information and communication technology (ICT) dramatically transforming the world".* This transformation is taking place the last few years, under the economic turmoil caused by the burst of the financial crisis that hit western economies towards the end of 2007 and resulted to a severe sovereign debt crisis, expressed by continuous sovereign credit ratings downgrades and a prohibitive cost of debt that excluded several sovereigns from debt markets. Therefore, a clear incentive exists in order to try to investigate and clarify the effect that ICT has at a country level on the costs and risks of lending, before and during crisis years and depending on the stage of economic development.

The emergence of the transformations in economies, described above, generated a need for analyzing the status of each country, in order to establish an understanding of where the country stands vis-à-vis the

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information society. This understanding is usually called e-readiness and until now, various academic institutions, private organizations and commercial publishers have issued measures in order to assess it and measure it (Grigorovici *et al*., 2004). E-readiness is a relatively new concept that evolved while striving to provide a unified framework of evaluation of the rapid rate of internet penetration throughout the world, the dramatic advance in the use of ICT in business and industry as well as the depth of the digital divide between more and less developed or developing countries. (Grigorovici *et.al*., 2004; Hanafizedah *et.al*., 2009).

The main contribution of this paper to the existing literature can be detected in three areas. First, we extend the empirical literature on the drivers of sovereign credit ratings and lending costs. Second, the ICT's impact is examined before and during crisis years in order to assess the effect on tranquil and turmoil periods. Third, we improve our understanding of how ICT affects economic growth, development and financial stability.

We employ a balanced dataset concerning 65 countries during 2001-2010 in order to empirically examine the relationship between a country's e-readiness and its credit ratings along with cost of debt. Our main hypothesis is that e-readiness will have an adverse effect on credit ratings and cost of debt due to the positive impact of ICTs to growth, directly and through spillovers, as has been suggested by Jorgenson and Stiroh, (2000), Oliner and Sichel (2000), Vu (2004) among others. We also test the hypothesis that the impact of e-readiness on ratings and cost of debt will be much stronger on developing countries, in line with Vu (2011), Jorgenson and Vu (2010) and Waverman *et.al.* (2005). Overall, our results lend support to both our hypotheses, indicating a clear path for developing countries in order to improve their credit profile.

The plan of this paper is as follows. Section B gives an overview of ICTs' impact on growth, the link between ICTs and credit ratings and the approximation of ICTs by the e-readiness concept. Section C outlines our research hypotheses and the methodology followed. Section D presents our empirical analysis and a discussion of findings and finally section E concludes.

2. Literature review

2.1. ICTs and growth

How and to what extent have the Information and Communication Technologies impacted economic growth and other macroeconomic fundamentals throughout the globe? Since the famous quote of Nobel Laureate, Robert Solow (1987): "*You can see the computer age everywhere but in the productivity statistics*" the question remains challenging on many aspects, raising numerous academic debates on econometric models and methods, data structure, collection and appropriateness, growth optimism and growth skepticism.

Beginning in the mid-90's the US economy experienced a major surge in labour productivity and grew in a surprisingly fast pace achieving at the same time low unemployment and inflation rates. This period coincided with significant investment in, and the diffusion of, ICTs; US firms pumped more than $3 trillion during 80's and 90's into IT investments, defined to include computer hardware, computer software and telecommunication equipment (Stiroh, 2003). The popular view is that ICTs and their implications have been the major driver and played a substantial role in explaining the sustained growth rates. A new term "new or digital economy", was coined by business press to depict a superior economic structure that arises as the joined outcome of globalization and ICTs' boost; signaling that the workings of the economy may have significantly changed with rules, principles, institutions that go well beyond those of traditional economy (Schreyer, 2000). Network externalities, production spillovers, lower information costs and organizational restructuring completely changes the way businesses operate in order to fully address and exploit the expected IT investment gains (Stiroh, 2003).

But while ICT has so many visible effects on the modern economy, its impact on productivity and economic growth proved unexpectedly difficult to be detected and established econometrically and remains a challenging task (Jalava and Pohjola, 2002). The early evidence was typically disappointing but the resurgence of US economy in the late 90s made a lot of the economists believe that the well expected token of the delayed ICT impact on US economy finally arrived. And in fact, Jorgenson and Stiroh (2000), and Oliner and Sichel (2000) in their discrete but widely cited work, after examining both the production and the use of ICT concluded that ICT is indeed the major driver of US productivity revival. Other researchers though remained skeptical; Gordon (2000) argued that ICT by no means measure up to the great inventions of the past and earns the same returns as any other type of capital.

The large and long-lasting literature concerning the impact of ICT on economic growth can be divided in groups based on their methodological approach (Vu, 2004). The first and major group, includes studies employing the growth accounting approach that relates output to various production inputs e.g. labour, physical capital and purchased material and to the level of technology. The extent that the output grows independently of factor inputs representing the ability to produce an increasing amount of output from the same input is called by the economists, total or multifactor productivity (TFP or MFP). The accumulation of ICT capital or "capital deepening" contributes to labour productivity as workers have at their disposal more and better capital equipment (Stiroh, 2003). Studies generally agree that ICT capital deepening and TFP gains in ICT sector have been major components of the acceleration of labour productivity (Haacker and Morsink, 2002); no consensus however has been reached on the effect of ICT on the aggregate TFP growth. In order to assess the sources of growth, the aggregate production function takes the following format:

$$Y = A\mathcal{F}(K_N, K_{ICT}, L) \qquad (1)$$

where *Y* represents the gross domestic product, K_N the flow of non ICT capital services, K_{ICT} ICT capital services, *L* stands for labour and *A*, or as already mentioned TFP, measures how effectively inputs are transformed to outputs, a Hicks-neutral[2] augmentation of the aggregate inputs (Ark and Inklaar, 2005; Stiroh, 2003). Under the standard economic assumptions of cost-minimizing producers, competitive factor markets and constant return to scales, theory suggests that equation can be transformed into a growth rate version where the growth rate of output equals the weighted (by their nominal share in total output) growth rates of inputs plus the growth rate of TFP. Thus, equation (1) can be rewritten as:

$$\Delta \ln Y = \alpha \Delta \ln K_N + \beta \Delta \ln K_{ICT} + \gamma \Delta \ln L + \Delta \ln A \quad (2)$$

Δ refers to a change or a first difference and the following equality also holds:

$$\alpha + \beta + \gamma = 1$$

By rearranging equation (2), average labour productivity growth, defined as $y = {}^{Y}/_{L}$, can be decomposed into the ratio of capital services to hours worked, $k = {}^{K}/_{L}$, and TFP growth. A further refinement of the basic equation can be made by splitting the TFP growth into two components, TFP growth originating in manufacturing industries producing ICT goods (A_{ICT}) and that from other industries (A_{OTHER}):

$$\Delta \ln y = \alpha \Delta \ln k_N + \beta \Delta \ln k_{ICT} + \Delta \ln A_{ICT} + \Delta \ln A_{OTHER} \quad (3)$$

Equation (3) allows the distinguishment of the three channels through which ICT affects growth and labour productivity. The first one is capital deepening, i.e. an increase in ICT capital services per hour worked, the second is an advance in TFP in ICT-producing sector and the third is an advance in TFP of other producing sectors through spillover effects. There is no reason of course to expect that such externalities exist if increases in TFP of the other sectors of the economy cannot be observed (Jalava and Pohjola, 2002).

The other group consists of studies that concentrate on microeconomic evidence of the impact of ICT on individual firms and industries employing a mixture of growth accounting methods and econometric models (see for example Brynjolfsson and Hitt, 2003) or studies that make use of econometric models with national panel data (see for example Pohjola, 2000).

ICT can be seen as a kind of General Purpose Technologies (GPTs) that spreads throughout the economy and significantly influences a variety of sectors in a country enabling the creative use of labour and the restructuring of organizational assets thus improving products and processes (Holt and Jamison, 2009). The bulk impact of ICT (alike to electricity) is indirect and mainly abuts on the way it is used to transform the economy and enable factors that foster productivity or GDP growth. The problem of measuring with precision the impact of ICT on the economy of an entire nation and the debate about the actual contribution of ICT to growth can also be seen as reflecting exactly this complexity.

[2] A technical change is considered to be Hicks-neutral if it does not affect the balance of labour and capital in the production function.

As already mentioned there is by now a substantial literature that empirically seeks to quantify the impact of ICT to productivity with mixed so far results. Typically, early studies, examining periods before the beginning of the 1990's report negative results while later studies tend to uncover a more positive and rather stable impact of ICT to growth (Papaioannou and Dimelis, 2007). In a highly celebrated study, Oliner and Sichel (2000) employed a modified neoclassical growth-accounting framework in order to examine the growth contribution of ICT in US economy from 1974-1999. They estimated that the use of ICT and the production of computers accounted for the two thirds of the one percentage point step up in productivity growth and suggested that ICT has been the underlying factor of the US economy resurgence. Jorgenson and Stiroh (2000) applied the Jorgenson's Production Possibility Frontier (PPF) (from 1960-1999), an alternative methodology to the growth accounting framework which attempts to capture the substitutions among outputs of investment and consumption goods as well as between inputs of labor and capital in order to explain the increase in productivity growth in US after 1995 and provided evidence that ICT is in fact the driving force in question. However they remained skeptical if ICT is in reality shifting the rules of the traditional economy since they found no evidence that the impact of ICT is like a phlogiston to every kind of economic activity as the theorists of "new or digital" economy suggest. Vu (2004) in his study aims to decompose the sources of output growth for 50 individual economies (22 industrialized and 28 developing) over two periods: 1990-1995 and 1995-2000. He concludes that ICT has played a positive role to output growth across all economies and for both periods; more interestingly the results also indicated the growing magnitude of ICT since there was a major shift in the contribution of ICT to growth from 0.17 in the first period to 0.37 percentage points to the second and that ICT impact is stronger for the industrialized group. Vu (2011) reverted to the subject by investigating the impact of ICT on growth using panel data of 102 countries for the period 1996-2005. He employed the cross-country regression framework allowing for country fixed-effects and showed that ICT was an important source of growth for the given period. Despite these findings the researcher made no attempt to infer causal links between ICT penetration and growth; in order to address this problem he employed a Generalized Method of Moments (GMM) estimator and suggested that not only there is a strong causal link between ICT and growth but that the marginal effect of the penetration of the internet users is larger than that of mobile phones which in turn is larger than that of personal computers. He also showed that the marginal effect of ICT penetration on growth is positive but lessens as the penetration increases. Papaioannou and Dimelis (2007) provide evidence of a positive and significant ICT growth effect based on sample of 42 developed and developing countries in the period 1993-2001. The researchers attempted to estimate a labour productivity growth equation by using fixed effects and the Arellano and Bond panel data estimators. The results suggest that ICT has been beneficial for both groups of countries, although the magnitude is larger for the developed countries.

Haacker and Morsink (2002) proposed a different path in order to unveil the ICT impact to growth. They suggested that since ICT deepening and TFP growth in ICT-producing sectors capture only the direct growth contribution of ICT use and production, the growth accounting framework by construction fails to attribute appropriately the generalized TFP growth to any particular type of expenditure or production, underestimating the indirect ICT contribution. In order to calculate the TFP growth the researchers set the following equation:

$$TFP = RGDP - \alpha K - (1 - \alpha)L$$

RGDP, K and *L* stand for rates of growth of real GDP, capital stock and labour force respectively while the dependent variable is the change in the average TFP growth between specified periods. The dataset consists of two distinct sub-periods: 1985-1995 and 1996-2000 and covers 20 industrialized countries. Their cross-section and panel regressions confirmed not only that ICT expenditure has a large, positive and significant effect on the acceleration of TFP growth in the late 1990's but also that the impact increases over time, suggesting that positive ICT spillover effects follow a gradual pattern.

On the other hand the main ICT skepticist, Gordon (2000) argued that in fact ICT has little impact on the US economy and fall short when compared to the impact of the technological revolutions of the past. His study first attributes a sizeable part of the US labour productivity growth of late 1990's to an unsustainable cyclical effect that will eventually fade out as the economy slows down and second suggests that there is no real evidence of positive ICT spillovers since aggregate TFP growth should only be attributed to the portion of the economy that produces computers and other durable goods; in fact he argues that TFP growth outside these sectors has actually decelerated. Schreyer (2000) employs a growth accounting framework in order to address the impact of ICTs capital input to growth for G7 concerning the time period 1985-1996, and concludes that while the contribution of ICT capital to growth has been significant and rising in relative terms for the group of G7 there is no sign of a broad-based acceleration of TFP growth (that could partly be attributed to ICT) except the US.

Although literature and academic debate has been focused on the appropriate estimation models of ICT's impact to growth (usually GDP) there is a number of studies that attempts to quantify the effect of specific information and communication technologies (internet, broadband, e-finance) on economic fundamentals like inflation rate, employment and FDI. Choi and Yi (2009) state that internet has influenced the economy from every aspect. In order to examine one of their hypotheses (i.e. that economic growth is positively related to the use of the Internet) they choose several economic factors as explanatory variables along with the "Internet" variable in order to determine the real per capita GDP. Data concerned 207 countries from 1991 to 2000. Several panel data models were employed and researchers found that the estimated coefficients for the Internet were statistically significant at the 1 percent level and that if Internet-user ratio increases by 1 percentage point then the growth rate increases from 0.049 percentage point to 0.059 percentage point. GMM showed that the results are quite robust. Following a similar

pattern of research work, Yi and Choi (2005) tried to estimate the impact of the internet on inflation and researchers found that the Internet significantly reduces inflation after controlling for the other variables. Moreover Choi (2003), using as proxies for the Internet the number of the Internet hosts and the number of the Internet users in 1995 showed that if a country intends to stimulate FDI (Foreign Direct Investment), Internet infrastructure add up to a prerequisite.

