The real estate risk premium : A developed/emerging country panel data analysis

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The real estate risk premium: A developed/emerging country panel data analysis

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Abstract

The objective of this paper is to identify the determinants of office capitalization rates for a panel of 52 countries (developed and emerging countries) between 2000 and 2006. Our assumption, based on a Capital Asset Pricing Model, is that the capitalization rate should be at least proportional to the country's risk perception, as measured by the risk premium on the 10-year government bond yield. Because of the endogeneity of the latter variable, our empirical methodology requires that we estimate first a model explaining the 10-year bond yield. It will be the occasion to discuss the determinants of the risk premium on the bond market. Using a SURE random effect Hausman-Taylor estimator (Hausman & Taylor, 1981), we also take into account the possible correlation between the country risk characteristics on the bond markets and those that determine the real estate market. Our results show that government bond yield is the main determinant of the capitalization rate. We estimate that a 1 percentage point increase in the government bond yield will raise the capitalization rate by about 0.19 percentage point. Real estate variables play also a role, but to a lesser extent. Turning to determinants of the 10-year bond yield, macroeconomic fundamentals are significant determinants of the country risk premium, especially the capacity to honor short-term financial engagements. In addition, the country's risk history has also very important effect on the investors' current risk perception.

JEL Classification: R33, G12, C33, G15

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The last decade has coincided with a renewed interest for real estate from a broad range of investors. As noted by RREEF Research (2007), global direct real estate investment reached US$ 580 billion in 2006, increasing threefold since 2001. In an era of falling interest rates, where financing became very inexpensive, global investors have looked increasingly at real estate as a secure and remunerative investment. In the same period, investments in emerging markets have soared to a great extent, real estate at the foremost, favored by high growth prospects, a stabilized economic situation after the financial crises of the 90s, a commitment to sound macroeconomic policies, an increasing integration into world financial markets, and fewer high return investment opportunities in developed countries. Hence, as capital flows have poured into real estate both in developed and emerging countries, we have observed a general downward trend in capitalization rates, a measure of real estate return defined as the cash flows earned on investment divided by price of the property. But, for all the excitement, one has to wonder if the price paid for a real estate asset is consistent with the country's "true" rate of return expectation, based on actual real estate and macroeconomic fundamentals, and its country risk assessment.

In particular, we should expect the capitalization rate (CAP or cap rate) to at least reflect the opportunity cost of capital and the risk premium associated with the country's investment environment. Applying the Capital Asset Pricing Model (CAPM) to real estate returns, our assumption is to compare the real estate capitalization rate to the 10-year government bond yield. This bond yield incorporates two components. On the one hand, government bonds are usually perceived as a low-risk investment, e.g. an opportunity cost of capital. Investors should expect a property market return at least equal the opportunity cost of capital, as measured here by the government bond yield. On the other hand, as investors seek an optimal allocation of their portfolio across countries, government bonds should also incorporate a risk premium component. Because they are determined by some common country characteristics, this real estate premium should reflect the country's default risk. But in addition, the investor's risk perception might also be determined by a whole series of country-specific real estate characteristics beyond the probability of default alone.

There are very few studies investigating real estate at a macro level and even less for emerging countries. Empirical papers have mainly focused on U.S. (Sivitanidou & Sivitanides, 1996 and 1999; Sivitanides *et al*., 2001) or European markets (Bond, Karolyi & Sanders, 2003). But these are relatively stable and risk-free markets. To obtain further insights about the pricing of risk by international investor, it becomes essential to enlarge the sample to developing countries where we find greater variations in the characteristics that determine the risk premium. The inclusion of emerging markets is especially called for considering the substantial boom in cross-border investments going to these countries recently.

Hence, the objective of this paper is thus to identify the determinants of office capitalization rates for a panel of 52 countries (developed and emerging countries) between 2000 and 2006. We will assume that, conditional on variables characterizing the office real estate market, the real estate risk premium should be proportional to the spread in government 10-year bond yields relatively to the U.S... This spread should represent a good approximation of the country's risk assessment since the United States are typically considered by global investors as the benchmark low-risk market. Based on this assumption, and by exploiting the panel dimensions of our data bank, we are then able to estimate a specific real estate risk assessment for each country. Moreover, because of the endogeneity of the bond yield as a determinant of the cap rate, our empirical methodology requires that we estimate a model explaining the 10-year bond yield. It will be the occasion to also discuss the determinants of the risk premium on the bond market. In particular, we try to investigate the significance of macroeconomic fundamentals and fixed country characteristics for the determination of the risk premium in both the bond and the real estate markets.

The empirics of this paper bring forward some important econometric matters. As already mentioned, there are reasons to believe that the long-term interest rate is not an exogenous variable. Idiosyncratic shocks in the economy might affect both the bond and the real estate market. This might cause the residuals of the cap rate regression equation to be correlated to the interest rate; the least square estimator will thus be biased. To avoid this problem, we follow two empirical strategies. First, based on a paper by Docker, Rosen & Van Dyke (2004), we estimate an equation for the 10-year bond interest rate, using as determinants variables measuring macroeconomic fundamentals and other country-risk characteristics. Then, the fitted values obtained from this first step are in the cap rate regression instead of the actual value of the interest rate. The second empirical strategy will be to estimate both equations (interest and cap rate) in a Seemingly Unrelated Regression Equation (SURE) system, taking into account the correlation that might exist between the real estate and the bond market. The two equations will be presumably related because of idiosyncratic shocks that affect both markets, but also because of specific inter-temporal country risk characteristics that will determine the risk premiums on both the bond and the real estate market. More precisely, we follow Egger & Pfaffermayr (2004) and devise a SURE random effect Hausman-Taylor estimator (Hausman & Taylor, 1981). Instead of using the fixed effect (FE) estimator to estimate these country risk characteristics, we let the residuals of each equation include an individual effect, as in the random effect model, to insure that the SURE system picks up the correlation between the country specific risk effects across the two equations. This SURE Hausman-Taylor random effect estimator as seldom been used so far in the empirical literature.

Our results show that the risk premium, as measured by the 10-year bond interest rate, is the most important determinant of the capitalization rate. The 10-year bond yield alone explains between 41% and 44% of the cap rate. Real estate variables play also a role, but to a lesser extent. Turning to the determinants of the 10-year bond yield, macroeconomic fundamentals are significant determinants of the country risk premium, but above all the crucial determinant is the country's capacity to honor short-term financial engagements. In addition, the country's risk history has also very important effect on the investors' current risk perception, independently of the country's actual macroeconomic situation. Finally, we show that both real estate and bond yields are characterized by a fixed country risk component and that these country effects might be correlated between these two markets.

The paper proceeds as follow. After a short review of literature (section 1), we introduce the CAPM model in section 2 and then present in section 3 the variables and data that will be used for the empirical investigation. In section 4, we describe in detail the two empirical strategies, discussing several important econometric issues. Section 5 is completely devoted to the bond yield equation, introducing first the empirical model and the variables determining the country risk (section 5.1) and then presenting the estimation results (section 5.2). Equipped with this model and the estimated results for the bond yield, we can finally proceed with the estimation of the cap rate equation in section 6, starting with the single equation regressions (first empirical strategy using the fitted values obtained from the interest rate regressions) in section 6.1, followed by the SURE results (second empirical strategy, using the SURE system) in section 6.2.

1. Review of literature

Several empirical studies have investigated the determinants of the cap rate (Froland, 1987; Evans, 1990; Ambrose & Nourse, 1993). More recently, a number of papers have employed an investment approach based on the CAPM model to define the cap rates. Sivitanidou & Sivitanides (1996) examine the differences in cap rates across 43 US metropolitan statistical areas (MSA) between 1991 and 1995. They show that variations across markets are significantly determined by differences in office market characteristics such as the vacancy rate, the completion rate, the absorption rate, the size of the market and the historical volatility of the MSA. The study of Sivitanidou & Sivitanides (1999), using a panel of 10 years (1985 to 1995) and 18 MSAs, reveals that the capitalization rates are also determined by both time-variant local office market effects (office space absorption, vacancy rates, office employment growth stability and past rates of rental-income growth) and national capital market trends (inflation and stock returns). Exploiting the panel dimension of their data, both these papers confirm the existence of local fixed office market effects across MSAs (individual fixed effects). Bond, Karolyi & Sanders (2003) estimate a CAPM model to understand the returns of real estate securities in a selection of European countries, providing also for a country-specific market risk component, but including as well some global market risk factors. Jud & Winkler (1995) devise a model mixing both the CAPM model and the Weighted Average Cost of Capital (WACC) – the WACC is the rate of discount that reflects the average cost of debt and of equity capital. Indeed, their results indicate that the capitalization rates are determined by the cost of debt (measured by a BAA debt rating) and the cost of equity (measured by the total return on the Standard & Poor's 500 Index).

Some studies can rely on longer time-series which allows them to investigate the stochastic properties of capitalization rates. Sivitanides, Southard, Torto & Wheaton (2001) also study the determinants of the capitalization rates across a panel of US MSAs, but using 16 annual observations. By exploiting this longer time dimension, these authors are able to model the capitalization rate as an adjustment process that evolves in time around an equilibrium value. Dokko, Edelstein, Pomer & Urdang (1991) and Hendershott & MacGregor (2005) use an Error Correction Model (ECM) to estimate the return-to-equilibrium properties of real estate returns, while Yiu & Hui (2006) extend the CAPM model by allowing for a time-varying discount rate. Then, they use the cointegration methodology to test for the existence of a long-term relationship between the capitalization rate and the growth-adjusted discount rate.

However, all this literature focuses on developed and mature markets (mostly the U.S. and European markets). The originality of this study is to include a set of emerging countries which are well integrated in the global property market. This extended sample comes at a cost though: real estate data are scare for emerging countries before year 2000. Thus, we cannot construct long time-series, which would have been more appropriate to study the stochastic properties of the capitalization rate. Yet, with 7 annual observations (from 2000 to 2006) and a sample of 52 developed and emerging countries, we can rely on a relatively large panel of 371 observations, which enables us to estimate country-specific risk components, similarly to Sivitanidou & Sivitanides (1996) and Sivitanidou & Sivitanides (1999).

Dockers, Rosen & Van Dyke (2004) include both developed and emerging markets in their sample, but in a single cross-section for year 1999. These authors attempt to estimate the hurdle rate on the real estate market. In a first step, they determine the economic/financial risk in the country, based on a series of risk variables. In a second step, they use the estimated country risk computed in the first step as a determinant of the capitalization rate. We will also follow a similar path. However, they define the residuals of their regression as a measure for the country risk premium. But, by construction, the OLS regression residuals are an independent and identically-distributed (i.i.d.) component which should be completely random. They cannot be interpreted as risk premium. However, by using panel data, we are able to estimate country-specific effects that we interpret as being an inter-temporal country risk assessment.