Soon after the domination of personal computers (PCs) in every business and household, it became apparent to users that their PCs would prove much more useful if they could exchange data on an acceptable speed. Massive investments in improvements of local and wider area data communication networks' bandwidth made possible the roll out of broadband services in the late 1990s. Crandall *et.al.,* (2007) regressed output (GDP) and employment on business taxes, level of unionization, wage, climate, education and level of broadband penetration (number of broadband lines per 100 persons). Data concerned 48 American States during 2003-2005. The ordinary least squares regression analysis that was conducted in order to estimate the effect of each of the dependent variables suggested that employment is rather strongly related to broadband penetration, especially in sectors like finance and education. Conclusions on growth are less precise but once again the broadband effect on growth is found to be statistically significant, regarding mainly the tertiary sector. Koutroumpis (2009) attempts to estimate the effect of broadband penetration on growth using a simultaneous equations model that endogenizes broadband investment by incorporating broadband supply, demand and output equations. The dataset was comprised from annual data of 22 OECD countries from 2002 to 2007. The results highlighted the existence of the critical mass phenomenon in broadband infrastructure by unveiling increasing returns to broadband investments as countries approached the threshold of 30 percent, amounting to half of the population having access to a broadband connection.

Taking as a starting point that innovation in payments has always acted as a growth stimuli, Shamin (2007) showed that e-finance technologies enhance the financial basis and depth of a country by enabling financial services to those so far bounded because of their low income or their living in remote rural areas. Cross sectional data for 61 countries (developed, emerging or developing) averaged over the period of 1990-2001, were used in this study. The results suggest that better ICT indicators, and especially the number of mobile phones subscribers and the number of Internet users, significantly enhance financial transactions and thus foster economic growth. Moreover, while for some countries a bi-directional causality between financial development and ICT is detected, for most of the cases the causality runs from ICT to financial depth. As Ko (2008) argued financial integration triggered by ICT advances, not only affect economic growth, but have an impact on a country's respond to an economic shock. Using a sample of 10 Asian countries and employing a panel vector autoregression approach, the researcher showed that high financially integrated economies led by sophisticated ICT infrastructure tend to suffer more from monetary

shocks (measured by the standard deviation of lending rate) and less under a fiscal shock (proxied by the standard deviation of real government consumption).

2.2. ICTs and growth in developing countries

As already mentioned, Papaioannou and Dimelis (2007) and Vu (2004) suggested that the ICT impact is stronger for the developed countries since they enjoy a better telecommunication infrastructure that allow them to fully realize the ICT gains. The concerns are corroborated by the possible presence of network effects in the application of ICT (Quiang *et.al.*, 2004; Lucas and Sylla, 2003); massive gains from ICT can be enjoyed after a critical mass of ICT investment and usage is reached. This finding can act as a barrier to positive ICT impact on growth in developing countries since ICT penetration in most of them reach much lower levels than threshold. However, contradicting views have been expressed on the subject as other researches argue that ICT comprise a unique opportunity for developing countries to leapfrog to a higher level of development and experience the potential advantages of being a late-comer. Seo *et.al.,* (2009) uses a cumulative growth model and a simultaneous three stage least squares (3SLS) method concerning 29 countries in the 1990's to examine how the interaction between ICT and growth, affects the growth gap between developed and developing nations. The results confirmed that countries with a solid infrastructure, experience larger positive ICT effects but also showed that countries with a relative low productivity level can reduce the gap relying on the knowledge spillovers that advanced ICT countries generate. Vu (2011) in his revisiting study showed as stated above that the marginal effect of ICT penetration on growth is larger when at its lower level, suggesting that developing countries would realize significant benefits from the diffusion of ICT. Waverman *et.al.,* (2005) showed that mobile phones play a crucial role for developing countries. They employed a dataset of 92 developed and developing countries from 1980 – 2003 in order to assess the impact of telecoms on economic growth and found that mobile telephony not only has a positive and significant effect on growth for both group of countries but also that the impact is twice as large for developing countries. Jorgenson and Vu (2010) analyzed the sources of economic growth in seven regions of the world during the period 1989 -2008 in order to identify the contribution of ICT on growth and project the world economic growth for years 2009 – 2019. They employed the PPF model and showed that despite the fact that after the dot-com crash of 2000 the contribution of ICT investment to world growth has been substantially moderated due to a major fall in industrialized countries (G7 and no G7 developed countries), in the remaining five regions (Developing Asia, Latin America, Eastern Europe, Northern Africa and Middle East, Sub-Saharan Africa) contribution of ICT on growth continued to expand.

2.3. Sovereign debt credit ratings and interest rates

Financial markets have shown a clear and growing trend during last decades for interconnection. Countries and economies, significantly different in development terms, strive to attract investments and funds beyond their borders. Different sovereign bond yields ultimately reflect the diverse markets' perception on the perceived credit risk of different sovereigns. The need of an accurate and time-consistent flow of information concerning a wide range of debt issuers led to a greater demand for sovereign credit ratings (Bissoondoyal-Bheenick, 2005). The demand was filled by three well-known American agencies, namely Standard & Poor's, Moody's and Fitch; the first two have been bestirring in sovereign rating market from the beginning of the century, though almost exclusively rating developed countries.

Sovereign credit ratings provide standardized forecasts of sovereign debt default probabilities and set also the benchmark for the ratings of others issuers domiciled within country's borders. Since agencies list numerous factors that underlie the assigned ratings and little is known on how they weigh and quantify their determinants, specifying the impact of each factor would have a vast interest for regulators, policymakers and investors, especially in the dramatic context of the ongoing European debt crisis. The explanatory variables that have been examined thoroughly in literature so far include, among others, liquidity, solvency political variables and macroeconomic fundamentals.

Generally governments seek assessment of their debt credibility in order to ease their access to international markets, since many lenders and investors prefer rated securities in order to satisfy the modern, more stringent risk management requirements which resulted mainly from the complex nature of their exposures (Cantor and Packer, 1995). It should be mentioned though, that a group of countries avoids rating due to the absence of reliable statistical and economic data or to dilatory actions taken by governments unwilling to be exposed to an independent audit, funded by them.

The first systematic study on the determinants of sovereign ratings was provided by Cantor and Parker (1996), who tried to identify the most important explanatory variables of 49 countries' credit ratings assigned by Standard & Poor's and Moody's. They found that per capita income, economic development, inflation, external debt and default history are key predictors of ratings and explain large part of rating variation. The ordinary least square estimation technique employed by Cantor and Parker (1996) received severe criticism, since it assumes that ratings, as depended variables, have been categorized into equally spaced, discrete intervals rating categories while they are of a discrete and ordinal nature. In line with this argument other researchers (Bissoondoyal-Bheenick *et.al*., 2006) proposed the use of other statistical techniques, like ordered response models. Their analysis corroborated the significance of factors like inflation and GNP per capita; highlighting at the same time the effect of other purely economic variables, namely current account balance and level of foreign reserves, and non purely economic, like the diffusion of technology, proxied by the usage of mobile phones (Bissoondoyal-Bheenick *et.al*., 2006).

2.4. ICT diffusion proxies and sovereign debt markets

The impact of technological development and advancement on sovereign debt ratings was pursued for the first time, to the best of our knowledge, by Bissoondoyal-Bheenick *et.al*., (2006) as we already stated above, who used as a proxy the mobile phone use; referring to the users of portable phones per 1000 people. The proxied factor played a crucial role in the modelling and in fact, was found to be the most important variable. The authors stated that such a variable is necessary in order to reflect the emerging digital economy and that mobile phone use is an appropriate proxy of technological advancement because it is available, objective and capturing a country's technological infrastructure and uptake. The analysis of the researchers' results suggested that when a mobile phone usage variable was included in the model, the accuracy of the prediction of the forecasted sovereign ratings was highly enhanced.

Although the proxy selection of mobile phone use was made earlier than the dominating emergence of 3G and 4G technology and the prevalence of smartphones that enabled the diffusion of Internet connectivity, it achieved to illustrate the distinguishable place that mobile telephony occupies among the various ICTs as the most rapidly adopted and spreading technology for the last couple of decades having a tremendous impact on economic growth (Geiger and Mia, 2009). In particular, the penetration level of mobile devices in developing countries is much higher than other technologies such as fixed telephony, internet and broadband, compensating for the flawed and underdeveloped infrastructure and improving the efficiency of their markets. As Kalil (2009) pointed out, this can be explained by a number of factors including, the relative ease of deploying mobile infrastructure versus landline phones and consequently broadband connections, a more liberal mobile service provision favoring competition, the decreasing costs of mobile handsets and the possibility of buying pre-paid cards.

Geiger and Mia (2009) explored the impact of mobile technologies on countries' e-readiness by computing the correlation between the 2007 mobile telephony penetration rates for 134 countries and their respective scores on e-readiness. The authors suggest that although a low mobile penetration rate (i.e. below the median rate) seems to disqualify a country from reaching a top-class e-readiness status (with Canada being the biggest outliner) the converse is not true, meaning that high mobile telephony diffusion does not necessarily lead to a high level of networked readiness. Moreover, although clearly positive, the relationship between mobile phone use and e-readiness gets looser as usage increases highlighting the importance of mobile technology for low and lower-middle-income countries and the less crucial role it plays when a country evolves to higher stages of development. Economist Intelligence Unit (2005 p.4, 2002 p.9) suggests that "all pieces, infrastructure, security, transparency, innovation and skills must be properly interlaced to ensure e-readiness" and that "mobile usage on its own is not a good indicator of a country's e-business environment". Thus, incorporating in sovereign debt modelling, a broader and more accurate representation of countries' technological advancement status like e-readiness, could considerably

enhance the forecasting and explanatory capabilities of such models and provide important policy guidelines for improving debt ratings and consequently, financial health.

2.5. The e-readiness concept and major measurement tools

Even though e-readiness tools set out to measure presumably the e-readiness element, these tools share limited commonality in definitions, terms and methods they use. Most of the measures have largely adopted quantitative approaches that assign to countries numerical scores on specific components of e-readiness tools and use a compound index as weighted average that aggregates the scores into a single over-all value that determines the level of e-readiness of countries. Usually these results are published annually or on regular intervals allowing a country to compare itself with other countries, as well as to compare its current position with that in the past (Mutula and Van Brakel, 2006; Bui *et.al.*, 2003). Three of the main tools, common in literature, are considered in brief in following (Ghavamifar *et.al.*, 2007).

A. Networked Readiness Index

The NRI (first published in 2001, annually since then) is prepared by the WEF and INSEAD and is a comprise of three components: the environment for IT; the readiness of the country's key stakeholders (individuals, businesses and governments) to use IT and the actual use of IT amongst these stakeholders. The final NRI score is a simple average of the three composing sub indices' scores.

B. The EIU E-Readiness Rankings

The Economist Intelligence Unit in its e-readiness rankings which are published annually since 2000, has worked in cooperation with the IBM Institute for Business Value. The model consists of over 100 separate quantitative and qualitative criteria, most of which are scored by the Economist Intelligence Unit's regional analysts and editors and are organized into six primary categories with a different impact in overall score.

C. E – Government Readiness Index

The United Nations Division for Public Economics and Public Administration together with the American Society for Public Administration formally presented the e-government readiness index in 2003 as a tool to measure how governments were aware and benefiting from ICTs. Although, governments affect with their policies, legislations and vision not only the legal framework but also the usage of ICTs, e-government index is a specific oriented index that does not reflect the concept of e-readiness to its entirety.

It is widely acknowledged that (Pena-Lopez, 2009; Dada, 2006) the two most influential and commonly used measures of e-readiness are the EIU rankings and the NRI. They both reflect a liberal school of thought with NRI giving more weight on governments and final users while EIU is more business oriented. As Pena-Lopez (2009) states this might be explained from the different environments of origin; EIU comes from an Anglo-Saxon environment while NRI framework firstly designed at a continental environment where State traditionally holds a more important role in any aspect of the socioeconomic life. Nevertheless, a

correlation analysis of the two indices carried through by Pena-Lopez (2009) revealed a very strong correlation between the two indices at the aggregate level; at the country level of course there are varying rankings reflecting the differences mentioned above.

The main criticism that has been made to e-readiness tools is that taking into account all aspects of socioeconomic framework they might be collecting impacts of any kind of policies (Pena-Lopez, 2009). Given their comprehensive approach and their ambition to include any feature that could play a role in a country's technological advancement and competitiveness, "analogue" economic and social indicators like tertiary enrolment levels, fiscal policies and taxation, in-company expenditure in R&D or freedom of press come to the fore and supplement the digital indicators in order to give a compound index. The question though still remains if these "analogue" indicators can actually investigate the performance of just the digital initiatives of a country (Pena-Lopez, 2009).

E-readiness tools have also suffered from attacks because they encompass technologies that have already reached saturation (e.g. fixed telephone) or are slowly approaching (PC users) and seem rather outdated and poor as sub-measures (Vehovar *et. al.*, 2006). Some researchers have also pointed out that not enough indication of the theoretical reasons for arriving at the index, weighting and factor adoption is provided by the publishers (Grigorovici *et.al*, 2004).

However, it should be recognized that e-readiness tools have evolved significantly over time in order to capture technology leaps and keep up to date. It should also be noted here that when published, e-readiness tools (at least, in their latter editions), are always accompanied by a section concerning their methodologies and revisions, although subjectivity and vagueness about the methods indicators are weighted remains.

2.6. E-Readiness tools as instruments for research

On the academic field the e-readiness concept has not been widely used so far, apart from pure ICTs papers that strive to detect the most influential indicators amongst pillars and variables used to produce the compound indexes (Wu *et.al.*, 2012) or in papers that compare and evaluate the proposed tools (Ghavamifar *et.al*., 2007, Vaezi and Bimar, 2009). Nevertheless, we can found in the literature two streams of research that make use of the concept, coming from different academic fields in order to address quite similar research questions.

In his influential work, Kovacic (2005), used for the first time a compound index (e-government Readiness Index, hereto) to explore the causal factors that provoke considerable differences between nations in terms of the adoption and usage of new technologies. The analysis focuses on the role that culture holds in countries' technological advancement utilizing the concepts and cultural models presented by the Dutch anthropologist Geert Hofstede and tests whether the national cultural dimensions have

significant impact on the e-Government readiness. Kovacic (2005), mentions two main reasons for adopting the e-Government framework: the inclusion and evaluation of more countries than any other index and the consistent manner key data are gathered. He also notes a drawback; the framework is based only on the supply side (at the time of Kovacic's research, later the index evolved) ignoring the systematic discrepancy between the offer of e-government facilities and the actual citizens' take up of the services offered (Zhao, 2011). Following Kovacic's work, Zhao (2011) utilized the shift of the late E-government indexes towards a more citizen-centric approach in order to address the cultural issues with a balanced view and analyzed the same two sets of indexes, e-Government index and Hofstede's culture dimension index adding also the fifth cultural dimension (long or short term orientation) that Hofstede *et.al*. (2010) presented in later revisions of his work. Another study aiming to provide a cultural interpretation of e-Government readiness (Khalil, 2011) also employed the e-Government index as the dependent variable and as independent the nine cultural dimensions of House *et.al*., (2004), which are known as the Globe project.

Coming from a different academic field, namely industrial marketing, Berthon *et.al.,* (2008a) and Berthon *et.al.,* (2008b) tried to shed light on the determinants that preclude firms at the national level from readiness for electronic relationships, with a focus on business to business (B2B) arrangements. Both studies addressed two important research questions, the role that social values can play in the development of transnational e-business and the hindering role that corruption in a society might play in these particular business relationships. To measure readiness for electronic transactions, researchers draw data from Economist Intelligence Unit Rankings.

Concerning our empirical analysis, we have chosen the NRI tool because it is available for a broader range of countries than EIU, thus making easier the compilation of a richer panel data set while E-government index is measuring a rather more constrained notion of e-readiness focusing on the governmental role.

3. Research questions and methodology

3.1. Hypotheses formulation

Motivated by the positive economic effects of a country's high level of competitiveness in information and communication technology (ICT) diffusion that has been addressed in the literature, our first hypothesis is:

$H1_0$: The levels of country credit rating risk and of sovereign debt interest rates are inversely associated to country's relative technological advancement or e-readiness.

The diffusion of the ICTs, advances transparency and freedom of business, increases efficiency and productivity, creates new sources of wealth and may lead to an enhanced quality and a diminished cost of governance. Moreover, in developing countries ICTs consist the only available way in providing basic

services, especially in rural areas, like education, healthcare and banking transactions; the absence of which obviously hinders any development opportunity. As Vu (2011), Jorgenson and Vu (2010) and Waverman *et.al.,* (2005), suggested, contradicting the findings of other researchers like (Papaioannou and Dimelis, 2007; Lucas and Sylla, 2003; Quiang *et.al.*, 2004), ICTs comprise a much more important determinant of growth opportunities for developing countries. Motivated by their work we formulate our second hypothesis:

$H2_0$: The relevance of a country's technological advancement or e-readiness to the levels of credit ratings risk and sovereign debt interest rates is not the same across different economic development categories. E-readiness does not carry the same importance for developed economies as compared to the developing and emerging economies.

This hypothesis stems also from the fact that during next decade ICTs will face a tremendous shift of domination towards the emerging economies. Developing countries at the moment drive over 80 percent of all new mobile subscriptions worldwide and as more citizens of those countries go online, gain access to mobile telephony and connectivity levels reach those of the developed countries, the former countries' global share of digital transactions will inevitably become predominant. China and India have already become key players in the world digital economy and are expected to play a major role in the future. Emerging economies face a unique opportunity and challenge, after years of underdevelopment and poverty for millions of their citizens, to enable access to primary services, fundamentally money and banking services to the, so far, unbankable and to leapfrog to higher stages of development by following their own, accustomed to their needs and necessities, technological pattern of best practices. Taking into account the vast technological opportunities that arise in the emerging economies, a higher level of e-readiness is expected to have a more significant impact on their economic growth than on developed ones and be appraised more positively by investors, lenders and agencies who mainly seek for profitable investment opportunities throughout the world, opportunities that could be given by those economies who enter the digital era with firm footstep.

3.2. Linear regression framework

Since we have a set of sixty five countries and each of them is measured at ten points in time we are dealing with a panel data set. Let Y_{it} be the response variable, X_{it} be a vector of time-varying regressors and Z_i be a vector of another set of time-invariant regressors. Let α_i be the unknown intercept for each country that does not vary over time, representing the combined effect on Y_{it} of all unobserved variables that are constant over time and ϵ_{it} be the error term, representing the purely random variation at each point of time.

Our basic model will then be:

$$Y_{it} = \beta X_{it} + \gamma Z_i + \alpha_i + \epsilon_{it} \quad (4)$$

These models can be tackled using pooled OLS, fixed effects or random effects. Although we assume statistical independence between α_i and ϵ_{it}, the allowance of any kind of correlation between α_i, X_{it} and Z_i will determine if we are going to use a fixed effects or a random effects approach. Following fixed effects means that we are going to allow for such correlation while random effects assumes that α_i is not correlated with regressors. It would be reasonable to suggest that the unobserved time-invariant variables that have an impact on Y_{it}, given the number and the extended set of the included variables in regression, are correlated with the vector X_{it} of time-varying regressors and therefore the use of fixed effects is appropriate and statistical sound. We also confirm the above theory by running the fixed and random effects regressions and conducting a Hausman test which suggest that a random effects estimator would be inconsistent[3]. Despite the fluctuations that the economic crisis caused to credit risk ratings, agencies do not tend to change their ratings so often and so dramatically. Although consistent, fixed effects do not allow an estimation of coefficients for time-invariant variables (albeit we are still controlling them) and therefore as Afonso *et al.,* (2011) suggest using fixed effects, would only allow us to capture credit ratings' movements across time since the average rating would be captured by the country-specific intercept α_i. Given the limited credit rating movements' across time, following fixed effects would mean that we are extracting very little information from our rich data. Drawing heavily on the work of Afonso *et. al.,* (2011) and Allison (2009) we opt for a hybrid random effects model that allows us to estimate coefficients for both time-variant and invariant regressors. We will assume that the country specific intercept α_i is linear combination of time-averages of the vector X_{it} of time-varying regressors.

Therefore we could formally write:

$$\alpha_i = \eta \bar{X}_i + e_i \quad (5)$$

where e_i is the random error term.

Substituting equation (5) in equation (4) we obtain:

$$Y_{it} = \beta X_{it} + \gamma Z_i + \eta \bar{X}_i + e_i + \varepsilon_{it} \quad (6)$$

Adding in both sides of equation (6) the $\beta \bar{X}_i$ term, equation (6) can be written as:

$$Y_{it} = \beta (X_{it} - \bar{X}_i) + (\beta + \eta) \bar{X}_i + \gamma Z_i + e_i + \varepsilon_{it} \quad (7)$$

The β coefficient can be interpreted as the short-run effect and $(\beta + \eta)$ as the long-run effect of the regressors and the model is run by random effects which will allow us to estimate $(\beta + \eta)$ coefficients.

[3] Calculations are available from the authors upon request.

3.3. Ordered response framework

The above considerations can be generalized to ordered response models, which prevailed the literature as more appropriate to credit risk ratings' nature. In order to motivate our response model and following Bissoondoyal-Bheenick (2005), we consider a latent continuous variable which is dependent upon the same variables of equation (7). Therefore we can formally write:

$$Y^*_{it} = \beta(X_{it} - \bar{X}_i) + (\beta + \eta)\bar{X}_i + \gamma Z_i + e_i + \varepsilon_{it} \qquad (8)$$

Since the latent variable is unobservable and continuous, several cut off points are assumed to be employed by the agencies in order to assign the final rating in the following way:

$$Y_{it} = \begin{cases} 1 \text{ if } y_{it}^* < c_1 \\ 2 \text{ if } C_1 < y_{it}^* < C_2 \\ \vdots \\ 20 \text{ if } c_{19} < y_{it}^* < c_{20} \\ 21 \text{ if } y_{it}^* > c_{20} \end{cases}$$

where the c_1 - c_{20} are the estimated threshold parameters[4].

4. Empirical application

4.1. Data and estimation procedure

In order to test out hypotheses we employ a balanced dataset of economic, financial and other qualitative variables for 65 countries sampled in an annual frequency between 2001 and 2010. Our sample of countries is grouped in two major clusters:

A. The OECD group consisting of 28 countries, namely Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Poland, Portugal, South Korea, Spain, Sweden, Switzerland, Turkey, United Kingdom and United States.

B. The non – OECD group consisting of 37 countries, namely Azerbaijan, Brazil, Bulgaria, Colombia, Costa Rica, Croatia, Dominican Republic, Egypt, El Salvador, Estonia[5], Ghana, Hong Kong, India, Indonesia, Israel[5], Jamaica, Jordan, Kazakhstan, Malaysia, Moldova, Morocco, Nicaragua, Pakistan, Peru, Qatar, Romania, Russia, Singapore, Slovenia[5], South Africa, Thailand, Trinidad and Tobago and Tunisia. Drawing on the previously presented literature we employ a set of time variant and time-invariant predictors that are

[4] Following Afonso *et. al.*, (2011) we estimate the coefficients and cut-off points using maximum likelihood utilizing G. Frechette's (2001) procedure in Stata.

[5] During 2010, Estonia, Israel and Slovenia signed the Convention on the Organization for Economic Co-operation and Development and became full members.

depicted in Table 2 along with their sources and the presumed effect that they will have on cost of debt and credit risk rating according to economic theory and previous empirical research.

Table 1. Linear transformation of assigned ratings by S&P, Moody's and Fitch.
Adopted from Afonso *et.al.* (2007) and modified accordingly by authors.

	Characterization of issuer and debt **by Moody's**	**RATING**					
		S&P	**Moody's**	**Fitch**	**Numerical Transformation**		**Average Marginal Effects Transformation**
INVESTING GRADE	Highest Quality	AAA	Aaa	AAA	1	1	1
	High Quality	AA+	Aa1	AA+	2	2	2
		AA	Aa2	AA	3	3	
		AA-	Aa3	AA-	4	4	
	Strong Payment Capacity	A+	A1	A+	5	5	3
		A	A2	A	6	6	
		A-	A3	A-	7	7	
	Adequate Payment Capacity	BBB+	Baa1	BBB+	8	8	4
		BBB	Baa2	BBB	9	9	
		BBB-	Baa3	BBB-	10	10	
SPECULATIVE GRADE	Likely to fulfil obligations, uncertainty	BB+	Ba1	BB+	11	11	5
		BB	Ba2	BB	12	12	
		BB-	Ba3	BB-	13	13	
	High Credit Risk	B+	B1	B+	14	14	6
		B	B2	B	15	15	
		B-	B3	B-	16	16	
	Very High Credit Risk	CCC+	Caa1	CCC	17	17	7
		CCC	Caa2			18	
		CCC-	Caa3			19	
	Near Default	CC AND C	Ca			20	
	Default	D	C	D	21	21	

Our dependent variables aim to capture sovereign credit risk and cost of debt. Three different proxies of sovereign credit risk are employed and namely the assigned credit ratings by the three major American agencies, Standard and Poor's (S&P), Moody's and Fitch. Following a vast strand of literature (Afonso *et.al.*, 2007; Bissoondoyal-Bheenick, 2005; Cantor and Packer, 1996)) the qualitative letter ratings are linearly transformed to numerical equivalents with number 1 representing the highest score (AAA for S&P and Fitch, Aaa for Moody's) and number 21 the lowest (D for S&P and Fitch, C for Moody's). The transformation is straightforward and is presented in Table 1. Nevertheless, unlike other empirical studies that employ the attributed sovereign rating on the 31st December of each year, we construct a weighted average rating, which assumes a fiscal year of 360 days, multiplies every assigned rating during the specific year by the days that this rating did not change, sums the products and then divides the sum by 360[6], while the result is

[6] Calculations are available from the authors upon request.

Table 2. Variables abbreviations, short descriptions and presumed impact. A positive sign (+) suggests that the variable is expected to have a positive impact on cost of debt and credit risk ranking while a negative sign (-) suggest a negative impact according to literature and empirical findings.