2. The Model

The capitalization rate of a given real estate investment is typically defined as the ratio of net operating income (NOI_t) on the value of property (V_t) at time *t*:

(1) $$C_t = \frac{NOI_t}{V_t}$$

The property value can be based on the market sales price of the property at time *t*. If investors are rational, this price should exactly reflect the sum of present value cash flows they expect to receive in the present and future years:

(2) $$P_t = \sum_{t=1}^{Z}\left[\frac{CF_t}{(1+d_t)^t}\right] + \sum_{t=Z+1}^{T}\left[\frac{CF_t}{(1+d_t)^t}\right]$$

where T is the property's life expectancy, d_t is the discount rate and the second expression in brackets represents the resale value of the property at time Z+1. Simplifying equation (2):

$$(3) \qquad P_t = \sum_{t=1}^{T} \left[\frac{CF_t}{(1 + d_t)^t} \right]$$

We can assume that NOI is equal to actual cash flows, that cash flows can be approximated by rents and that future rents are expected to grow at a rate g_t:

$$(4) \qquad NOI_t = \text{ãRENT}_t$$

$$(5) \qquad CF_t = \text{ãRENT}_t (1 + g_t)$$

where γ is simply an approximation parameter. Inserting the cash flow CF_t approximation (5) in equation (3):

$$(6) \qquad P_t = \gamma RENT_t \left\{ \sum_{t=1}^{T} \left[\frac{(1 + g_t)^t}{(1 + d_t)^t} \right] \right\}$$

We can now substitute the NOI equation (4) and the price equation (6) in the capitalization rate equation (1):

$$(7) \qquad C_t^e = \frac{\gamma RENT_t}{\gamma RENT_t \left\{ \sum_{t=1}^{T} \left[\frac{(1 + g_t)^t}{(1 + d_t)^t} \right] \right\}}$$

Simplifying equation (7), we can define the equilibrium capitalization rate (C^e):

$$(8) \qquad C_t^e = \frac{1}{\left\{ \sum_{t=1}^{T} \left[\frac{(1 + g_t)^t}{(1 + d_t)^t} \right] \right\}} + e_t$$

where e_t is an i.i.d. shock that might affect the real estate market at time t. Notice that the rent term disappears in equation (8). As rents (or cash flows) are expected to increase, investors are assumed to take this increase fully into account in the valuation of the property, leaving the capitalization rate level unchanged. Hence, the capitalization rate should evolve as a mean-reverting stationary process in time. In the very short-term, a surge in rents will put upward pressure on the capitalization rate. But, as investors integrate this information in their valuation estimates, the price of the property should also increase, thereby reducing the capitalization rate back to its initial value. The adjustment might not be immediate because of some market inefficiencies, but the capitalization rate should gradually return to its long-term equilibrium value.

From equation (8), the capitalization rate depends on two factors: the discount factor d_t and the growth of rents g_t. In fact, equation (8) can also be interpreted as the growth-adjusted required nominal return on property. As in Jud & Winkler (1995), Sivitanidou & Sivitanides (1999), Hendershott & MacGregor (2005) and Yiu & Hui (2006), this required return on property can be derived using the Capital Asset Pricing Model (CAPM):

$$(9)\ \ d_t = Rrf_t + \partial_t + \hat{a}\left[Rop_t - \left(Rrf_t + \partial_t\right)\right]$$

where Rrf_t is the real risk-free rate, π_t is the inflation rate and Rop_t is the opportunity cost of capital. However, some risks are particular to the real estate market and will not affect necessarily other types of investments. The capitalization rate should also reflect that specific real estate risk. Re-arranging equation (9) and adding a real estate specific risk premium (Rre):

$$(10)\ \ d_t - \left(Rrf_t + \partial_t\right) = \hat{a}\left[Rop_t - \left(Rrf_t + \partial_t\right)\right] + Rre_t$$

The expression to the left of the equality is the spread in the return on property, in real terms, against the risk-free rate. Thus, the CAPM, defined by equation 10, assumes that this spread should be at least equal to the spread in an alternative investment (the opportunity costs) in real terms, plus a component expressing the additional perceived risks specific to the real estate market. The β is the property *beta*: the spread in the real estate market should be proportional to the spread in the alternative investment, but not exactly equal given that both investments are of different nature.

Using the CAPM model, we can redefine equation (8) as:

$$(11)\ \ C_t^e = \frac{1}{\left\{\sum_{t=1}^{T}\left[\frac{\left(1+g_t\right)^t}{\left(1+\left(Rrf_t+\partial_t\right)+\hat{a}\left[Rop_t-\left(Rrf_t+\partial_t\right)\right]+Rre_t\right)^t}\right]\right\}} + e_t$$

The empirical model will therefore relate the capitalization rate to a nominal risk-free rate, the spread in the return on an alternative investment, a specific real estate risk component and some variables approximating the expected growth in cash flows. We expect a positive relationship between these determinants of the capitalization rate, except for the growth expectations: higher expectations of cash flows growth should increase the price of property and thus decrease the cap rate.

3. The variables and data

The objective of this paper is to measure the country risk premium in the real estate market. One general indicator of country risk is the spread in the 10-year government bond's yield (GovBond) with respect to the U.S. 10-year T-Bond At the same time, the government bond yield can be considered as a relevant opportunity cost of capital, since the bond market is perceived as a low-risk safe investment.

It follows that, in equation (11), the return on the alternative investment Rop_t will be define by GovBond, while the risk-free rate Rrf_t will be set to the U.S. 10-year T-Bond (US-TBOND). Both rates are in nominal terms, incorporating the inflation component π_t . From equation (11), along with the spread in the bond market, the determinants of the capitalization rate is decomposed into two further components: the growth in cash flows and the specific real estate risk.

Growth expectations can be derived on current disposable information. Hence, we will use the one-year lagged value (at time *t*-1) of the inflation rate (INFL) and of the real GDP growth (GDP%) to approximate the expected growth of cash flows at time *t*. Instead of using direct growth proxies, we can also rely on annual variations in the vacancy rate (VACANCY%). When the vacancy rate increases, we should observe a lower (or negative) rental growth rate; when the vacancy rate decreases, the adjustment between demand and supply is tighter and we should therefore observe an increase in the rental growth rate[1]. Note that when using VACANCY%, we lose the observations of year 2000.

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[1] Notice that the level and the deviation of the vacancy rate have different effects on the real estate market. The real estate cycle theory can be broke down in three types of cycles: physical market cycle, rental growth cycle and financial market cycle (see Mueller 1995). For the purpose of this paper, we will only discuss the first two types. The physical market cycle characterized by the vacancy rate indicates the interaction between the supply demand function in a real estate market. As described by Mueller (1995), the physical market cycle is divided into four quadrants based upon the rate of change in both demand and supply. The first two quadrants - recovery and expansion - are up-cycles where the growth rate of demand outstrips that of supply, whereas the other two quadrants – hypersupply and recession - are down-cycles where the demand growth rate is below that of supply. The addition of the long term average vacancy rate (LTAV) [also called natural vacancy rate and formerly called the equilibrium level by Mueller (1995)] in the physical cycle theory is very important as it enables to determine in which quadrant the marketplace is located therefore establishing if the latter is under or oversupplied by space. Furthermore, one must know that demand and supply dynamics differ whether the market is located below or above the LTAV and that the latter differs for each property type (office, retail, industrial and multi-residential) and markets.

The role of the LTAV in the rental growth theory is imperative as it enables to estimate the rate of rental growth the marketplace will generate during the cycle. When the vacancy rate is above its LTAV, the rate of rental growth is slower than the inflation rate level while when it is below its LTAV rental growth is faster than the rate of inflation. Moreover, as mentioned in Mueller (1995), the growth rate in rental rates will steadily increase during up-cycles (trough to peak) and steadily decrease during down-cycles (peak to trough). More specifically, during the recovery phase rents tend to decrease near the bottom of the cycle and to slowly increase as it approaches the LTAV because demand is absorbing the excess supply of space in the marketplace. Additionally, rents will augment at the rate of inflation when the vacancy rate equals its LTAV. Once the vacancy rate moves into the expansion phase of the cycle, rents grow at a faster pace than inflation because of less available spaces in the market and will reach the market peak when demand and supply are in equilibrium. During this phase, rent levels will reach the economic construction cost level that will allow profitable new construction projects to start. As the market moves toward equilibrium the number of development projects will increase and may

In our model, cash flows are approximated by rents. However, the rent variable cancels out in equation (8) since rents should be fully taken into account in the price of real estate. But in reality, prices may not adjust perfectly and immediately to changes in rents. As a control, we construct an index of real rents (RENT). Using data on the rent levels, we simply impute the evolution of rents (in real terms) from an initial index set to 100 in year 2000 for all countries[2].

The liquidity of the market is another important determinant of the capitalization rate. *Ceteris paribus*, investors may prefer to operate in a larger market to minimize transaction costs and hedge out the variability in price (Bernoth, von Hagen & Schuknecht, 2004; Favero, Pagano & von Thadden, 2004). A market with a large inventory and a more developed property market[3] should guarantee investors less volatility in the standard deviation of returns because market inefficiencies are lower than in an emerging property market. For these reasons, we expect illiquid markets to display higher capitalization rates, therefore higher market returns, to compensate for the larger transaction costs investors need to bear to invest into that market. To measure the liquidity of the real estate market, we will use two variables. First, the depth of the market (DEPTH) is defined as the total inventory of office spaces (in square feet) in a city divided by its population[4]. Second, the total inventory divided by the city's area (DENSITY) gives an approximation of the market supply. In addition, we have constructed a dummy variable taking the value of 1 when REITs (Real Estate Investment Trusts) are in operation in the country's real estate market (from the first year of existence), and zero otherwise. The existence of REIT operators should enhance the liquidity of the real estate market.

We also consider three qualitative country indexes that might also affect the risk perception, compiled by the ICRG/PRS Group: the bureaucracy quality (BUREAU), law & order (LAW) which assess the strength and impartiality of the legal system and the popular observance of the law, and the investment profile (IPROFIL) which is a composite rating that combines three types of investment risks: contract viability/expropriation, profits repatriation and payments delays.

Finally, we include time-fixed effects to capture global trends in the real estate market, for instance: the world real estate cycle, the global supply of funds going into real estate, the general "appetite for risk" of international investors, etc.

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bring the market into a state of oversupply (quadrant III or hypersupply phase) if supply exceeds demand. In the hypersupply phase, rental growth will remain above the inflation rate until the vacancy declines to reach its LTAV. In the case where supply continues to exceed demand, the vacancy rate will increase above its LTAV moving into the recession phase (or quadrant IV). In this phase, one can observe below inflation or negative rental growth until the cycle reaches its trough as new construction and completions come to an end.

[2] By using an index, we avoid the issue of purchasing power differences across countries.

[3] More precisely, office buildings in our case.

[4] The best variable to calculate the depth of an office market is the number of employees working in the services industry, but the unavailability of the data at the city level for most of the emerging countries forced us to use population data.

Table 1 summarizes the set of variables that will be used as determinants of the capitalization rate. The rent index (RENT) and the two real estate variables DEPTH and DENSITY are not in percentage format, contrary to the dependent variable CAP and the other determinants. Thus, these variables are transformed into logs in all regressions, which will insure a stronger fit.

Table 1: List of variables for the capitalization rate equation
Dependent variable
→ Capitalization rate (CAP)
Risk premium
→ 10-year bond yields (GovBond)
Growth of cash flow
→ Rent index in logs (RENT)
→ Vacancy rate (VACANCY%): annual changes
→ Real GDP growth lagged one year (GDP%(-1))
→ Inflation rate lagged one year (INFL(-1))
Real estate variables
→ Depth of the market in logs (DEPTH): total inventory /population
→ Density of the market in logs (DENSITY): total inventory /area
→ Existence of Real Estate Investment Trusts (REIT): 1 or 0 otherwise
Qualitative variables
→ Bureaucracy quality (BUREAU)
→ Law & order (LAW)
→ Investment profile (IPROFIL)

Data

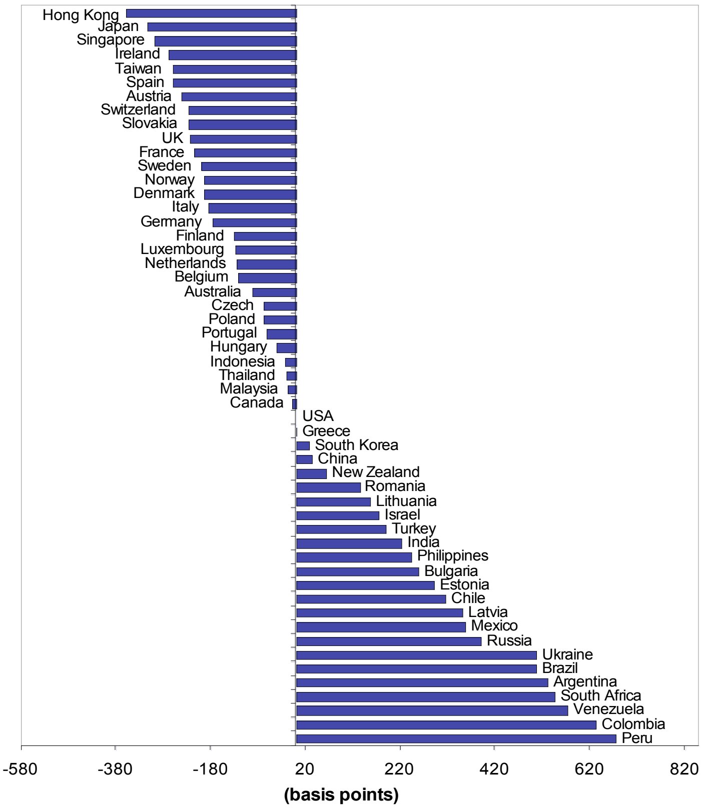
We focus on a set of 52 developed and developing countries (see the list of countries in Appendix 1) for which annual office market data are available on a consistent basis. For most of these countries, real estate figures are quite hard to find before year 2000. But from 2000 up to 2006, we were able to construct an almost balanced data bank, with only two missing observations for Venezuela for years 1999 and 2000[5]. In total, we obtain a panel of 362 observations, with T=7 annual observations (2000 to 2006) over N=52 countries (and two missing observations).

Office market data (cap rates, rents, vacancy rates and inventory) are compiled using a combination of different real estate sources: Colliers, DTZ, Bentall, REIS and Ober Haus Real Estate Advisors. Furthermore, office market data include all classes of office space (A, B and C) and are typically given at the metropolitan level. For most countries, the data are available consistently only for a single city, the Capital-City or the country's main metropolis). But for some countries, we have data on several important cities, in which case we have chosen to take the weighted-average value by each city's population[6]. In Appendix 2, we show the list of cities from which national figures have been inferred for each country.

[5] For Venezuela, we were not able to find consistent observations on real estate data for these two years.

[6] To compute these national weighted averages, we must use, for each country, the same set of cities across real estate variables to insure the consistency of the data.

Graph 1: Average spread (2004-2006) in the capitalization rate against the U.S. capitalization rate



Sources: Colliers, DTZ, Bentall, REIS and Ober Haus Real Estate Advisors.

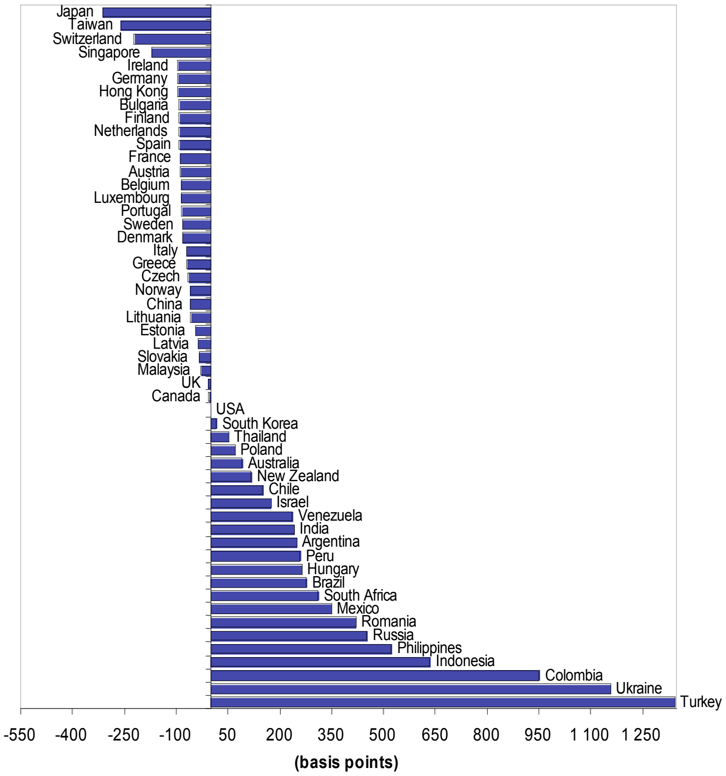
Data on annual government 10-year bond yields are taken from Bloomberg, Datastream and Eurostat. Some countries in our sample do not have a government bond market or bonds with a 10-year maturity. In these cases, we use the available rate that comes closest to a long-term interest rate[7]. The International Monetary Fund's World Economic Outlook provides statistics on inflation and GDP growth. Appendix 3 offers a more detailed description of the data and sources.

Graph 1 and Graph 2 shows respectively the spread in the capitalization rate and in GovBond against the U.S. (average 2004-2006).The ranking between both spreads is quite close. All member-states of the European Union (except Poland and Hungary) have long-term interest rates that are systematically lower than the U.S.. Even if the U.S. has often been perceived as the risk-free benchmark country, the European Union – especially members of the Eurozone – may have now become a more relevant benchmark nowadays. Negative spreads against the U.S. are also observed in some "Asian Tigers" (Taiwan, Singapore and Hong Kong) and in Malaysia, these countries being all characterized by a very high level of trade and investment openness. Japan may be in a special economic situation, having a nominal discount rate close to zero in the last couple of years. The highest spreads are found in

[7] For some countries, we have to use the longest government bond yield available (mostly, 5-year maturities) or the lending rate. But this concerns mostly countries with a higher risk assessment. Hence, since these countries tend to have a much higher rate level. Thus, the spread with the U.S. bond yield still represents a good approximation of the country risk.

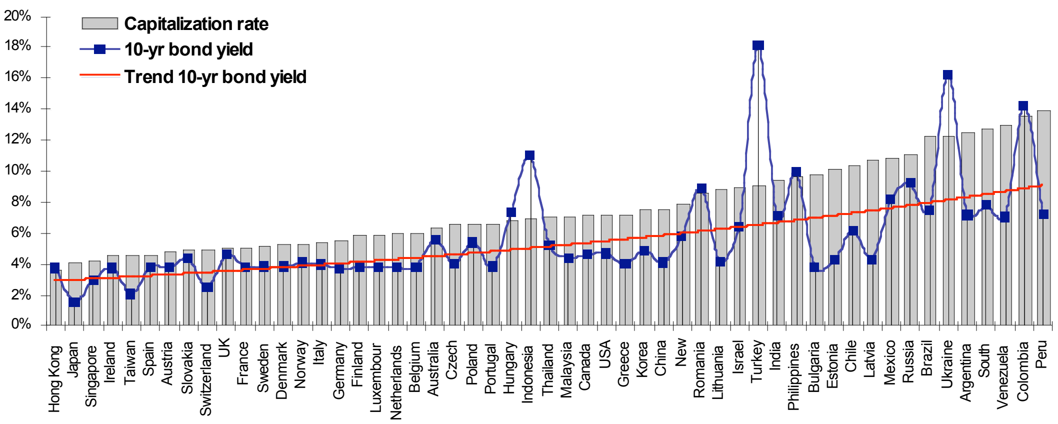
developing countries, and especially those that experienced a financial crisis over the last decade (Argentina, Indonesia, Mexico, Russia, Turkey, etc.).

Graph 2: Average spread (2004-2006) between the 10-year government bond yield and the U.S. T-Bond



Sources: Bloomberg, Datastream and Eurostat.

Graph 3: Relationship between capitalization rate and the 10-year government bond yield (average 2004-2006).



Sources for the 10-year bond yields: Bloomberg, Datastream and Eurostat. Sources for the cap rate: Colliers, DTZ, Bentall, REIS and Ober Haus Real Estate Advisors.

To illustrate the relationship between both bond yields, Graph 3 relates the capitalization rate (in ascending order) with the long-term bond yields (all in annual average 2004-2006). Looking at the bond yield trend across countries (the red straight line), we can indeed observe a positive relationship with the capitalization rate, but there are some large discrepancies. This suggests that other determinants are driving the capitalization rates, and we expect variables characterizing the office real estate market to also have an impact on the property market return.