Variable	Description	Source	Effect
RTGSP_INT, RTGM_INT, RTGF_INT	Sovereign credit ratings assigned by S&P, Moody's and Fitch accordingly. The qualitative letter rating is transformed linearly to numerical equivalents with number 1 representing the highest score (AAA for S&P and Fitch, Aaa for Moody's) and number 21 the lowest (D for S&P and Fitch, C for Moody's), see also Table 1.	S&P, Moody's, Fitch	
YTM	The yield to maturity of a 10-year zero coupon benchmark bond multiplied by 100. If none available then the closest maturity is selected.	DataStream	
NRI	The Network Readiness Index: It is published annually by World Economic Forum and INSEAD and ranges from 1 to 10 with higher values indicating a higher diffusion and use of ICT's.	The Global Information Reports	?
BLNC	The Current Account balance: The sum of trade balance (goods and services exports less imports), net income from abroad and net current transfers. A positive current account balance reflects a country's net investment abroad while a negative current account balance reflects the foreign net investment to the country. Expressed as a fraction of GDP.	World Bank	(+/-)
COMP	Global Competitiveness Index: It assesses the competitiveness of a country and examines its growth and prosperity potentials. The Index is expressed in a range from 0-10 with higher values indicating a higher competitiveness status.	World Economic Forum	(-)
CRED	Domestic credit to private sector: Refers to financial resources provided to the private sector by financial corporations, such as through loans, purchases of non-equity securities, and trade credits and other accounts receivable, that establish a claim for repayment. Expressed as a fraction of GDP.	World Bank	(+/-)
CRPT	Corruption Perception Index: The CPI scores and ranks countries based on how corrupt a country's public sector is perceived to be. It is a composite index, a combination of surveys and assessments of corruption and is published annually, ranging from zero (highly corrupt) to ten (highly clean).	Transparency International	(-)
DFCT	Cash Surplus or deficit: Revenue (including grants) minus expense, minus net acquisition of nonfinancial assets. Expressed as a fraction of GDP.	World Bank, DataStream	(-)
DFLT75/DFLT95	The two dummy variables correspond to a default to any of the three types of default identified by S&P, local currency debt, foreign currency bond debt and foreign currency bank debt. If any of these kinds of default took place during 1975-2010 then the dummy variable DFLT75 takes the value of one while if it took place during 1995 – 2010 then the dummy variable DFLT95 takes the value of one.	S&P	(+)
EURO/OECD	The two dummy variables correspond to a membership to Eurozone and OECD respectively; a value of one means that a country is a member of the Eurozone or OECD.	Eurozone, OECD	(-)
FDGDP	Foreign Government Debt: The portion of a government's debt that was borrowed from foreign lenders including commercial banks, governments or international financial institutions. Expressed as a fraction of GDP.	Euromonitor, Own calculations	(+)
FRDM	The Index of Economic Freedom: It's a composite index that mainly reflects the level of enforcement of the rights of individuals to accumulate private property, to start, operate and close a business and to transfer capital resources through a country's border. The Index takes values from 1 -100 with higher values indicating a higher rank of economic freedom.	The Heritage Foundation	(-)
GNI	Gross National Income: It is the aggregate value of the gross balances of primary incomes for all sectors and is defined as GDP plus compensation of employees receivable from abroad plus property income receivable from abroad plus taxes less subsidies on production receivable from abroad less compensation of employees payable abroad less property income payable abroad and less taxes plus subsidies on production payable abroad. Expressed in current US$ (2013). Natural log transformed.	World Bank	(-)
HDI	United Nation's Human Development Index: It is a composite statistic of life expectancy, education and standard of living published annually. It can take any value from 0 (least developed) to 1 (most developed).	United Nations	(-)
INFL	Inflation: As measured by the consumer price index.	World Bank	(+)
LGL (`x')	The five dummy variables show the origin of the legal system. LGLFRC, LGLGRM, LGLSKN, LGLSOC and LGLUK stand for a legal system that originates from France, Germany, Scandinavia, Socialist States and United Kingdom.	La Porta *et.al.*, (1999)	(+/-)
PDGDP	Public Debt: Total debt owned by any level of the Government. It consists of all liabilities that require payment or payments of interest and/or principal by the debtor to the creditor at a date or dates in the future. Expressed as a fraction of GDP.	IMF	(+)
REV	Government Revenues: A sum of taxes, subsidies, social contributions, grants receivable and other current and capital transfers. Expressed as a fraction of GDP.	IMF	(-)
TAX	Tax revenues: It refers to compulsory transfers to the central government for public purposes. Certain compulsory transfers such as fines, penalties, and most social security contributions are excluded. Expressed as a fraction of GDP.	World Bank, DataStream	(+/-)
UNPL	Unemployment: Refers to the share of the labour force that is without work but available for and seeking employment. Expressed as a fraction of total labour force.	World Bank	(+)

rounded to the closest integer. The idea behind the constructed rating is that a single rating at just one point in time cannot comprise a satisfactory proxy of sovereign credit risk since it disregards any upgrades or downgrades that took place during each year. Cost of debt is proxied by the yield to maturity of 10-year zero coupon sovereign benchmark bond. If none available then the closest maturity is selected. Unfortunately, we were able to find comparable bonds only for 36[7] out of the 65 countries of our sample, so our empirical analysis for yields to maturity will be confined to them.

4.2. Descriptive statistics

The descriptive statistics for the variables under study are depicted in Table 3.

Table 3. Descriptive Statistics

	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis
RTGSP_INT	7.3169	7.0000	20.0000	1.0000	5.0570	0.1655	1.8077
RTGM_INT	7.0954	7.0000	18.0000	1.0000	5.1316	0.1967	1.7048
RTGF_INT	7.2615	7.0000	17.0000	1.0000	4.9487	0.1364	1.7397
YTM	5.0465	4.4443	16.0000	0.9041	2.2554	1.9626	8.7424
NRI	4.2615	4.1000	6.0500	2.1000	0.7998	0.1841	1.9369
BLNC	-0.0041	-0.0134	0.3859	-0.2983	0.0887	0.5967	5.1643
COMP	4.5448	4.4900	6.0300	2.9900	0.6733	0.0697	2.0228
CRED	0.8116	0.6916	3.1946	0.0559	0.5577	0.8357	3.0543
CRPT	5.4734	4.8000	9.9000	1.8000	2.3480	0.3492	1.7302
DFCT	-0.0142	-0.0169	0.2000	-0.3133	0.0459	0.5953	8.8006
FDGDP	0.2326	0.1762	1.4136	0.0032	0.2064	1.9474	9.0292
FRDM	66.0999	65.0000	90.0000	48.7000	9.0804	0.4344	2.6938
GNI	25.6227	25.6922	30.3124	21.1785	1.7598	0.1633	2.6241
HDI	0.8215	0.8445	0.9710	0.4950	0.1137	-0.7439	2.8223
INFL	4.9737	3.3007	54.4002	-4.8633	5.6470	3.5900	24.6045
PDGDP	0.5373	0.4630	2.1529	0.0369	0.3400	1.4375	6.4007
REV	0.3327	0.3381	0.5843	0.1273	0.1106	0.0500	2.2290
TAX	0.1802	0.1712	0.3578	0.0174	0.0588	0.2975	2.5603
UNPL	0.0800	0.0740	0.3120	0.0040	0.0425	1.5381	7.0510

As we can observe in the table above, the dependent variables proxying credit risk, present a rather flat distribution (kurtosis less than 3) and are positively skewed while the proxy of cost of debt is highly kurtotic. The attributed credit ratings exhibit a wide variability and yields to maturity range from 0.9041 (Japan, 2003) to 16 (Colombia, 2001). Concerning Network Readiness Index, United States seize the first

[7] The 36 countries are: Australia, Austria, Belgium, Bulgaria, Canada, Colombia, Czech Republic, Denmark, Finland, France, Germany, Greece, Hong Kong, Hungary, India, Ireland, Israel, Italy, Japan, Lithuania, Malaysia, Netherlands, New Zealand, Norway, Philippines, Poland, and Portugal.

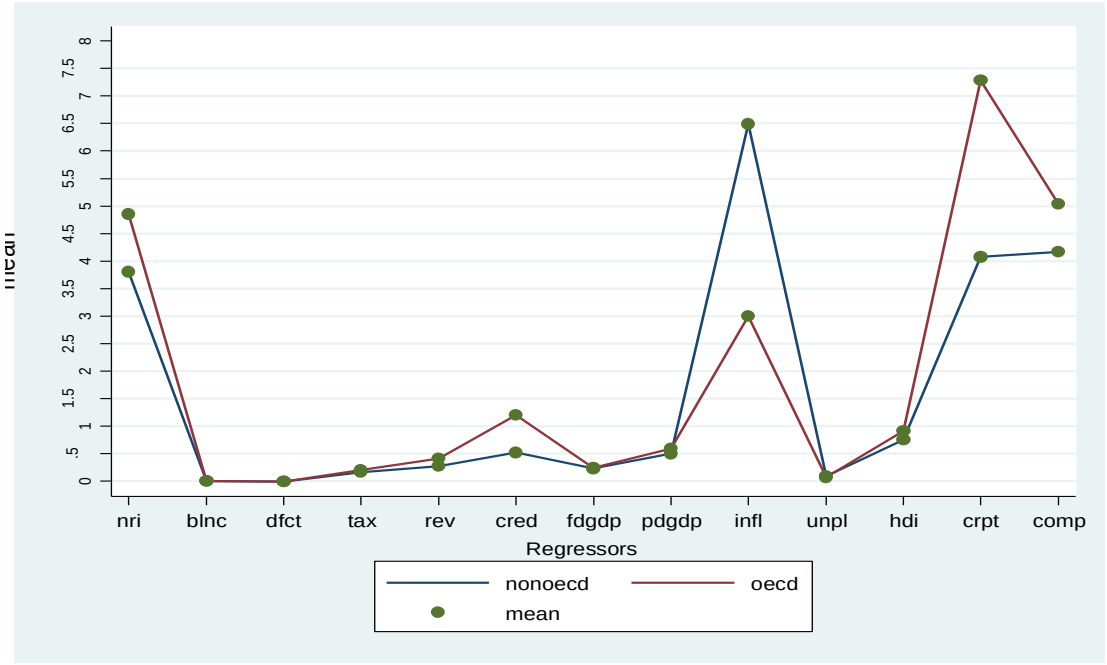

Fig. 1. Main Regressors' averages (2001-2010) for OEDC and non-OECD countries

place on average by a mean of 5.595, followed by Singapore, which present an average of 5.567 while the third place is occupied by Sweden with an average of 5.556. The index presents a very similar variability for both OECD and non-OECD members (sd: 0.592 and 0.615 respectively). However, OECD members score about a unit higher with an average of 4.8576, compared to an average of 3.8032 for non-OECD countries. Table 4 presents all averages per variable and year for both OECD and non-OECD countries and also the aggregate average for all years under study (see also Fig. 1). The last two columns of Table 4 depict the percentage change between average values of 2001 and 2010 per variable and group of countries and the p-values of the Satterthwaite-Welch t-test between averages of variables across all years for OECD and non-OECD countries. Considering the following Table we can note that credit risk ratings have deteriorated for OECD countries between 2001 and 2010 concerning S&P (-14.4 percent) and Fitch (-4.74 percent) while Moody's remained more optimistic (+2.81 percent). All agencies upgraded, on average, non-OECD countries, with Moody's improving its assigned credit ratings to non-OECD countries by 10.12 percent. The actual cost of debt has fallen sharply by 23.08 percent for OECD countries and 37.69 percent for non-OECD ones. The average assigned NRI score for OECD countries was lowered by 3.97 percent while it grew by 9.26 percent for non-OECD countries, always comparing 2001 and 2010 average values. Table 4 figures, suggest a general deterioration of OECD countries macroeconomic fundamentals like BLNC (-44.56 percent), DFCT (1355.41 percent), FDGDP (58.78 percent), PDGDP (22.58 percent) and UNPL (35.59 percent) illustrating the economic turmoil and the tight fiscal policies caused by the burst of the financial crisis of 2007 in U.S. which mainly affected the Western economies. On the other hand non-OECD countries seem to escape much of the crisis backwash and present significant improvements concerning their macroeconomic fundamentals; BLNC (294.88 percent), FDGDP (-36.81 percent), PDGDP (-21.21 percent) and UNPL (-13.48 percent).

Table 4. Average values per year for OECD (upper line) and non-OECD (bottom line) countries.