4. Empirical strategy and Econometrics issues

In the capitalization rate equation (11), GovBond might be an endogenous variable, in the sense of being correlated with the residual term e_t. To deal with this issue, we will use two empirical strategies. In the first strategy we will use an orthogonalized fitted estimation of the 10-year bond yield in the cap rate regression while, in the second strategy, we will estimate both the cap rate and the long-term interest rates within a Seemingly Unrelated Regression (SURE) system (Zellner, 1962).

Formally, we will in fact estimate two equations:

(12) $$GovBond_{it} = \sigma + \beta_1 X1_{it} + \tau_t + e1_{it}$$

(13) $$CAP_{it} = \delta + \beta_2 GovBond_{it} + \beta_3 X2_{it} + \tau_t + e2_{it}$$ for $i = 1,\ldots, N$ and $t = 1,\ldots, T$.

where *i* is the country index, *t* the time index, X1 are some determinants of the long-term interest rate spread, X2 are the real estate and cash flow variables determining the cap rate (defined previously), τ_t are time specific effects, $e1_{it}$ and $e2_{it}$ are i.i.d. residual terms. Section 5 below is completely dedicated to the GovBond equation (empirical model and estimation).

Suppose that the contemporaneous residuals are correlated between equations (12) and (13):

$$E(e1_{it}\, e2_{it}) \neq 0$$

This might occur if an economic shock in the economy impacts both long-term bond yields and the office real estate market fundamentals. Then, GovBond will not be exogenous in equation (13):

$$E(GovBond_{it} e2_{it}) \neq 0$$

and the OLS estimation will be biased.

We can assume that investors assign to each country a general risk perception, depending on time-invariant characteristics. Thus, a country will be associated to a specific risk premium, notwithstanding the actual state of its economy or real estate market:

(14) $$GovBond_{it} = \sigma + \beta_1 X1_{it} + \tau_t + u1_i + e1_{it}$$

(15) $CAP_{it} = \delta + \beta_2 GovBond_{it} + \beta_3 X2_{it} + \tau_t + u2_{it} + e2_{it}$

where u_{1i} and u_{2i} are the country-specific effects in, respectively, the GovBond equation and in the CAP equation. We can assume that the individual country effects are random, e.g. they are part on the residual term:

(16) $GovBond_{it} = \sigma + \beta_1 X1_{it} + \tau_t + z1_{it}$ where $z1_{it} = u1_i + e1_{it}$

(17) $CAP_{it} = \delta + \beta_2 GovBond_{it} + \beta_3 X2_{it} + \tau_t + z2_{it}$ where $z2_{it} = u2_i + e2_{it}$

The random effects ($u1_i$, $u2_i$) and the remaining residuals ($e1_{it}$, $e2_{it}$) are assumed to have zero mean, and:

$$E(u1_{it} e1_{it}) = 0$$

$$E(u2_{it} e2_{it}) = 0$$

This random effect (RE) formulation brings forth another type of correlation between the CAP and the GovBond equation. In addition to the correlation across equations $E(e1_{it} e2_{it}) \neq 0$, we could expect a further correlation between the individual effect u_{1t} in the GovBond equation with the individual effect u_{2t} in the CAP equation:

$$E(u1_{it} u2_{it}) \neq 0$$

The country-specific risk perception on the bond market will surely be linked to the specific risk perception on the office real estate market. Some types of country risks will presumably affect only the real estate market, but not the bond market, and vice-versa. For example, landlord legal rights and rent regulations will have an impact on the capitalization rate but not on the bond market. But some unobservable country risk characteristics might affect both the bond and the real estate yields. Therefore, the long-term bond yields will also be correlated with the individual effect in the CAP equation:

$$\mathrm{E}(GovBond_{it} u2_{it}) \neq 0$$

Since we still have that:

$$\mathrm{E}(GovBond_{it} e2_{it}) \neq 0$$

Hence:

$$E\left(\text{GovBond}_{it} z2_{it}\right) \neq 0$$

GovBond is said to be *doubly endogenous* since it might be correlated with both the idiosyncratic shock $e2_{it}$ and the individual effect u_{2i} in the CAP equation.

The **first strategy** is as follows. Instead of relying on the random effect specification, the specific country risk component may also be estimated by the fixed effect (FE) estimator. This is equivalent to adding country dummies in equations (14) and (15) to estimate the country specific effect u_{1i} and u_{2i}. It so happens that the fixed effect estimator leads to exactly the same coefficient results as the 'within estimator', even if both estimators are conceptually different. The within estimator takes all variables of the model in deviations from their respective individual country average, and then estimates the transformed model by OLS. Hence, the individual effects are eliminated by this within transformation, which thereby removes the correlation between $u1_i$ and $u2_i$, but also between $u2_i$ and GovBond (or any other RHS variables).

Then, as in Docker, Rosen & Van Dyke (2004), to handle the further endogeneity of the GovBond variable with respect to the idiosyncratic shock $e2_{it}$, we use the fitted values of GovBond. We first estimate the determinants of the 10-year bond yield. Then, we add into the CAP equation the fitted values obtained from this first regression in place of GovBond. Hence, since the fitted values do not include the residual component $e1_{it}$, we have that:

$$E\left(\widehat{\text{GovBond}}_{it} e2_{it}\right) \neq 0$$

Hence, the first strategy consists of three steps:

Step 1: estimate the GovBond equation (14) with the FE effect estimator;

Step 2: compute the fitted values of this regression;

Step 3: estimate the CAP equation (15) with the FE effect estimator, but with the fitted values instead of the actual values of the interest rate.

But more generally, any type of correlation between the two equations can be handled using the SURE estimator. This will be our **second strategy**. With country fixed effects in each equation, the only remaining cross-equation correlation is between the idiosyncratic shocks $e1_{it}$ and $e2_{it}$. Hence, equation (14) and (15) can be efficiently estimated within a SURE system of equations, taking into account this correlation in the idiosyncratic residuals.

However, it might be interesting to specifically consider the correlation between the individual effects u_{1i} and u_{2i}. Instead of eliminating this correlation by using the FE estimator, we could estimate equations (16) and (17) within a SURE random effect estimator (SURE-RE). By doing so, we take into account the correlation between the whole residual terms $z1_{it}$ and $z2_{it}$, which include both the idiosyncratic shocks and the individual effects. However, this SURE-RE estimator will not be efficient because the presence of the constant terms u_{1i} and u_{2i} in the residuals $z1_{it}$ and $z2_{it}$ induces a form of autocorrelation in time. In addition, the SURE-RE may be biased because we have assumed that the individual effect u_{2i} is still correlated with the GovBond variable in the CAP equation. More generally, we could expect the individual effects to be correlated with any of the X variables. For example, a country having a high level of short-term debt in average might be perceived as riskier than other countries, notwithstanding the annual evolution of the short-term debt. One solution is to use the instrumental variables (IV) methodology. The objective is to find instruments that are correlated with the *X* variables, but not with the individual effects. This is not an easy task, and the within estimator, which is unbiased and efficient, seems a more convenient solution. But, by subtracting out the fixed effects u_i, the within estimator discards information about the channels linking the long-term bond yield and the cap rate.

To handle these problems, we follow Egger & Pfaffermayr (2004) and devise a SURE Hausman-Taylor estimator. The approach of Egger & Pfaffermayr (2004) combines the Hausman-Taylor random effect IV estimator with the SURE methodology. To remove the autocorrelation, the first step is to transform each equation by pre-multiplying all variables with the usual GSL random effect expression (see Baltagi, 1980):

$$\Omega^{-1/2} = W_N + \theta B_n \quad \text{with} \quad \theta = \sqrt{\overline{\sigma_w^2} \Big/ \left(\overline{\sigma_w^2 + T\sigma_u^2}\right)} \qquad \text{for each equation.}$$

where W_N is the within operator, B_N is the between operator, σ_u^2 is the variance of the individual effects ($u1_i$ or $u2_i$) and $\overline{\sigma_w^2}$ is the estimated variance of the remaining residual ($e1_{it}$ or $e2_{it}$). These variances are obtained as usual from the random effect GSL feasible estimator. Then to overcome the endogeneity problem, we also rely on the IV methodology, in the spirit of Hausman & Taylor (1981). These authors distinguish between variables (time-variant and time-invariant variables) which are not correlated with the individual effects (*doubly exogenous* variables) and variables which are correlated with the individual effects (*singly exogenous* variables). As instruments for the singly exogenous variables, Hausman & Taylor proposes to use the following set of variables: the individual mean (the country average of each variable) of the doubly exogenous variables, along with their deviation from this individual mean, the doubly exogenous time-invariant variables and the singly exogenous variables in deviation from their individual mean. By construction, these last variables, by removing the individual mean should not be correlated with the individual fixed effects. Thus, in a second step, we estimate both equations in a SURE system, using the GLS transformed equations and the Hausman-Taylor instruments.

Hence, the second strategy consists of the following steps:

Step 1: estimate $\Omega^{-1/2}$ for each equation using random effect GSL feasible estimator and the Hausman-Taylor instruments[8];

Step 2: premultiply all variables with $\Omega^{-1/2}$;

Step 3: compute the instrumented values for each endogenous variables, using the Hausman-Taylor instruments;

Step 4: estimate both modified equations (using the GLS transformation and the instrumented endogenous variables) with SURE.

To close this discussion on the econometric methodology, notice that the FE estimator, which amounts to incorporating country dummies in the regression, is equivalent to assuming that each country has its own constant term in each equation. Then, the estimated coefficient of this country dummy may be interpreted as the inter-temporal (up to our time sample) country-specific risk premium[9], conditional on variables *X*.

Note also that in equation (12) to (17), we do not use spreads, but the actual level of the bond yield and cap rate. The spreads are defined relatively to the U.S. T-Bond. In econometric terms, since these U.S. yields are constant across countries for a given year, using the spread or the actual level will only affect the constant terms (σ and δ) in the regressions when time effects (τ_t) are included. Since, for identification, we need to exclude one country when using country fixed effects, we choose to exclude the U.S., so that all country-specific effects can be directly interpreted relatively to the U.S. own specific effect, given by the coefficient of the constants. This means that we could estimate the U.S. country-specific risk when using the actual levels, whereas the U.S. T-Bond yield is only the "assumed" risk-free rate.

5. The 10-year government bond spread equation

Both our empirical strategies require that we specify and estimate an empirical model for the GovBond equation. This is done in the next section.