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Average 2001 -2010	2001-2010 change (%)	Pr(|T|>|t|)[a]
RTGSP	3.2500	3.2143	3.0714	3.0000	3.0000	2.9643	3.0000	3.0714	3.3571	3.7097	3.1638	-14.14	**0.0000**
	11.4054	11.2973	10.8919	10.7568	10.4054	10.1081	9.8108	9.8378	10.1081	10.5294	10.5151	7.68	
RTGM	3.2857	2.9286	2.5000	2.4643	2.4643	2.4286	2.4643	2.5000	2.7857	3.1935	2.7015	2.81	**0.0000**
	11.4865	11.2162	10.8108	10.6216	10.4054	10.2162	9.9730	9.8108	9.9189	10.3235	10.4783	10.12	
RTGF	3.3571	3.2857	3.2143	2.9643	2.9286	2.8571	2.8929	2.8929	3.1071	3.5161	3.1016	-4.74	**0.0000**
	11.2973	11.2162	10.9189	10.8108	10.2973	10.0811	9.7568	9.6757	10.1351	10.4706	10.4660	7.32	
YTM	5.4476	5.2460	4.5306	4.4787	4.0529	3.7917	4.3343	4.6126	3.8424	4.1905	4.4527	-23.08	**0.0000**
	8.5728	7.5827	6.9167	6.6435	5.7138	5.4139	5.7279	6.1840	5.9656	5.3418	6.4063	-37.69	
NRI	5.0050	4.9071	4.5536	4.6000	4.8393	4.9821	4.9821	5.0393	4.8607	4.8065	4.8576	-3.97	**0.0000**
	3.5963	3.6486	3.5365	3.6622	3.7784	3.9054	4.0054	4.0432	3.9270	3.9294	3.8032	9.26	
BLNC	0.0056	0.0071	0.0043	0.0042	-0.0015	-0.0070	-0.0106	-0.0211	-0.0043	0.0031	-0.0020	-44.56	0.5790
	-0.0049	-0.0071	0.0019	-0.0066	-0.0056	-0.0019	-0.0206	-0.0278	0.0074	0.0096	-0.0055	294.88	
COMP	5.2232	4.9186	5.0536	5.0779	4.9729	5.1711	5.0425	5.0324	4.9694	4.9233	5.0385	-5.74	**0.0000**
	4.1581	4.0668	4.0500	4.1489	3.9781	4.2984	4.2486	4.2565	4.2187	4.2317	4.1656	1.77	
CRED	1.0066	1.0021	1.0428	1.0845	1.1887	1.2891	1.3228	1.3229	1.3752	1.3239	1.1959	31.52	**0.0000**
	0.4379	0.4351	0.4495	0.4650	0.4968	0.5258	0.5728	0.5842	0.6074	0.5717	0.5146	30.54	
CRPT	7.2000	7.2000	7.3000	7.3000	7.4000	7.4000	7.4000	7.3000	7.3000	7.1000	7.2900	-1.39	**0.0000**
	4.1000	4.1000	4.0000	4.0000	4.1000	4.1000	4.1000	4.1000	4.1000	4.0000	4.0700	-2.44	
DFCT	-0.0032	-0.0131	-0.0164	-0.0118	-0.0035	0.0058	0.0084	-0.0085	-0.0447	-0.0460	-0.0133	-1355.41	0.7810
	-0.0181	-0.0183	-0.0162	-0.0118	-0.0058	-0.0045	0.0008	-0.0101	-0.0354	-0.0285	-0.0148	-57.58	
FDGDP	0.1862	0.2058	0.2160	0.2261	0.2307	0.2336	0.2338	0.2732	0.3078	0.2956	0.2409	58.78	0.3237
	0.3053	0.2952	0.2877	0.2612	0.2182	0.1900	0.1649	0.1547	0.1858	0.1929	0.2256	-36.81	
FRDM	70.0000	70.2000	70.1000	69.8000	69.8000	71.1000	71.3000	72.1000	72.2000	71.9000	70.8500	2.71	**0.0000**
	62.2000	62.2000	62.6000	62.2000	61.8000	62.2000	62.6000	62.6000	63.0000	62.8000	62.4200	0.96	
GNI	26.2947	26.3928	26.5862	26.7414	26.8227	26.8851	27.0249	27.0931	26.9722	26.8013	26.7614	1.93	**0.0000**
	24.1784	24.2381	24.3714	24.5189	24.6733	24.8446	25.0347	25.1984	25.1360	25.2941	24.7488	4.61	
HDI	0.9110	0.9170	0.9240	0.9280	0.9340	0.9380	0.9430	0.8740	0.8750	0.8760	0.9120	-3.84	**0.0000**

Table 4. Average values per year for OECD (upper line) and non-OECD (bottom line) countries.

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Average 2001 -2010	2001-2010 change (%)	Pr(|T|>|t|) [a]
INFL	0.7520	0.7570	0.7620	0.7690	0.7790	0.7830	0.7890	0.7120	0.7130	0.7020	0.7518	-6.65	**0.0000**
	5.1007	3.9031	2.8835	2.4331	2.4817	2.7025	2.7306	4.2304	1.2888	2.2915	3.0046	-55.07	
	6.8055	5.1362	5.7515	6.9437	6.3242	6.4460	6.7567	11.2703	4.3432	5.0874	6.4865	-25.25	
PDGDP	0.5638	0.5678	0.5719	0.5725	0.5672	0.5605	0.5408	0.5952	0.6769	0.6911	0.5908	22.58	**0.0004**
	0.5903	0.5927	0.5855	0.5327	0.4929	0.4416	0.4047	0.3946	0.4507	0.4651	0.4951	-21.21	
REV	0.4145	0.4095	0.4117	0.4104	0.4156	0.4194	0.4194	0.4145	0.4079	0.4075	0.4130	-1.68	**0.0000**
	0.2567	0.2566	0.2616	0.2675	0.2718	0.2801	0.2852	0.2891	0.2756	0.2626	0.2707	2.28	
TAX	0.2052	0.2007	0.1995	0.2000	0.2059	0.2084	0.2090	0.2047	0.1942	0.1948	0.2022	-5.07	**0.0000**
	0.1534	0.1529	0.1567	0.1608	0.1714	0.1728	0.1751	0.1735	0.1606	0.1548	0.1632	0.87	
UNPL	0.0617	0.0662	0.0686	0.0696	0.0681	0.0632	0.0571	0.0574	0.0771	0.0837	0.0673	35.59	**0.0000**
	0.1027	0.1024	0.0991	0.0948	0.0894	0.0829	0.0756	0.0736	0.0872	0.0889	0.0897	-13.48	

Notes: [a] *p-values of the Satterthwaite-Welch t-test that allow for unequal variances formatted in bold, depict statistically significant difference between averages of variables across all years for OECD (upper line) and non-OECD (bottom line) countries.*

Moreover, in order to test the equality of variables' means between the two set of countries we employ a Satterthwaite-Welch t-test which cannot reject the null hypothesis of equality only for BLNC, DFCT, and FDGDP. Overall this means that our sample consists of two well defined set of countries. On the other hand the failure to reject the equality of means for these variables, illustrates once more the financial crisis faced mainly by OECD countries.

The following Table 5 presents the Pearson correlation coefficient between the variables proxying sovereign credit risk and cost of debt and the explanatory variables. As it was expected the assigned ratings of the three main agencies are highly interdependent. Cost of debt (YTM) also exhibits a strong and stable across agencies correlation with credit ratings. The NRI is very strongly and negatively correlated with credit ratings and still strongly but more loosely with YTM.

This is a first indication that our first hypothesis holds. Corruption perceptions, competitiveness and economic freedom are also found to be highly correlated with credit ratings and YTM. It is also striking to note that FDGDP and PDGDP are as expected positively correlated with credit risk ratings albeit weakly but possess the opposite sign of correlation concerning the YTM (although for FDGDP the correlation is statistically

insignificant). A possible explanation could be that markets as long as a country remains solvent and keeps deficits under control (DFCT presents a statistically significant correlation with all dependent variables) will keep financing a country's debt.

In order to have a better insight of the way the explanatory variables correlate with response variables we break the correlation analysis in two parts, one for each set of countries and we apply a Fisher z-transformation to Pearson correlation coefficients in order to assess the significance of the difference between the two coefficients (see Table 6). The correlation between credit risk ratings and YTM is found to be much stronger for non-OECD countries (the difference is statistically significant for S&P), possibly because investors and debt holders have (or think they have) a much clearer picture of OECD economies.

Table 5. Correlation Analysis

	RTGSP	RTGM	RTGF	YTM	NRI
RTGM	0.9831 *				
RTGF	0.9928 *	0.9858 *			
YTM	0.6309 *	0.6331 *	0.6436 *		
NRI	-0.8672 *	-0.8677 *	-0.8738 *	-0.5620 *	
BLNC	-0.3027 *	-0.2572 *	-0.2973 *	-0.2383 *	0.2848 *
COMP	-0.8885 *	-0.8843 *	-0.8905 *	-0.5955 *	0.9372 *
CRED	-0.7507 *	-0.7674 *	-0.7657 *	-0.5743 *	0.7597 *
CRPT	-0.8814 *	-0.8806 *	-0.8790 *	-0.5160 *	0.8993 *
DFCT	-0.2652 *	-0.2203 *	-0.2475 *	-0.1291 *	0.2534 *
FDGDP	0.1921 *	0.1781 *	0.1874 *	-0.0121	-0.2499 *
FRDM	-0.6997 *	-0.6961 *	-0.6969 *	-0.4311 *	0.7344 *
GNI	-0.5594 *	-0.5496 *	-0.5784 *	-0.3424 *	0.5237 *
HDI	-0.8235 *	-0.8293 *	-0.8235 *	-0.4749 *	0.7450 *
INFL	0.5380 *	0.5189 *	0.5306 *	0.5760 *	-0.4317 *
PDGDP	0.0384	0.0048	0.0194	-0.2918 *	-0.0015
REV	-0.6340 *	-0.6372 *	-0.6269 *	-0.1988 *	0.5389 *
TAX	-0.3423 *	-0.3356 *	-0.3289 *	-0.0394	0.3013 *
UNPL	0.3774 *	0.3663 *	0.3801 *	0.3726 *	-0.4139 *

Notes: A star denotes statistically significant values at the 5 percent level using a two-tailed test

The NRI is negatively correlated with all response variables for both set of countries and exhibits a much stronger correlation for non-OECD countries presenting a first indication that our second hypothesis holds as well.

Graphical depictions of these correlations are shown in Fig.2, along with overlaying bivariate regressions lines, one for each group of countries. A much more steeper slope is discernible for non-OECD countries, suggesting a larger impact of NRI in this group of countries. Regarding the fundamental macroeconomic factors, OECD countries' credit risk ratings and cost of debt is mainly correlated with GNI, INFL and BLNC while tax revenues seem to be interpreted rather differently by agencies and markets. More specifically

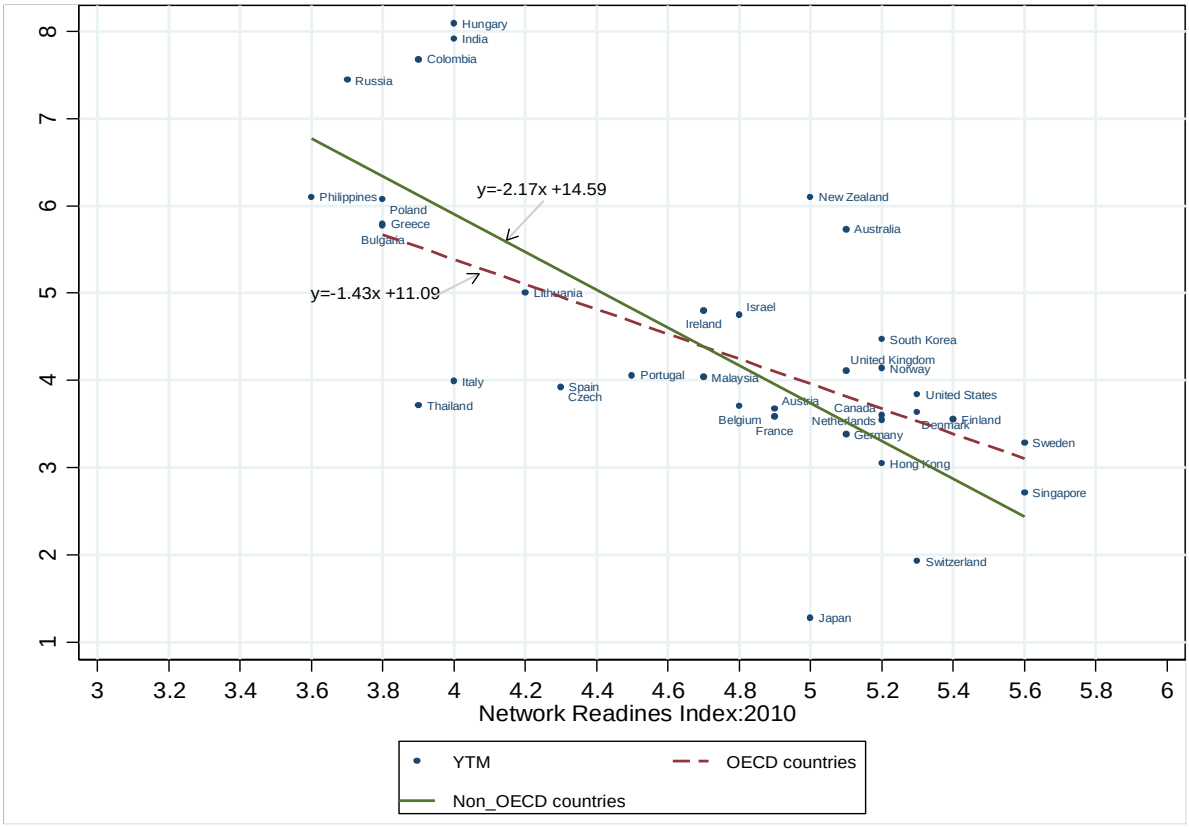

Fig. 2. Scatterplot between YTM and NRI (Year 2010) and bivariate regression line by OECD membership

TAX is negatively correlated with credit risk ratings but positively with cost of debt. A possible explanation could be that markets interpret an increase in tax revenues as a clear sign of economic distress while agencies as an indication of adequate debt service ability.

Concerning non-OECD countries, ratings and YTM are largely correlated with BLNC, DFCT and FDGDP (which in this case present a more anticipated behaviour, being positively correlated with cost of debt). Tax revenues are negatively correlated with both ratings and YTM (though insignificant).