5.1. The empirical model

The risk premium on the GovBond should reflect the sovereign default risk on the country's debt. As determinants of GovBond, we will use a set of macroeconomic variables measuring the country's solvency and characterizing its macroeconomic policies. In choosing these determinants of sovereign risk, we follow a large empirical literature on government default risks[10] (see for example Alesina *et*

[8] Note that the Hausman-Taylor instruments are used to compute the between variance in the first step, to obtain unbiased coefficients for the GLS feasible estimator.
[9] Lemmen & Goodhart (1999) interpret similarly their country-fixed effects in estimating the European credit risk in a panel setting.
[10] Rowland & Torres (2004) offer an interesting summary of all the determinants of credit spreads used in the literature.

al., 1992; Cantor & Packer, 1996; Eichengreen & Mody, 1998; Lemmen & Goodhart, 1999; Rowland & Torres, 2004). The sources of the data are detailed in Appendix 3, while Table 2 lists all the variables that will be considered in the GovBond equation.

Solvency variables

Debt variables: the country's level of indebtedness could simply be measured by the stock of the government's debt (DEBT) in proportion to the GDP. We also consider the government interest payments as a percentage of government revenues (IDEBT), the government debt as a percentage of government revenues (DEBTREVENUE) and the foreign debt as a percentage of total debt (FOREIGNDEBT)[11]. We expect the risk premium to increase with the level of indebtedness.

Liquidities: given the level of indebtedness, the liquidity variables measure the country's capacity to honor its financial engagements [12]. The government's budget balance (BUDGETBAL) as a percentage of GDP is a good indicator of the government flexibility to repay debt and interests. A budget deficit is also a flow worsening the stock of debt. Exports as a percentage of GDP (EXP) and the current account as a percentage of GDP (ACCOUNT) are also considered, as liquidities can be obtained from export proceeds. Moreover, persistent current account deficits may not be sustainable in the long-term and this may have an effect on the stability of the currency. We also use the international liquidities as a percentage of months of import cover (LIQUID) and the official foreign exchange reserves in level (RESERVES) or as a percentage of GDP (RESERVES%). Greater liquidities should enhance the country's capacity to confront financial engagements, and thus reduce the risk of default (thus the risk premium).

Macroeconomic policies

Real GDP growth (GDP%): a strong economic expansion may signal the existence of greater investment opportunities in the country. In addition, a higher level of economic growth generates a stronger fiscal ability to repay debt. We thus expect a negative relationship between real GDP growth and the bond yield.

Inflation (INFL): a strong or instable inflation rate may reflect the mismanagement of the country's monetary policy. As high inflation rates tend to generate uncertainty, we expect a positive relationship between the inflation rate and the bond yield. As a measure of inflation, we use the inflation rate in consumer prices.

All the above variables (solvency and macroeconomic policies) will be referred as the country's *macroeconomic fundamentals*. The macroeconomic data comes from the IMF's World Economic

[11] We could also use the short-term debt as a percentage of total external debt or the total debt service as a percentage of GNI. However, these two variables are only available for emerging countries.
[12] Not to be confounded with the liquidity of the real estate market.

Outlook, the World Bank's World Development Indicator and the Economist Intelligence Unit (EIU). Some solvency variables are also provided by Moody's Country Credit Statistical Handbook.

Table 2: List of variables for the long-term interest rate equation

Dependent variable
→ 10-year government bond yields, annual average (GovBond)

Solvency variables
→ Government's debt as a % of GDP (DEBT)
→ Government interest payment as a % of government revenues (IDEBT)
→ Government debt as a % of government revenues (DEBTREVENUE)
→ Foreign debt as a % of total debt (FOREIGNDEBT)
→ Short-term debt as a % of total external debt (SHORTDEBT)
→ Total debt service as a % of GNI (DEBTSERVICE)
→ Government's budget balance as a % of GDP (BUDGETBAL)
→ Exports as a % of GDP (EXP)
→ Current account as a % of GDP (ACCOUNT)
→ International liquidities as a percentage of months of import cover (LIQUID)
→ Official foreign exchange reserves (RESERVES)
→ Official foreign exchange reserves as a % of GDP (RESERVESP)

Macroeconomic policies
→ Real GDP growth (GDP%)
→ Inflation rate (INFL)

Qualitative index
→ Bureaucracy quality (BUREAU)
→ Law & order (LAW)
→ Investment profile (IPROFIL)
→ Moody's sovereign risk ratings (MOODY)
→ Standard & Poor's sovereign risk ratings (S&P)

History variables
→ Impulse function of short-term interest rate highest deviation between 1995 and 1999 (IMPULSE)
→ Annual average of monthly interest rate in the three past years (LAGRATE)
→ Existence of a lending arrangement with the IMF in the current and two last years (IMF5)
→ Existence of any lending arrangement with the IMF between 1995 and 1998 (IMF2)

International conditions
→ 3-month bond yields (SHORTUS)
→ New York Stock Exchange Composite Share Price Index (STOCKUS)

Qualitative risk variables

We also consider the qualitative indexes compiled by the ICRG/PRS Group and defined previously for the CAP equation: the bureaucracy quality (BUREAU), law & order (LAW) and the investment profile (IPROFIL). One could also use the sovereign risk rating of Moody's (MOODY) or Standard & Poor's (S&P) as a determinant of the risk premium. Moody's sovereign risks are classified in 21 ratings, from "Aaa" (obligations that are judged to be of the highest quality, with minimal credit risk) to "C" (lowest rated class of bonds, typically in default, with little prospect for recovery of principal or interest). We have assigned to each rating a value from 1 to 21, from the best rating "Aaa" to the worst rating "C". Similarly, we have transformed the Standard & Poor's sovereign risk rating in 29 real values, from the best rating ("AAA+", extremely strong capacity to meet its financial commitments.) to the worst ("D", default). But these ratings are composite indexes that take into account a whole series of economic variables and political risks. Hence, the risk ratings will be, by construction, highly correlated to the previous qualitative variables, but also with many of the macroeconomic fundamentals (Cantor & Packer, 1996). Therefore, in the GovBond equation, the sovereign risk ratings and the set of all other variables should be used alternatively.

History of risk

One very important factor influencing the investors' perception is the country's recent history of lending and risks. A country that suffered a financial crisis or a period of macroeconomic instability might sustain a higher risk premium in the following years, notwithstanding the current quality of the economic fundamentals or macro policies. Indeed, recent financial crises might affect the investor's current risk perception and it might take some time before they are able to appraise their risk evaluation strictly according to the country's actual economic and financial situation. Several countries in our sample, mostly Asian emerging markets but also Russia, Turkey and some Latin American countries have experienced the financial crises that occurred in 1997-1998, Typically, a financial crisis can be identified by sharp and sudden increases in the country's short-term interest rates. Then, when confidence is restored, the short-term interest rates gradually return back to its equilibrium value[13]. Hence, our sample starts in 1999 with many countries having very high long-term interest rates - a situation that cannot be wholly explained by the macroeconomic fundamentals in 1999 - followed thereafter by a downward trend in global interest rates.

Therefore, to measure the impact of a past financial crisis on current risk perceptions, we have devised a special indicator, called IMPULSE. Using monthly data on short-term interest rates (ISHORT) from 1994 to 2006 (data from Datastream), we estimate an autoregressive model AR(12) to determine the stochastic process of the short-term interest rates for each country:

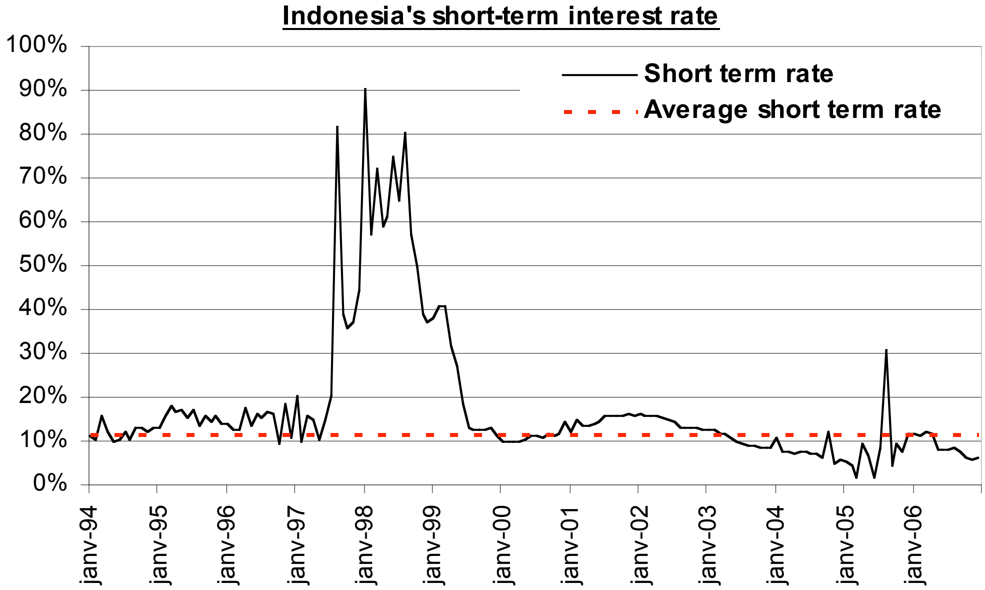
$$ISORT_{it} = \sum_{k=1}^{12} \rho_{ik} ISHORT_{it-k} + e_{it} \qquad \text{for } k = 12 \text{ lags.}$$

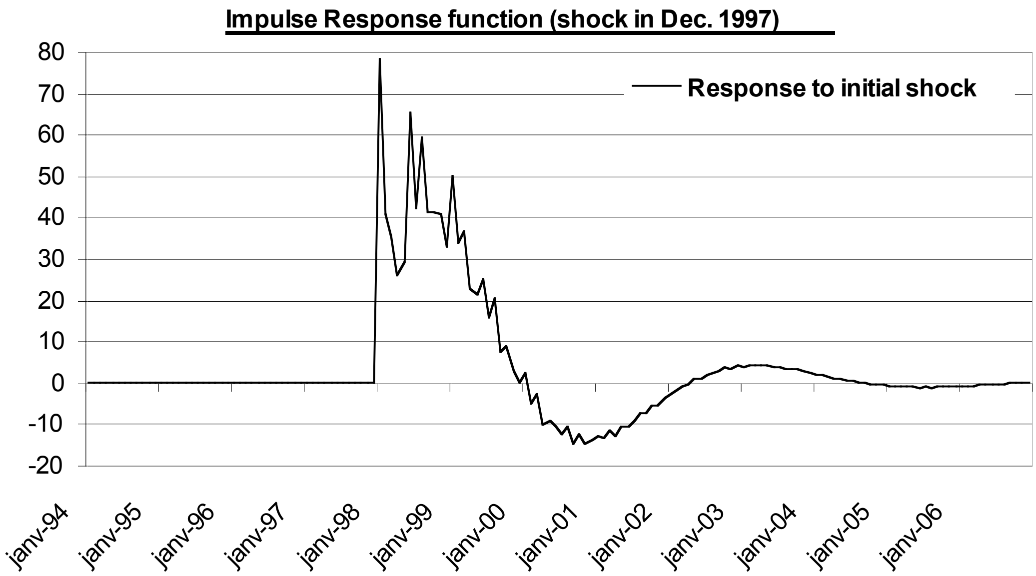
where i is again the country index and t is the time index. The number of lags is set to 12 (one year of monthly observations). Based on this AR(12) estimation, we can simulate the effect of a given shock on future values of the risk premium for each country. More precisely, we first compute the deviation between the highest peak in the short-term interest rate - occurring between 1994 and 2000 - and the average level before the crisis. This deviation is a measure of the magnitude of the shock on the economy. Then, we simply simulate the effect of this shock on future interest rate values, using an impulse response function based on the AR(12) estimates. Hence, for each subsequent month, we get a value of what would be the remaining effect of the initial shock on the risk premium. To get annual values, we simply take the value of the impulse function in December of each year. For the countries that have not experienced the effects of a financial crisis, we could not identify a clear peak in short-

[13] The risk premium might be then modeled as a stochastic long memory process. A long memory process is a stationary process that returns to equilibrium very slowly after a shock.

term interest rates; therefore the indicator is set to zero[14]. The higher the deviation in the short-term interest rate (the shock caused by the crisis) and the closer the shock to the beginning of our time sample, the higher the values of the impulse function. Hence, this variable encompasses three elements: 1. the fact of being affected or not by a financial crisis; 2. the magnitude of the crisis; 3. the estimated evolution in time of this shock. In that sense, the variable works as a sort of time trend specific to each country that experienced a financial crisis.

Graph 3: The case of Indonesia: Short-term interest rates and Impulse function





Source: Bloomberg

[14] More precisely, the indicator is set to zero for countries for which the deviation between the average short-term interest rate and the highest value is lower than 3 p.p. (percentage points) and that applies for instance to all developed countries.

For most countries for which we have detected a period of financial instability between 1994 and 2000, the highest level of short-term interest rates was observed in December 1998. In Graph 3, we illustrate the typical situation of Indonesia, with a peak in short-term interest rates in December 1998. The average rate before the crisis is also shown (dotted line). Then, underneath, we plotted the impulse function of a shock equal to the deviation between the average rate and the highest peak. The effect of the shock gradually diminishes in time, then oscillates around zero and finally vanishes.

In addition, we have also devised three other variables of risk history that will show to be useful. First, we use the annual average of short-term interest rates over the last three years (LAGRATE). A country's lending and crisis history can also be inferred by its relationship with the International Monetary Fund (IMF). We have constructed two dummy variables based on the existence of a lending arrangement with the IMF: IMF5 take a value of 1 if the country has had any lending arrangement with the IMF in the current or the last 2 years, and IMF2 assigns to each country a fixed value equal to the total number of years the country has resorted to the IMF between 1995 and 1999.

Global conditions

Finally, to take into account global macroeconomic and financial conditions, we include time-fixed effects in the model. These time effects capture the global business cycle, the *market sentiment*[15], the availability of liquidities, etc. In particular, after the burst of the high-tech bubble in 2000 and the global economic slowdown that followed, we expect bond yields to be higher in average in 1999 than in 2001. Alternatively, since the U.S. is perceived as a benchmark market, we can approximate the world economic situation by using both the U.S. short-term interest rates, e.g. the 3-month T-Bill yields (SHORTUS) and the New York Stock Exchange Composite Share Price Index (STOCKUS). Both variables are taken from Datastream.

Data

For the INTEREST regression, we could rely on one additional year (1999) and country (Israel)[16]. Hence, we obtain a larger sample than for the cap rate equation, with 424 observations, over N=53 and T=8. This strengthens the GovBond estimation results, by providing for more degrees of freedom. However, we exclude from the sample all observations for which the GovBond is higher than 40%. This is the case for 16 observations. We believe that these are influential observations, having noticed sharp differences in the estimated coefficients and their significance level when they are kept in the regressions.

[15] Favero, Pagano & von Thadden (2004) show that a proxy for the world market sentiment toward risk– as measured by the differential between high-risk U.S. corporate bonds and U.S. government bonds at the corresponding maturity — is the most important explanatory variable for Euro-area yield differentials.

[16] We have real estate data for Israel, but not on a consistent basis. Hence, Israel is excluded from the cap rate equation, but we choose to keep it in the interest rate equation to strengthen the estimates.

Appendix 4 (Table A1 and A2) shows the correlation matrix between some of the determinants of INTEREST. Noteworthy high correlations are indicated in bold. A country's macroeconomic environment is the result of an interlinked and complex system of economic conditions and policies, with several feedback effects between different economic variables. For example, we find a correlation between the inflation rate, the debt variables, the sovereign risk ratings, and especially with each of the qualitative risk indexes (except GOVSTAB). The mismanagement of macroeconomic policies seems to be more acute in countries characterized by high political, legal or investment risks. In fact, very high inflation rates are usually considered as the result - rather than the cause - of poor economic policies or economic instability. More generally, all the qualitative risk indexes are highly correlated between them (except again GOVSTAB) and with the agencies' credit ratings. Hence, each of these ratings reflects the general state of risk in the country. In that sense, they should be used alternatively in the spread equation.

5.2 Results for the GovBond equation

Bivariate regressions

As a preliminary exercise, it might be interesting to evaluate the explanatory power of each variable, e.g. the variable's capacity to explain the risk premium on the Treasury bond market. Hence, we regress GovBond spread against US-TBOND on each of its determinants individually. These bivariate regressions will also be helpful in selecting the final regression model, by looking at the explanatory power of each variable. Results are shown in Table 3, where we only indicate the *t*-test and the R^2 of the bivariate regressions.

Table 3: Pair-wise individual regression
Dependent variables: spread of the 10-year government bond yields with the US 10-year T-Bond.

	t-test		R^2		*t*-test		R^2
Indebtedness variables				**Credit ratings**			
DEBT	-0.62		0.0008	MOODY	14.90	***	0.5450
IDEBT	10.34	***	0.3136	S&P	13.40	***	0.4988
DEBTREVENUS	3.06	***	0.0264				
FOREIGNDEBT	5.83	***	0.0682	**Qualitative variables**			
				BUREAU	-12.34	***	0.2635
Liquidities				LAW	-15.94	***	0.3111
ACCOUNT	-2.32	**	0.0106	IPROFIL	-10.21	***	0.2809
EXP	-7.85	***	0.0574				
LIQUID	-0.64		0.0009	**Risk history**			
RESERVES	-6.52	***	0.0302	IMPULSE	7.01	***	0.2168
RESERVES%	-4.28	***	0.0107	LAGRATE	16.58	***	0.6725
BUDGETBAL	-3.90	***	0.0515	IMF2	7.17	***	0.2088
				IMF5	8.06	***	0.2785
Macroeconomic policy							
GDP%	0.90		0.0020				
INFL	9.34	***	0.4705				

Notes: OLS regression of GovBond on the indicated variable and a constant. The *t*-test is the *t*-Student associated with the coefficient of the variable. Estimation using White heteroscedasticity robust standard errors. Observations excluded when GovBond>0.4. * = significant at 10%; **=significant at 5%; ***= significant at 1%.

We start by investigating the explanatory power of the variables measuring indebtedness. The debt as a percentage of GDP (DEBT) is not significant and has almost no explanatory power. This might seem surprising, but in fact, several stable and low-risk developed countries (Belgium, Italy, France, etc.) are dragging very high levels of indebtedness without any consequence on their probability of default. In fact, the determining criteria that matters for the risk premium are rather the capacity to honor short-term maturities, and particularly the interest payments on debt. Hence, the variable having the highest explanatory power is the government's interest payments. It explains around 31% of the risk premium.

All the liquidity variables are significant, except LIQUID, with the ratio of export to GDP (EXP) having the highest explanatory power. Concerning the variables characterizing the macroeconomic policies, GDP growth (GDP%) does not appear to have a significant impact, but the inflation rate (INFL), on the contrary, has an overwhelming explanatory power (47%). The 10-year government bond yields are taken in nominal terms. Hence, inflation is already a component of the independent variable. Second, since the inflation rate is highly correlated to other risk determinants, high inflation rates might signal a general level of country risk: the countries considered more risky tend to be those associated with poor macroeconomic policies. This conjecture leads us to express some doubts about the interpretation and the selection of the inflation rate variables in the bond yield equation.

The Moody's and S&P's credit ratings have a very high explanatory power of respectively 54% and 49%. This was to be expected since these ratings are specifically designed to appraise the sovereign probability of default, taking into account a whole series of quantitative (macroeconomic variables) and qualitative (political and legal risks, etc.) variables. The other qualitative determinants have a fairly good explanatory power (between 26% and 31%).

Finally, Table 3 shows the persistence of past risk history on current risk perceptions. The average long-term bond yield in the last three years (LAGRATE) explains alone about 67% of the current spread. Our impulse function variable (IMPULSE) is also significant, with an R^2 of 21%. The existence of current or past lending arrangements with the IMF has also a high explanatory power of about 21% (IMF2) to 38% (IMF5).

Multivariate regressions

Using the insights obtained from the previous bivariate regressions, we devise a base regression model, selecting a set of right-hand side (RHS) variables that have a good explanatory power, while avoiding over-fitting the model with correlated variables that might conceptually have an equivalent effect on the long-term bond yield. Hence, we now estimate the full GovBond equation using the following base model:

- **Debt variables**: IDEBT and FOREIGNDEBT
- **Liquidities**: BUDGETBAL, LIQUID or RESERVESP

- **Macroeconomic policy**: GDP growth (GDP%).
- **Risk history**: the IMPULSE variable and IMF5.

The OLS and FE results are presented in Table 4 for different specifications.