Table 6. Correlation analysis for OECD (upper line) and non-OECD (bottom line) countries

	RTGSP	RTGM	RTGF	YTM	NRI
RTGM	**0.9569***				
	0.9708*				
RTGF	0.9829*	**0.9627***			
	0.9866*	**0.9729***			
YTM	**0.4307***	0.4934*	0.5078*		
	0.6293*	0.5835*	0.6087*		
NRI	**-0.6755***	**-0.6505***	**-0.6784***	**-0.3399***	
	-0.8070*	**-0.8193***	**-0.8239***	**-0.5866***	
BLNC	-0.3976*	-0.3102*	-0.3996*	-0.3506*	0.3985*
	-0.4267*	-0.3905*	-0.4303*	-0.3818*	0.3475*
COMP	**-0.7471***	**-0.7168***	**-0.7429***	**-0.3714***	0.8835*

Table 6. Correlation analysis for OECD (upper line) and non-OECD (bottom line) countries

	RTGSP	RTGM	RTGF	YTM	NRI
CRED	**-0.8356***	**-0.8431***	**-0.8454***	**-0.6435***	0.8975*
	-0.5456*	-0.6030*	-0.5817*	-0.4984*	**0.5553***
	-0.6372*	-0.6455*	-0.6501*	-0.6153*	**0.6889***
CRPT	-0.7708*	-0.7674*	-0.7475*	**-0.2967***	0.8147*
	-0.7843*	-0.7846*	-0.7877*	**-0.5052***	0.8289*
DFCT	-0.3762*	-0.3227*	-0.3614*	**-0.0043**	**0.4293***
	-0.3791*	-0.3353*	-0.3604*	**-0.3659***	**0.2340***
FDGDP	**0.0512**	**0.015**	**0.0272**	**-0.004**	**-0.2526***
	0.4603*	**0.4623***	**0.4785***	**0.4541***	**-0.4328***
FRDM	-0.6084*	-0.6001*	-0.5916*	**-0.1689***	0.6618*
	-0.5903*	-0.5943*	-0.5967*	**-0.4769***	0.6373*
GNI	-0.2427*	-0.1866*	-0.2627*	**-0.4590***	**0.1540***
	-0.2783*	-0.2535*	-0.3047*	**0.027**	**0.3147***
HDI	**-0.7449***	**-0.7600***	**-0.7321***	-0.3450*	0.5711*
	-0.6380*	**-0.6285***	**-0.6333***	-0.2884*	0.5513*
INFL	**0.5833***	**0.5833***	**0.5805***	**0.6421***	-0.3019*
	0.4257*	**0.3983***	**0.4167***	**0.4616***	-0.3332*
PDGDP	**0.1006**	**0.0256**	**0.0712**	**-0.4409***	-0.1307*
	0.2804*	**0.2680***	**0.2684***	**-0.0971**	-0.1211*
REV	-0.3548*	-0.3635*	-0.3320*	0.0131	0.2327*
	-0.3091*	-0.2821*	-0.2809*	0.1232	0.1915*
TAX	-0.1262*	-0.1189*	-0.0893	**0.3347***	0.1009
	-0.1941*	-0.1660*	-0.1772*	**-0.1344**	0.1408*
UNPL	**0.3877***	**0.3935***	**0.4013***	**0.1580***	**-0.5607***
	0.2405*	**0.2184***	**0.2414***	**0.5556***	**-0.2259***

Notes: Values formatted in bold depict statistically significant difference at the 5 percent level between the two correlation coefficients (Fisher Z's transformation).
(*) statistically significant at 5 percent.

4.3. Is a country's e-readiness inversely associated with credit risk rating and cost of debt?

In light of the methodological considerations above, our discussion will be focused on the random effects estimation that appear on Table 7. We employ a backward selection stepwise procedure with a 0.05 significance level for removal from the model.

Then we rerun the model including only the regressors that our selection strategy suggested as having a statistical significant impact. As we already explained, an ordered probit random effects estimation will be followed, in order to estimate credit risk ratings and a panel linear random effects estimation concerning cost of debt (YTM). Since it is hard to directly grasp how large the effects of regressors are on ratings through the ordered probit coefficients, we compute the average marginal effects. In order to gain more

insight on the interpretation of independent variables when computing marginal effects[8], ratings are merged following the characterization of debt by Moody's and shown in Table 1.

Overall, our results confirm our first hypothesis that a country's relative technological advancement, mainly on the field of information and communication, as is being proxied by NRI is inversely associated with credit risk ratings and cost of debt, meaning that countries that score higher in NRI index, perform better on credit ratings and are able to borrow from financial markets at a lower cost. As we can see on Table 7, NRI seems to have only a long-run effect since all short-run coefficients regarding all regressions are insignificant. On the long-run a marginal increase in NRI increases the probability of a debt characterization of one (Highest Quality) by 0.049 for S&P and by 0.035 for Fitch while reduces the probability of six (Very High Credit Risk) by 0.022 for S&P and by 0.023 for Fitch. Moody's seems to place much more weight on technological diffusion since a marginal improvement in NRI would increase the probability of a debt being accredited as one of the highest quality by 0.115 and reduces the probability of six (Very High Credit Risk) by 0.112. Concerning the cost of debt a point increase in NRI improves cost of debt by around one percentage point (p.p.).

Concerning the macroeconomic fundamentals increased GNI drives ratings and cost of debt down mainly on the short-run, except S&P where both short and long-run coefficients are significant. Marginal effects suggest that for a marginal increase in GNI natural log, the probability of a debt characterization of one (Highest Quality) would increase by 0.05 for S&P and by 0.75 for Moody's and Fitch while the probability of a characterization of six (Very High Credit Risk) would fall by 0.025 for S&P, by 0.072 for Moody's and by 0.049 for Fitch. On the short-run a five percent increase in GNI would improve YTM by 0.104 percentage points.

Domestic credit to private sector is found to be significant on the long-run across all agencies and for debt markets. The findings suggests that although increased domestic credits to private sector raise the repayment claims and make a country's economy more vulnerable to a crisis, a growing share of credit as a fraction of GDP improves ratings and cost of debt. A growing inflation drives upwards ratings and yields to maturity on the short and on the long-run with agencies weighing more a persisting inflation. More specifically a marginal increase in inflation on the long run reduces the probability of a debt characterization of one (Highest Quality) by 0.014 while only by 0.003 for a short-run marginal increase. The change in probability for Moody's and Fitch is 0.01 and 0.002 respectively. On the long run a one percentage point increase of inflation would increase YTM by 0.5255 p.p. while on the short run the magnitude would be smaller and YTM would be increased by 0.2623 p.p.

Unemployment does not seem to have a significant impact on cost of debt, on the other hand findings on the regressor provide us with interesting insights concerning ratings. The short-run coefficients are all of

[8] In order to preserve space we do not present marginal effects estimations but calculations are available by authors upon request.

positive sign indicating a deterioration of ratings while marginal effects show a rather large impact. Interestingly for S&P and Fitch the marginal effect on a debt characterization of one (Highest Quality) by a small increase in unemployment is so large that the effect exceeds 1 which means that the slope of the probability curve is changing rapidly and the slope of the tangent line is no more a good approximation. On the long-run the findings are mixed. S&P considers an increase in unemployment on average as a negative sign while Moody's and Fitch seem to evaluate it as a sign of structural reforms and further deregulation of labour markets.

Regarding the governmental variables, tax revenues level do not seem to have a significant impact on cost of debt although all agencies evaluate excess taxation on the long-run as an anguished effort to fulfill a country's obligations by choking the economy. On the other hand an improvement on public revenues on the long-run has an positive impact on ratings while markets seem to penalize it by 0.06 percentage points for one p.p. increase in public revenues. Public debt also seem to be perceived differently by markets and agencies. An increase in the regressor, deteriorates S&P ratings on the short and long-run while as we already commented on section *4.2.,* debt markets do not seem alerted by such an increase and would interpret it as a sign of solvency. Of course public debt is closely connected with deficit, which agencies and markets on the short and long-run penalize as a clear sign of economic distress that hinders government's ability to finance public debt and meet payment obligations. A one percentage point decrease in deficit would drive yields down by 0.16 p.p. on the long-run and by 0.1 p.p. on the short-run while a marginal decrease in the same regressor would increase the probability of a debt characterization of one (Highest Quality) by 0.45 for Moody's and by 0.42 for Fitch.

Turning to the external variables, current account balance has an inverse impact on credit ratings on the long-run across all agencies. A marginal improvement in current account balance on the long run increases the probability of a debt characterization of one (Highest Quality) by 0.54 for S&P and by 0.5 for Fitch while reduces the probability of a debt characterization of six (Very High Credit Risk) by 0.24 and 0.33 respectively.

On the other hand foreign debt as a fraction of GDP drives up ratings for Moody's and Fitch on the long-run while a bit puzzling is that S&P seems to interpret an increase on the average foreign debt as a rating decreasing factor, probably as a sign of foreign investors' trust.

Concerning the rest of the variables under study, history of defaults seem to be penalized only by Moody's; a Eurozone membership is appraised across all agencies while markets decrease yields by 2.1 p.p., reflecting the widespread perception that currency unification would lead to a unification of credit risk for the country members (a perception that proved to be false). Being a member of OECD also leads to lower credit risk rating albeit markets do not seem to regard this membership as a significant determinant of debt's cost.

Table 7. Baseline Regression for all countries

	RTGSP[9]		RTGM[1]		RTGF[1]		YTM	
NRI_AVG	-0.9493**	*(0.0010)*	-1.6672**	*(0.0000)*	-0.7406**	*(0.0080)*	-1.0705*	*(0.0410)*
NRI_DIFF	-0.0160	*(0.9530)*	0.2149	*(0.4340)*	0.0590	*(0.8290)*	0.2961	*(0.3310)*
BLNC_AVG	-12.9623**	*(0.0000)*	-3.3343*	*(0.0180)*	-14.5711**	*(0.0000)*		
BLNC_DIFF	0.3008	*(0.7760)*	1.0677	*(0.3110)*	1.3501	*(0.2030)*		
COMP_AVG								
COMP_DIFF								
CRED_AVG	-2.0741**	*(0.0000)*	-2.0491**	*(0.0000)*	-1.0924**	*(0.0000)*	-1.8406**	*(0.0000)*
CRED_DIFF	0.0234**	*(0.9450)*	-1.3390**	*(0.0020)*	0.1967	*(0.5630)*	0.3398	*(0.4520)*
CRPT_AVG	-0.9312**	*(0.0000)*			-0.8924**	*(0.0000)*		
CRPT_DIFF	-0.4555**	*(0.0030)*			-0.3482*	*(0.0210)*		
DFCT_AVG			-19.5601**	*(0.0000)*	-17.7894**	*(0.0000)*	-16.2059**	*(0.0000)*
DFCT_DIFF			-3.7224	*(0.1050)*	-8.5438**	*(0.0000)*	-10.2233**	*(0.0010)*
FDGDP_AVG	-2.3531**	*(0.0000)*	0.8733*	*(0.0360)*	3.8813**	*(0.0000)*		
FDGDP_DIFF	0.4605	*(0.6070)*	0.8507	*(0.1450)*	1.3456*	*(0.0210)*		
FRDM_AVG	-0.0060**	*(0.6640)*	-0.0350*	*(0.0200)*	-0.0136	*(0.3380)*	0.0932**	*(0.0040)*
FRDM_DIFF	-0.0672**	*(0.0030)*	-0.0769**	*(0.0010)*	-0.0864**	*(0.0000)*	0.1091**	*(0.0010)*
GNI_AVG	-0.5035**	*(0.0000)*	0.0631	*(0.3620)*	-0.0113	*(0.8480)*	-0.0016	*(0.9920)*
GNI_DIFF	-0.8471**	*(0.0000)*	-1.5426**	*(0.0000)*	-1.6311**	*(0.0000)*	-2.1414**	*(0.0000)*
HDI_AVG			-6.1846**	*(0.0000)*				
HDI_DIFF			-7.9324**	*(0.0000)*				
INFL_AVG	0.2821**	*(0.0000)*	0.2189**	*(0.0000)*	0.3686**	*(0.0000)*	0.5255**	*(0.0000)*
INFL_DIFF	0.0476**	*(0.0000)*	0.0182	*(0.1140)*	0.0255*	*(0.0340)*	0.2623**	*(0.0000)*
PDGDP_AVG	4.5108**	*(0.0000)*					-1.3147**	*(0.0010)*
PDGDP_DIFF	2.2909**	*(0.0020)*					-0.4818	*(0.5450)*
REV_AVG	-14.2792**	*(0.0000)*	-11.5038**	*(0.0000)*	-13.2808**	*(0.0000)*	5.9895*	*(0.0360)*
REV_DIFF	-1.9599	*(0.4580)*	5.8054*	*(0.0350)*	4.0767	*(0.1280)*	8.9694	*(0.1140)*
TAX_AVG	5.5140**	*(0.0010)*	12.1787**	*(0.0000)*	11.5739**	*(0.0000)*	2.2177	*(0.4710)*
TAX_DIFF	-1.6330	*(0.6120)*	0.3424	*(0.9170)*	-0.3119	*(0.9220)*	-6.7262	*(0.3450)*
UNPL_AVG	2.1679**	*(0.1800)*	-5.5566**	*(0.0050)*	-8.3161**	*(0.0000)*	10.6447	*(0.0710)*
UNPL_DIFF	19.6414**	*(0.0000)*	11.8290**	*(0.0000)*	14.9329**	*(0.0000)*	1.8043	*(0.6290)*
DFLT75			0.7604**	*(0.0000)*				
DFLT95			-0.0266	*(0.8800)*				
EURO	-1.0514**	*(0.0000)*	-2.2684**	*(0.0000)*	-3.7601**	*(0.0000)*	-2.0932**	*(0.0000)*
OECD	-1.8628**	*(0.0000)*	-2.3598**	*(0.0000)*	-2.4738**	*(0.0000)*	-0.3571	*(0.3750)*
LGLGRM	-0.3240	*(0.4440)*	0.6872	*(0.1190)*	-0.1900	*(0.6070)*		
LGLSKN	2.0081**	*(0.0000)*	-1.2656*	*(0.0260)*			-0.7012	*(0.2300)*
LGLSOC							-3.7988**	*(0.0000)*
LGLUK	-1.1076**	*(0.0000)*	-0.9494**	*(0.0000)*	-1.5279**	*(0.0000)*	-0.9725**	*(0.0070)*
_CONS							3.1581	*(0.4420)*
LogLik	-675.04491		-695.9326		-683.23273			
R-squared							0.7394	

[9] In order our maximum-likelihood estimation to converge, we merged S&P ratings between 17-20 to 17 (4 changes made), Moody's ratings between 17-18 to 17 (2 changes made) and Fitch ratings between 17-21 to 17 (1 change made)

Table 7. Baseline Regression for all countries

	RTGSP[9]	RTGM[1]	RTGF[1]	YTM
Rho[a]				0.1663
Hausman Test[b]				1.01 *(0.3158)*

Notes: The coefficient with the variable followed by _AVG denotes the long-run coefficient while the coefficient with the variable followed by _DIFF denotes the short-run coefficient. (*), (**) statistically significant at 5 percent, 1 percent. P-values in brackets.