Table 4: estimation results for the GovBond equation – OLS and FE estimators

	1A	2A	3A	4A	5A	6A
	OLS	**OLS**	**OLS**	**OLS+Time effects**	**FE**	**FE+Time effects**
IDEBT	0.368***	-	0.2963***	0.289***	0.528***	0.4228***
	(9.19)		(10.22)	(9.79)	(7.34)	(5.19)
FOREIGNDEBT	0.0304***	0.0451***	0.0111*	0.0124**	-0.0034	0.0027
	(4.19)	(4.91)	(1.80)	(2.08)	(-0.24)	(0.18)
BUDGETBAL	0.0776	-0.2663***	-	-	-	-
	(1.44)	(-2.98)				
LIQUID	-0.0009**	-0.0007	-0.0015***	-0.0015***	-0.0023***	-0.0020**
	(-2.00)	(-1.28)	(-3.74)	(-3.72)	(-2.77)	(-2.23)
EXP	-0.0117***	-0.0267***	-0.0065**	-0.0074**	-0.0314***	0.0014
	(-3.20)	(-5.96)	(-2.10)	(-2.26)	(-2.64)	(0.11)
GDP%	0.1282	0.1831	0.1516*	0.2227**	-0.0546	-0.0641
	(1.31)	(1.63)	(1.92)	(2.44)	(-0.83)	(-0.82)
IMPULSE	-	-	0.0029***	0.0029***	0.0024***	0.0020***
			(5.34)	(5.33)	(3.87)	(3.04)
IMF5	-	-	0.0485***	0.0470***	0.0189***	0.0155**
			(6.28)	(6.04)	(2.67)	(2.29)
Constant	0.0381***	0.0663***	0.0366***	0.0282***	0.0515***	0.035***
	(6.83)	(10.73)	(8.16)	(4.98)	(4.65)	(3.29)
F-test Time effects	-	-	-	2.14*	-	4.98
(p-value)				(0.0386)		(0.0000)
F-test Country effects	-	-	-		20.22	18.57
(p-value)					(0.0000)	(0.0000)
Nb of obs.	415	415	415	415	415	415
R^2	0.3532	0.1406	0.5967	0.6124	0.8491	0.8576

Notes: Estimation using White heteroscedasticity robust standard errors. Observations excluded when GovBond>0.4. In parentheses below coefficient: *t*-statistics. * = significant at 10%; **=significant at 5%; ***= significant at 1%.

Looking at column 1A of Table 4, the macroeconomic fundamentals alone explain about 35% of GovBond. All variables have significant coefficients as well as the expected sign, except GDP% which is insignificant though. A higher foreign debt (FOREIGNDEBT) and larger interest payments (IDEBT) tend to increase the risk premium, while greater liquidities (LIQUID) and exports (EXP) both contribute to lowering the risk premium. Because of the high correlation between the interest payments (IDEBT) and the budget balance (BUDGETBAL), the latter is not significant when estimated in combination with the former. When IDEBT is pulled out of the regression (column 2A), BUDGETBAL becomes significant with the expected negative coefficient: the higher the public budget surplus (or the lower the budget deficit), the greater the capacity to confront short-term financial engagements. In column 3A**,** we add the risk history, using the effects of past interest rate shocks (IMPULSE) and the indicator of past IMF leading (IMF5). Both variables are highly significant, with a positive effect on risk premiums. We are now able to explain about 59% of the risk premium. The addition of time-fixed effects (column 4A) improves slightly the fit of the regression and they are jointly significant (as indicated by the *F*-test[17] in the lower part of the Table 4).

[17] The *F*-test evaluates the joint significance of all group of coefficients (here, time or country effects).

In the two last columns of Table 4, we proceed to the fixed-effect (FE) estimator. These country-fixed effects are also jointly significant. As usual, the addition of country dummy variables increases considerably the fit, with an R2 of 0.86 in the regression with time effects (column 6A). With the FE, FOREIGNDEBT becomes insignificant, while the coefficient of IDEBT increases notably and remains the determinant having the highest significance level. The coefficients of the FE estimator are efficient and unbiased – as opposed to the OLS and random effect estimator. Therefore, the long-term bond yield fitted values – labeled GovBond-HAT - that will be used latter on in the CAP equation are computed from the FE specification 6A (outlined accordingly in Table 4).

Specification 6A includes both time and country fixed effects. As explained previously, the constant can then be interpreted as the U.S. specific base risk rate in 2006 (since for identification, this year was chosen to be excluded from the time effects), which is about 3.5%. We reprint specification 6A in Table 5, but now showing the coefficients for the time effects. As indicated by their positive coefficient values, the average GovBond was significantly higher between 1999 and 2001 than in the subsequent years. From the base rate of 3.5% in 2006, average rates were about 1.53 p.p. (percentage points) higher in 1999, 1.35 p.p. in 2000 and 1.57 p.p. in 2001.

Instead of using time effects, we include in column 1B of Table 5 the variables taking into account the US economic cycle. The general evolution of global long-term interest rates tends to follow the U.S. economic situation, as shown by the positive coefficient of the U.S. short-term interest rates (SHORTUS). But, at the same time, we note a negative correlation between the evolution of 10-year bond yields and US stock market returns. This negative correlation is expected by economic theory, but in reality, the sign of the correlation between long-term interest rates and stocks is not fixed in time. According to Ilmanen (2003), a positive correlation between stock and bond returns prevailed during most of the 1900s, but periods of negative correlation was observed in the early 1930s, the latte 1950s, and in the recent period. He also found that growth and volatility shocks tend to push stock and bond returns in opposite directions. Hence, in periods of stock market weaknesses, of high volatility and of economic downturn, we thus expect an increasing negative correlation between the two markets, as investors tend to allocate a greater interest into less risky and more stable instruments such as fixed income investments. However, the fit is higher when using only the fixed-time effects, which capture any kind of global trends and world events, beyond the US specific situation only.

In Table 5, we also investigate the effects of other interesting determinants of risk. In column 2B, we replace the country fixed effects with some area fixed effects: the 15 European Union member-states before enlargements (EU), the European countries that joined the EU in 2004 or 2007 (ENLARG), the Asian countries (ASIA), the Latin American countries (LATIN), and all the remaining countries (OTHERS)[18], except the U.S. that is again excluded for identification. Now, from a base rate of 1.66 % in the U.S. (as indicated by the constant), the risk premium is, in average, about 5.95 p.p. higher for Latin American countries, 2.47 p.p. higher in for Asian countries and 1.65 p.p. higher in the EU

[18] See Appendix 1 for a list of countries with their classification into the four areas.

enlargement countries. For European Union member-states, the difference with the U.S. constant is not significant.

Table 5: estimation results for the GovBond equation – OLS and FE estimators

	Time effects		Area effects	Qualitative index			Credit ratings	
	6A	1B	2B	3B	4B	5B	6B	7B
	FE+time effect	**OLS+US evolution**	**OLS**	**OLS**	**OLS**	**OLS**	**OLS**	**OLS**
IDEBT	0.4228***	0.507***	0.2498***	0.256***	0.238***	0.225***	-	-
	(5.19)	(7.10)	(8.19)	(8.95)	(5.71)	(5.51)		
FOREIGNDEBT	0.0027	-0.00198	0.0043	0.0109*	0.0097*	0.0060	-	-
	(0.18)	(-0.13)	(0.72)	(1.81)	(1.71)	(1.03)		
LIQUID	-0.0020**	-0.0021**	-0.003***	-0.002***	-0.002***	-0.003***	-	-
	(-2.23)	(-2.19)	(-6.76)	(-6.46)	(-4.82)	(-5.99)		
EXP	0.0014	-0.0278**	0.0028	0.0002	-0.0065**	-0.0036	-	-
	(0.11)	(-2.33)	(-0.90)	(0.07)	(-1.96)	(-1.06)		
GDP%	-0.0641	-0.0571	0.2115**	-0.0078	0.1741	0.0553	-	-
	(-0.82)	(-0.78)	(2.39)	(-0.11)	(1.94)	(0.76)		
IMPULSE	0.0020***	0.0023***	0.0027***	0.0019***	0.0024***	0.0024***	0.0017***	0.0017***
	(3.04)	(3.67)	(5.02)	(3.83)	(4.05)	(4.46)	(3.50)	(3.35)
IMF5	0.0155**	0.0177**	0.0354***	0.0318***	0.0419***	0.0382***	0.0278***	0.0311***
	(2.29)	(2.52)	(4.99)	(4.20)	(5.18)	(5.20)	(2.79)	(3.07)
constant	0.035***	0.019***	0.0166***	0.1136***	0.071***	0.1453***	0.0287***	0.0142***
	(3.29)	(3.96)	(2.87)	(8.61)	(4.63)	(5.93)	(9.08)	(3.08)
STOCKUSA	-	-0.223***	-	-	-	-	-	-
		(-2.81)						
SHORTUSA	-	0.0009	-	-	-	-	-	-
		(1.18)						
UE	-	-	0.0027	-	-	-	-	-
			(0.85)					
ENLARG	-	-	0.0165***	-	-	-	-	-
			(2.69)					
ASIA	-	-	0.0247***	-	-	-	-	-
			(3.42)					
LATIN	-	-	0.0595***	-	-	-	-	-
			(6.32)					
OTHERS			0.0423***					
			(6.26)					
BUREAU	-	-	-	-0.023***	-	-	-	-
				(-7.23)				
LAW	-	-	-	-	-0.007***	-	-	-
					(-3.33)			
IPROFIL	-	-	-	-	-	-0.009***	-	-
						(-5.09)		
MOODY	-	-	-	-	-	-	0.0062***	-
							(11.89)	
S&P	-	-	-	-	-	-	-	0.0055***
								(10.42)
D1999	0.0153**	-						
	(2.35)							
D2000	0.0135***	-						
	(2.61)							
D2001	0.0157***	-						
	(3.42)							
D2002	0.0093**	-	See *F*-test	See *F*-test	See *F*-test	See *F*-test	See *F*-test	See *F*-test
	(1.97)							
D2003	0.0037	-						
	(0.85)							
D2004	0.0020	-						
	(0.55)							
D2005	-0.00436	-						
	(-1.15)							
F-test Time effects	4.98	-	3.70	4.07	2.99	2.15	3.35	4.43
(p-value)	0.0000		(0.0007)	(0.0003)	(0.0045)	(0.0375)	(0.0018)	(0.0001)
F-test Country effects *(p-value)*	18.57	21.35	-	-	-	-	-	-
	0.0000	(0.0000)						
Nb of obs.	415	415	415	415	415	415	415	415
R^2	0.8576	0.8732	0.6914	0.6957	0.6310	0.6739	0.6301	0.6015

Notes: Estimation using White heteroscedasticity robust standard errors. Observations excluded when GovBond>0.4. Country fixed effects are excluded with the use of area effects, qualitative risk variables and the credit ratings. In parentheses below coefficient: *t*-statistics. * = significant at 10%; **=significant at 5%; ***= significant at 1%.

The qualitative risk indexes have also a significant effect on the risk premium (specifications 3B, 4B and 5B). The quality of the bureaucracy (BUREAU), law and order (LAW) and the investment profile (IPROFIL) have all a significant and negative coefficient: countries that are better rated for these characteristics tend to display a lower risk premium.

Finally, instead of using the macroeconomic fundamentals, we investigate the relationship between the credit ratings and the risk premium, using the ratings of Moody's and Standards & Poor's (specifications 6B and 7B). The sovereign credit rating measures the country's actual default risk. Thus, to be complete, we also include the variables of risk history and the time effects. Using this condensed model, we are still able to explain 60% (with S&P) and 63% (with MOODY) of the risk premium. Hence, the mapping between the risk premium and the credit risk ratings is pretty high. Credit ratings are better predictors of the countries' general risk than the macroeconomic fundamentals alone.