[a] *Fraction of variance due to u_i or the intraclass correlation*

[b] *The null hypothesis is that random effects estimations is consistent and therefore preferable to fixed effect. P-values in brackets.*

The Index of Human Development is significant for Moody's since a marginal improvement in HDI would increase the probability of a debt characterization of one (Highest Quality) by 0.68 on the long-run and by 0.42 in the short-run. Corruption and business freedom have also a significant impact on ratings on the long and the short-run. A marginal improvement in Corruption Index on the long-run where the magnitude is larger would increase the probability of a debt characterization of one (Highest Quality) by 0.067 for S&P and by 0.051 for Fitch while the probability of a debt characterization of 7 (Near Default or Default) would fall by 0.023 for S&P and by 0.01 for Fitch. On the other hand, a marginal improvement in Business Freedom Index would increase the probability of debt characterization of one (Highest Quality) by 0.003 for S&P, by 0.006 for Moody's and by 0.004 for Fitch. Markets also seem to appraise positively, changes towards a more liberal business environment mainly on the short-run since a one point increase in Business Freedom Index would reduce the cost of debt by 0.11 p.p.

A country's legal system that originates from United Kingdom seems to be evaluated as a safety valve by all agencies (always in comparison to the French legal system which is our base) and also leads to one percentage point drop in the cost of debt, confirming that it is perceived as the safest legal system by the investors. Scandinavian legal system origination seems to be evaluated differently by S&P (riskier than French) and Moody's (safer than French) while markets seem to place their trust, not only on Anglo-Saxon legal systems, but also upon countries that their legal system have a socialistic background.

4.4. Has a country's e-readiness a different level of impact on its credit ratings and cost of debt depending on its development stage?

Following the same econometric procedure[10] we turn to our second set of hypotheses, which suggest that while NRI is inversely associated with credit ratings and cost of debt for the entirety of countries, it will have a much more severe impact on non-OECD countries' ratings and yields. Table 8 & 9 present the regression analysis for OECD and non-OECD countries respectively.

[10] We do not attempt to estimate marginal effects on the subsamples due to limited variation

Overall, the results seem to lend support to our second hypothesis as well. Short and long-run NRI coefficients are not statistical significant for OECD countries (with the exception of Moody's were NRI enters the regression with the opposite sign on the short-run) while on the contrary, long-run NRI coefficients concerning the non-OECD countries are statistical significant across all agencies, presenting an inverse correlation with credit ratings.

Additionally debt markets seem to put also emphasis on the technological performance of a non-OECD country by reducing their cost of debt by 1.1 percentage points for every additional point in the NRI they manage to reach. The findings allow us to suggest that concerning the non-OECD countries, agencies and markets distinguish the continuing and long lasting efforts a country makes to advance its technological status, as an important determinant of its ability to service its debt in the future.

Table 8. Regressions for OECD countries

	RTGSP[11]		**RTGM**[1]		**RTGF**[1]		**YTM**	
NRI_AVG	1.9970	*(0.2000)*	-1.2055	*(0.4130)*				
NRI_DIFF	-0.3246	*(0.5760)*	1.2638*	*(0.0240)*				
BLNC_AVG	-45.1795**	*(0.0000)*	-7.6187	*(0.2370)*	-34.5925**	*(0.0000)*		
BLNC_DIFF	6.5342	*(0.2500)*	25.1513**	*(0.0000)*	8.0091	*(0.1490)*		
COMP_AVG								
COMP_DIFF								
CRED_AVG	-7.9416**	*(0.0000)*	-3.4561**	*(0.0030)*	-9.4273**	*(0.0000)*	-0.4535	*(0.0810)*
CRED_DIFF	0.1472	*(0.8080)*	-2.6696**	*(0.0010)*	2.6770**	*(0.0020)*	0.6297*	*(0.0100)*
CRPT_AVG	-0.5485	*(0.1430)*	-0.8984	*(0.0520)*	-3.8723**	*(0.0000)*		
CRPT_DIFF	-1.6664**	*(0.0000)*	-1.0718**	*(0.0030)*	-1.4402**	*(0.0010)*		
DFCT_AVG			-9.7951	*(0.2610)*	-19.0273	*(0.1860)*		
DFCT_DIFF			-35.9636**	*(0.0000)*	-7.5810	*(0.2450)*		
FDGDP_AVG	-13.2815**	*(0.0000)*			-23.0815**	*(0.0000)*	0.8190	*(0.4410)*
FDGDP_DIFF	4.1157*	*(0.0460)*			2.8425	*(0.1540)*	0.7792	*(0.3070)*
FRDM_AVG	-0.3188**	*(0.0000)*	-0.2434*	*(0.0320)*	0.1035	*(0.3290)*		
FRDM_DIFF	-0.1671*	*(0.0140)*	-0.0114	*(0.8440)*	-0.0666	*(0.3980)*		
GNI_AVG					-3.5061**	*(0.0000)*	0.0857	*(0.3020)*
GNI_DIFF					-4.3677**	*(0.0000)*	-1.7971**	*(0.0000)*
HDI_AVG					-30.2879	*(0.2720)*		
HDI_DIFF					13.5892*	*(0.0270)*		
INFL_AVG	1.8734**	*(0.0000)*	0.6579**	*(0.0030)*	1.5154**	*(0.0000)*	0.7522**	*(0.0000)*
INFL_DIFF	0.3332**	*(0.0010)*	0.5171**	*(0.0000)*	0.2264*	*(0.0200)*	0.1752**	*(0.0000)*
PDGDP_AVG	10.3598**	*(0.0000)*			10.8257**	*(0.0000)*	-0.5811	*(0.0840)*
PDGDP_DIFF	9.0164**	*(0.0000)*			14.9529**	*(0.0000)*	0.5367	*(0.3230)*

[11] In order our maximum-likelihood estimation to converge, we merged S&P ratings between (9-10 to 10, 12-13 to 13, 14-16 to 16) (4 changes made); Moody's ratings between (8-10 to 8, 12-13 to 13) (4 changes made) and Fitch ratings between (14-16 to 14, 11-13 to 11, 9-10 to 9) (8 changes made).

Table 8. Regressions for OECD countries

	RTGSP[11]		RTGM[1]		RTGF[1]		YTM	
REV_AVG	-31.9096**	*(0.0000)*	-11.6464*	*(0.0390)*	10.4693	*(0.1460)*		
REV_DIFF	9.6996	*(0.4270)*	24.7771	*(0.0560)*	15.3047	*(0.2520)*		
TAX_AVG	22.8588**	*(0.0080)*	2.5516	*(0.7650)*	-4.2216	*(0.5430)*	5.4154**	*(0.0030)*
TAX_DIFF	1.0132	*(0.9480)*	5.7536	*(0.7260)*	0.2887	*(0.9860)*	-2.6294	*(0.4410)*
UNPL_AVG	34.1301	*(0.1210)*	-6.8458	*(0.7770)*	24.4086	*(0.3270)*	6.3743	*(0.1260)*
UNPL_DIFF	23.2029**	*(0.0010)*	11.4162	*(0.1200)*	-7.0706	*(0.4270)*	-4.4668	*(0.0830)*
DFLT75	0.9245	*(0.4500)*	-0.0520	*(0.9760)*	2.3060	*(0.1370)*		
DFLT95								
EURO	-1.2525	*(0.1080)*	-4.0779**	*(0.0020)*	-7.5500**	*(0.0050)*	-0.4282	*(0.1610)*
OECD								
LGLGRM							0.4599	*(0.1060)*
LGLSKN								
LGLSOC			-3.1069*	*(0.0210)*	-16.4932**	*(0.0000)*	0.3480	*(0.4030)*
LGLUK	-5.1251**	*(0.0000)*	-0.2477	*(0.7810)*	-1.6057	*(0.1000)*	0.3941	*(0.0740)*
_CONS							-0.4144	*(0.8660)*
LogLik	-129.87933		-142.72305		-105.66864			
R-squared							0.8162	
Rho[b]							0.23179	
Hausman Test[c]							0.10 *(0.7471)*	

Notes: The coefficient with the variable followed by _AVG denotes the long-run coefficient while the coefficient with the variable followed by _DIFF denotes the short-run coefficient. (*), (**) statistically significant at 5 percent, 1 percent. P-values in brackets.

[a] *Fraction of variance due to u_i or the intraclass correlation*

[b] *The null hypothesis is that random effects estimations is consistent and therefore preferable to fixed effect. P-values in brackets.*

Regarding OECD countries, all agencies seem to take into account mainly the current account balance on the long-run. It is worth mentioning that on the short-run, Moody's appraise a decrease in deficit as a sign of economic distress and as an effort to cut down consumption. It is also interesting that for this group of countries and on the long-run, increases on average foreign debt signal a growing trust by the investors and drive downwards credit ratings while the short-run deviation from the average enters positively and significantly the S&P model, indicating the difference between long-run trust and short-run increased indebtedness. On the other hand, public debt on the short and the long-run leads to a deterioration of ratings for S&P and Moody's. Inflation also leads to a deterioration of credit ratings on both short and long-run and across all agencies while unemployment short-run deviation from the average enters positively and significantly only the S&P estimation. Eurozone membership and legal system originating from UK or having a socialistic background seem to have an significant inverse impact on ratings driving them downwards. On the other hand, debt markets seem to employ a rather limited number of determinants concerning the OECD cluster of countries and penalize a short-run expansionary credit policy, a short and long-run raise in inflation and a long-run raise in tax revenues considering such a raise as signal of unnecessary growth of public expenses that need to be financed and abstract resources from the real economy.

When attributing ratings to non-OECD countries, agencies, except NRI, seem to put emphasis on average current account balance and long-run fiscal balance (DFCT). In contrast to OECD countries, average foreign debt in non-OECD countries is a predictor of rating deterioration. Inflation on the long run and unemployment on the short run are also significant determinants of non-OECD credit risk ratings.

Concerning the cost of debt of non-OECD countries, no significant random effects were found to exist probably because of the small sample that we had in our disposal and therefore no panel random effects analysis was performed. Instead, we carried out a pooled panel regression without breaking our variables in averages and deviations from the average.

The findings suggest that apart from NRI, current account and fiscal balance, along with inflation, taxation and public debt are the main predictors of the cost of debt that non-OECD countries face. It is worth mentioning that taxation enters the cost of debt model with a negative sign meaning that for this group of countries markets consider increased taxes as a reassuring sign that the country will continue to meet its debt obligations.

Prior default is also penalized by markets while a socialistic or an Anglo-Saxon background of the country's legal system enhance investor's trust to a country's creditworthiness.

Table 9. Regressions for non_OECD countries

	RTGSP[12]		**RTGM**		**RTGF**		**YTM**[13]	
NRI_AVG	-0.7213*	*(0.0430)*	-2.1971**	*(0.0000)*	-2.0276**	*(0.0000)*	-1.1046*	*(0.013)*
NRI_DIFF	0.2943	*(0.4260)*	0.1813	*(0.6140)*	0.4763	*(0.1900)*		
BLNC_AVG	-11.4006**	*(0.0000)*	-14.5229**	*(0.0000)*	-6.0306**	*(0.0000)*	-10.2203**	*(0.002)*
BLNC_DIFF	1.9284	*(0.0950)*	1.9258	*(0.0790)*	3.2939**	*(0.0030)*		
COMP_AVG								
COMP_DIFF								
CRED_AVG	-0.0362	*(0.9250)*	-1.2085**	*(0.0010)*	-1.6554**	*(0.0000)*		
CRED_DIFF	-0.5611	*(0.4330)*	-1.2824	*(0.0720)*	0.7721	*(0.2770)*		
CRPT_AVG	-1.4742**	*(0.0000)*	-0.9524**	*(0.0000)*	-1.1602**	*(0.0000)*		
CRPT_DIFF	-0.0507	*(0.8010)*	-0.3091	*(0.1240)*	-0.1939	*(0.3280)*		
DFCT_AVG	-12.6801**	*(0.0000)*	-12.8392**	*(0.0000)*	-23.5866**	*(0.0000)*	-29.8458**	*(0.0000)*
DFCT_DIFF	-2.4567	*(0.4470)*	0.6823	*(0.8150)*	-2.2534	*(0.4410)*		
FDGDP_AVG	1.7713*	*(0.0320)*	2.0171**	*(0.0000)*	2.0624**	*(0.0000)*		
FDGDP_DIFF	0.0353	*(0.9760)*	-0.8175	*(0.2410)*	-0.6669	*(0.3490)*		
FRDM_AVG	0.0250	*(0.1200)*	0.0373*	*(0.0280)*	0.0164	*(0.3660)*		
FRDM_DIFF	-0.0731**	*(0.0060)*	-0.1152**	*(0.0000)*	-0.0877**	*(0.0010)*		
GNI_AVG	-0.0881	*(0.2460)*	0.1008	*(0.1390)*	0.0884	*(0.2000)*		
GNI_DIFF	-1.6114**	*(0.0000)*	-1.6426**	*(0.0000)*	-2.1620**	*(0.0000)*		
HDI_AVG							13.8186**	*(0.0000)*

[12] In order our maximum-likelihood estimation to converge, we merged S&P ratings between (2-3 to 3, 17-20 to 17) (6 changes made); Moody's ratings between (2-3 to 3) (1 change made) and Fitch ratings between (2-3 to 3, 17-21 to 17) (3 changes made)

[13] Pooled panel regression without breaking of variables in averages and deviations from the average

Table 9. Regressions for non_OECD countries

	RTGSP[12]		RTGM		RTGF		YTM[13]	
HDI_DIFF								
INFL_AVG	0.2147**	*(0.0000)*	0.0525*	*(0.0150)*	0.2048**	*(0.0000)*	0.3334**	*(0.0000)*
INFL_DIFF	0.0364*	*(0.0140)*	0.0197	*(0.1390)*	0.0262	*(0.0670)*		
PDGDP_AVG	2.0969**	*(0.0000)*					3.6511**	*(0.0000)*
PDGDP_DIFF	0.1273	*(0.9000)*						
REV_AVG	-7.6366**	*(0.0000)*						
REV_DIFF	-1.2424	*(0.6700)*						
TAX_AVG							-14.6369**	*(0.0040)*
TAX_DIFF								
UNPL_AVG	2.7448	*(0.1340)*	-2.4317	*(0.1830)*	4.8072*	*(0.0100)*		
UNPL_DIFF	18.7531**	*(0.0000)*	10.9957**	*(0.0050)*	19.0432**	*(0.0000)*		
DFLT75								
DFLT95							2.7126*	*(0.0100)*
EURO			-1.1997	*(0.3870)*	-3.7517**	*(0.0010)*		
OECD								
LGLGRM								
LGLSKN								
LGLSOC							-3.4939**	*(0.0000)*
LGLUK	-0.8137**	*(0.0020)*					-3.0371**	*(0.0000)*
_CONS							1.4380	*(0.4500)*
LogLik	-464.11889		-487.90444		-465.9145			
R-squared							0.7699	

Notes: The coefficient with the variable followed by _AVG denotes the long-run coefficient while the coefficient with the variable followed by _DIFF denotes the short-run coefficient. (*), (**) statistically significant at 5 percent, 1 percent. P-values in brackets.

4.5. Robustness checks and years of crisis

The burst of the economic crisis towards the end of 2007 and the deterioration of ratings and the sharp increases in cost of debt that followed, make necessary the investigation of the stability of our estimated models before and after the beginning of the economic crisis. Therefore we divide our sample in two periods; 2001-2006 and 2007-2010 and we conduct a Chow test which we present at the bottom of Table 10. Our null hypothesis, that our coefficients are constant across the two periods is strongly rejected for all our response variables indicating a possible break in time, around 2007 which coincides with the burst of the economic crisis.

In order to take a more close look since Chow test suggests a break, we rerun our models separately for the two aforementioned periods and we present the results in the following Table 10 in confrontation. Interestingly, NRI on the long run is a significant predictor during the crisis years (2007-2010) for Moody's and Fitch, with the exception of S&P where the coefficient is very similar to this of the antecedent period

albeit no longer significant. So, our findings suggest that our first hypothesis is quite robust despite time breaks and that NRI is an important predictor of credit ratings before and after the beginning of the economic crisis that could possibly have altered the determinants.

Concerning the other variables, striking is that in relation to the current account balance and the crisis years, the long-run coefficients are entering the models with a negative sign and the short-run with the opposite, indicating that for the period 2007-2010, agencies prize economic policies that aim in reducing deficits or on enlarging surpluses but on the short-run consider balance deficit shortenings not a result of economic growth but as a result of economic distress that cuts down consumption. Other important differences that can be spotted between the two periods is the positive appraisal by agencies of the domestic credit to the private sector during crisis years probably as a reaction to recession and the significant effect of unemployment during 2007-2010 not only on the long but also on the short run.

Regarding the debt markets, there is no evidence that a discernible changing context of determinants exist before and after the time break and NRI fails to enter the estimation model as a significant predictor in both periods.

5. Conclusions

In this paper we investigate the role played by ICT technologies in the assigning process of credit risk ratings by the three market dominating agencies (S&P, Moody's and Fitch) and the way financial debt markets appraise a country's technological advancements. In order to test our hypotheses, we use ratings and yields to maturity of 10-year zero-coupon sovereign benchmark bonds along with a balanced panel data set of economic, financial and qualitative regressors provided by previous literature.

Concerning our econometric approach and drawing heavily on the work of (Afonso *et. al*., 2011) we have used an random effects approach by adding time-averages of time-varying regressors in the model that allowed us to provide estimations of short and long-term variables' coefficients, along with estimations for time-invariant variables while eliminating the correlation between the country specific error (α_i) and the vector X_{it} of time-varying regressors.

Overall our results confirm our first hypothesis that a country's e-readiness status in adversely associated with credit risk ratings and cost of debt. The findings corroborate the view that ICTs, of which e-readiness is a metric of their usage and diffusion, play not only a direct role in growth and development but also have an long-run impact on other important determinants of economic and financial policies like cost of debt and credit ratings that could possibly hinder or foster a country's growth. Moreover, the results lend support to our second hypothesis as well, indicating that in developing countries, ICTs play a much more crucial role in the assignment of credit rating and the cost of debt.

Keeping in mind the findings of Vu (2011), Jorgenson and Vu (2010) and Waverman *et.al.,* (2005) that ICTs continue to expand their contribution to developing countries growth, our results provide an indirect indication that by putting much more emphasis on developing countries e-readiness, agencies and financial debt markets ultimately agree with the key long-run role of ICTs concerning that cluster of countries.

Our findings also suggest that on the short run the most important determinants of credit risk ratings and cost of debt are GNI and unemployment while on the long run domestic credit to private sector, current account balance, public revenues and taxation seem to play a more important role. Inflation, budget deficit or surplus and public debt have an impact on the response variables on the short and the long-run. Being a member of Eurozone, a legal system that originates from Anglo-Saxon or socialistic legal traditions and no history of default are also found to be appraised positively by agencies and markets. Our robustness checks suggest that e-readiness keeps on having a significant adverse impact on ratings before and during crisis years.

A straightforward policy implication can be derived from our findings; investing in ICTs and their diffusion will not only contribute to growth directly and through spillovers but will ease, especially for non-OECD countries, access to debt markets.

Table 10. Regressions 2001-2006 & 2007-2010. Robustness Check.

	RTGSP		RTGM		RTGF		YTM	
	2001-2006	**2007-2010**	**2001-2006**	**2007-2010**	**2001-2006**	**2007-2010**	**2001-2006**	**2007-2010**
NRI_AVG	-1.1246*	-1.4189	-2.2933**	-3.5412**	-1.1801**	-2.4594**	-1.2130	-0.3235
NRI_DIFF	-0.4644	1.7753	-0.0797	-1.3905	-0.2657	-0.8975	0.2480	0.8009
BLNC_AVG	-20.0806**	-35.7416**	-7.0230**	-8.3607*	-2.2536	-21.9490**		
BLNC_DIFF	0.9820	10.7241**	1.0566	4.0135	1.8724	13.5271**		
COMP_AVG								
COMP_DIFF								
CRED_AVG	-2.0009**	0.2328	-1.3376**	-0.9794	-0.5884	0.1156	-1.8433*	-1.2489*
CRED_DIFF	0.2558	-6.1946**	-2.0847*	-5.9749**	0.7913	-4.6014**	-0.3233	0.3162
CRPT_AVG	-2.1804**	-4.2568**			-2.0490**	-2.5713**		
CRPT_DIFF	-0.4298	-1.5708**			-0.8126**	-1.2875**		
DFCT_AVG			-17.2623**	-51.9223**	-30.8700**	-65.1731**	-21.8161**	-11.6111*
DFCT_DIFF			7.5653	9.6595*	4.2288	-12.3667**	-21.4751**	-4.9363
FDGDP_AVG	-1.8166*	4.1952*	2.2424**	8.6832**	2.5374**	13.4406**		
FDGDP_DIFF	1.5802	-3.8567	-1.5892	4.8870*	0.2329	0.7233		
FRDM_AVG	0.0038	-0.0961*	-0.0099	-0.2288**	0.0086	-0.1387**	0.1145	0.0386
FRDM_DIFF	-0.1611**	-0.3176**	-0.1687**	-0.1134	-0.2308**	-0.1705**	0.1368**	-0.0590
GNI_AVG	-0.2080*	-2.7144**	0.5135**	-0.8148**	-0.2014*	-1.8940**	0.0186	-0.1194
GNI_DIFF	-3.2423**	-0.5133	-2.6137**	-4.8249**	-4.0011**	-2.3393*	-2.4919**	1.9706
HDI_AVG			-13.6316**	-16.7984**				
HDI_DIFF			-16.7481**	-7.0468*				
INFL_AVG	0.3792**	1.0128**	0.3229**	0.3995**	0.4823**	0.5706**	0.6184**	0.4526**
INFL_DIFF	0.0534**	0.0088	0.0184	0.0040	0.0172	0.0273	0.2382**	0.1659**
PDGDP_AVG	4.1680**	10.0445**					-1.3363	-0.9074
PDGDP_DIFF	-0.3610	17.1438**					-1.3862	1.0592
REV_AVG	-21.0933**	-42.2974**	-10.6641**	-16.2706**	-15.1178**	-29.2464**	5.9783	4.5683
REV_DIFF	-0.6190	-0.8925	5.8951	-2.4201	6.4834	-4.1452	18.5957*	8.8984
TAX_AVG	17.8363**	21.5214**	10.8177**	4.4088	26.8880**	21.8595**	1.3922	2.9643

Table 10. Regressions 2001-2006 & 2007-2010. Robustness Check.

	RTGSP		RTGM		RTGF		YTM	
	2001-2006	**2007-2010**	**2001-2006**	**2007-2010**	**2001-2006**	**2007-2010**	**2001-2006**	**2007-2010**
TAX_DIFF	2.8250	12.8688	0.9814	2.3078	-6.6258	12.1185	-10.4151	12.5373
UNPL_AVG	2.5203	4.7304	-4.6412	-5.1004	-8.6640**	-10.2051*	10.5000	12.2188
UNPL_DIFF	14.2640**	47.0723**	4.3369	22.9106**	1.7039	52.1652**	17.8124**	2.0151
DFLT75			1.0827**	1.0928*				
DFLT95			-1.3866**	-0.0721				
EURO	-4.2226**	-9.1480**	-4.2516**	-5.9915**	-7.1404**		-2.1562**	-1.4238**
OECD	-3.2810**	-0.6369	-4.8434**	-3.2704**	-4.0773**		-0.3486	0.2308
LGLGRM	0.1056	-4.2086*	0.3076	-0.5696	-0.2589	-0.7651		
LGLSKN	5.9371**	5.4184**	-2.0400*	-1.0919			-0.1322	-1.0310
LGLSOC							-4.7862**	-2.1552**
LGLUK	-0.4447	-5.0808**	-2.4269**	-2.5724**	-3.4062**	-3.9920**	-0.9040	-0.4852
_CONS							1.6546	4.2392
LogLik	-357.3352	-162.86234	-391.71751	-207.88605	-347.32345	-181.33454		
R-squared							0.7954	0.7591
Rho[a]							0.57737	.24860747
Chow Test[b]	F-statistic 3.89 *(0.000)*		F-statistic 2.87 *(0.000)*		F-statistic 4.666 *(0.000)*		F-statistic 3.08 *(0.000)*	

Notes: The coefficient with the variable followed by _AVG denotes the long-run coefficient while the coefficient with the variable followed by _DIFF denotes the short-run coefficient. (*), (**) statistically significant at 5 percent, 1 percent. P-values in brackets

[a] *Fraction of variance due to u_i or the intraclass correlation*

[b] *The formula for the Chow test is:* $\frac{\frac{ess_C-(ess_1+ess_2)}{k}}{\frac{ess_1+ess_2}{N_1+N_2-2*k}}$ *and the resulting test statistic is distributed F(k, N_1+N_2-2*k). Our null hypothesis is that coefficients are constant across the two periods.*

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