6. Results for the capitalization rate equation

Now that we have established and estimated the model for the 10-yr government bond yield equation, we are able to estimate the CAP equation. We start by presenting the single equation regressions, using GovBond-HAT, the fitted values of the 10-yr government bond yield that are extracted from the regression 6A of Table 4. Then, we implement the SURE estimations.

6.1 First empirical strategy: single equation results

Appendix 4 (Table A3) indicates the correlation matrix between the determinants of the cap rate, to which we add GDP per capita and Moody's credit rating. It so happens that the density and depth variables are highly correlated with GDP per capita and with the credit ratings. As a result, these two real estate variables are also highly correlated with the long-term government bond yields. Hence, we get a correlation between the market depth or density and the country risk. Yet, we want this risk effect to be taken up by the risk premium in the bond market. We are not really capturing the extent of outside options in the market. In order to single out the specific real estate liquidity risk, we have performed a regression of each liquidity variables (DEPTH and DENSITY, taken in logs) on GDP per capita. Then, the residuals from these regressions, labeled DEPTH-HAT and DENSITY-HAT, are taken as liquidity variables. These residuals measure in fact the liquidity of the market given the level of economic development (or risk). In this way, we obtain variables that are orthogonal to the country risk assessment, as already measured by the long-term bond yield.

In Table 6, we first investigate the performance of the variables that we have constructed - the 10-yr government bond yield (GovBond-HAT), depth (DEPTH-HAT) and density (DENSITY-HAT) - compared to their actual values. In the first two columns, we simply regress the cap rate on GovBond (column 1C) and on its estimated value (column 2C). As predicted by the CAPM model, there is a positive relationship between the risk premium on government bonds and the cap rate. GovBond alone explains between 41% (with the actual value) to 44% (with GovBond-HAT) of the real estate yield. As explained previously, the estimated value GovBond-HAT will be used in the next regressions to avoid any endogeneity problems.

Table 6: estimation results for the CAP equation

	1C OLS	2C OLS	3C OLS	4C OLS	5C OLS	6C OLS	7C OLS
GOVBOND	0.3922*** (9.46)	-	-	-	-	-	-
GOVBOND-HAT	-	0.4292*** (10.76)	-	0.2842*** (6.89)	0.4021*** (9.98)	.3229*** (8.05)	.4093*** (10.12)
FUND	-	-	0.3470*** (7.54)	-	-	-	-
EFFECT	-	-	0.5508*** (13.80)	-	-	-	-
LN(DEPTH)	-	-	-	-0.0089*** (-9.70)	-	-	-
DEPTH-HAT	-	-	-	-	-0.0066*** (-5.08)	-	-
LN(DENSITY)	-	-	-	-	-	-.0082*** (-9.57)	-
DENSITY-HAT	-	-	-	-	-	-	-.0064*** (-6.54)
REIT	-	-	-	-0.0012 (-0.57)	-0.0073*** (-2.92)	-.0022 (-1.07)	-.0068*** (-2.92)
constant	0.05542*** (19.36)	0.0525*** (19.47)	0.0585*** (17.83)	0.0859*** (17.34)	0.0572*** (18.60)	.1529*** (13.30)	.0569*** (18.74)
Nombre obs.	357	357	357	357	357	357	357
R^2	0.4115	0.4419	0.4705	0.5848	0.4945	0.5858	0.5127

Notes: Estimation using White heteroscedasticity robust standard errors. Observations excluded when GovBond>0.4. In parentheses below coefficient: *t*-statistics. * = significant at 10%; **=significant at 5%; ***= significant at 1%.

At this point, it might be interesting to breakdown GovBond-HAT into a component determined only by the fundamentals and history variables (FUND) and a component representing the fixed country effects (EFFECT). The country effects correspond simply to the estimated coefficient of the country dummies. FUND is then the predicted value of GovBond based on the *X* variables (IDEBT, FOREIGNDEBT, LIQUID, EXP, GDP%, IMPULSE and IMF5), the constant and the time effects, less the country effects. In regression 3C of Table 6, both components of GovBond are used as determinants of the cap rate. The country fixed risk effects (EFFECT) have a higher coefficient value than the component based on fundamentals and history (FUND). The former is also more significant. It shows that the fixed country perception is a more significant determinant of the real estate yield than macroeconomic fundamentals.

Turning to real estate liquidity variables, both measures (DEPTH, DENSITY) have a high significant level and their coefficients and *t*-tests are almost identical. The same can be said for their respective estimated values (DEPTH-HAT, DENSITY-HAT), but the coefficients of the estimated values are lower than the actual values, with a lower *t*-test. This was to be expected since the estimated values are whitened of the general country risk perception as measured here by the level of economic development. Indeed, the coefficient of GovBond-HAT is much lower when the actual values of DEPTH and DENSITY are used. When the fitted values are included instead, the GovBond coefficient returns to a value around 0.4. This shows that we are rightly capturing the liquidity of the real estate market, conditioning on the economic development level of the country. Since the results for DEPTH-HAT and DENSITY-HAT are almost identical, we prefer to work with the density variable that has a more convenient interpretation in terms of real estate markets[19]. The existence of REITs in the country contributes to lowering the risk premium, but this indicator is not always significant.

Table 7: estimation results for the CAP equation

	1D	2D	3D	4D	5D
	OLS	**OLS**	**FE**	**FE + Time effect**	**RE + Time effect**
GOVBOND-HAT	0.3991*** (10.06)	0.3911*** (9.78)	0.3908*** (8.94)	0.2335*** (3.40)	0.3390*** (7.91)
DENSITY-HAT	-	-0.0050*** (-4.83)	-0.0082** (-2.59)	-0.0143** (-2.06)	-0.0084*** (-4.60)
REIT	-	-0.0079*** (-3.14)	0.0018 (0.35)	0.0044 (0.90)	0.0005 (0.14)
LN(RENTS)	0.0198*** (2.79)	0.0180** (2.49)	0.0036 (0.69)	0.0059 (1.07)	0.0096* (1.87)
VACANCY%	-0.0053** (-2.42)	-0.0040* (-1.75)	-	-	-
GDP% (-1)	0.1113* (1.77)	0.0398 (0.64)	0.0228 (0.68)	0.06868** (1.97)	0.0641* (1.90)
constant	-0.0391 (-1.28)	-0.0246 (-0.79)	0.0313 (0.95)	0.0015 (0.04)	0.0038 (0.16)
F-test Time effects *(p-value)*	-	-	-	4.83 (0.0001)	31.53 (0.0000)
F-test Country effects *(p-value)*	-	-	26.29 (0.0000)	26.08 (0.0000)	-
Hausman test *(p-value)*	-	-	-	-	13.87 (0.2403)
Nombre obs.	308	308	357	357	357
R²	0.4998	0.5457	0.8385	0.8575	-

Notes: OLS estimation using White heteroscedasticity robust standard errors. Observations excluded when GovBond>0.4. In parentheses below coefficient: *t*-statistics. * = significant at 10%; **=significant at 5%; ***= significant at 1%.

We now estimate in Table 7 the full cap rate model by adding the proxies for the growth of NOI: rents, growth of vacancy rate and lagged GDP growth. Contrary to the CAPM model, these variables have a positive impact on the cap rate. In the case of VACANCY%, recall that a decreasing vacancy rate signals higher expectations of NOI growth. Hence, the negative coefficient still indicates that the expected growth of NOI, expected from a lower vacancy rate, has a positive effect on cap rates. This unexpected positive effect may indicate that these variables are in fact poor proxies for future NOI growth. Furthermore, it might be that real estate prices do not adjust instantly to the expectations of NOI growth. From our CAPM model, the evolution of rents should be rationally taken into account in the pricing of real estate. Hence, the cap rate should be mean reverting in time. But Sitivanides, Southard, Torto & Wheaton (2001) show that, for the US metropolitan markets, capitalization rates are not mean-reverting: investors seem to appraise the time path of rental growth by looking myopically backward and not forward. In any event, the growth proxies are not significant with fixed effects or when the real estate liquidity variables are included in the regressions.

[19] We believe that real estate markets that are evaluated through their *Highest and Best Use* (HBU) will display higher density levels (ex: New York vs. Phoenix) therefore attracting more investments, and thus represent a better liquidity proxy than DEPTH (population/inventory).

Note that, when using VACANCY%, we lose one year of observations. Since we expect a fairly high relationship between GDP%, RENTS and VACANCY%[20], we choose to withdraw VACANCY% in all

Table 8: estimation results for the CAP equation

	FE + Time effect 4D	Area effects	Qualitative index			Credit ratings	
		1E	2E	3E	4E	5E	6E
		OLS	OLS	OLS	OLS	OLS	OLS
GOVBOND-HAT	0.2335*** (3.40)	0.2755*** (7.12)	0.2520*** (5.04)	.2741*** (6.07)	.3146*** (6.54)	0.1316*** (2.58)	0.1468*** (2.91)
DENSITY-HAT	-0.0143*** (-2.06)	-0.0017* (-1.67)	-0.0046*** (-4.93)	-.00685** (-6.69)	-.0059*** (-5.50)	-0.005*** (-6.09)	-0.0054*** (-6.44)
REIT	0.0044 (0.90)	-0.0029 (-1.347)	-0.0021 (-1.00)	-.0062*** (-2.97)	-.00479** (-2.08)	-0.0014 (-0.74)	-0.00097 (-0.50)
LN(RENTS)	0.0059 (1.07)	0.0197*** (3.20)	0.0098 (1.45)	.0164** (2.47)	.01940*** (2.80)	0.0211*** (3.39)	0.0232*** (3.59)
GDP% (-1)	0.06868** (1.97)	0.1516*** (2.89)	0.0125 (0.23)	.0516 (0.95)	.03563 (0.66)	0.01238 (0.26)	-0.00615 (-0.11)
constant	0.0015 (0.04)	-0.0326 (-1.22)	0.0507 (1.55)	.0155 (0.50)	.0002 (0.01)	-0.0494* (-1.77)	-0.0681** (-2.33)
UE	-	-0.0196*** (-5.82)	-	-	-	-	-
ENLARG	-	0.0163*** (2.94)	-	-	-	-	-
EU-ENTRY		-0.0242*** (-3.30)	-	-	-	-	-
ASIA	-	-0.0218*** (-5.46)	-	-	-	-	-
LATIN	-	0.0175*** (3.40)	-	-	-	-	-
OTHERS		-0.0054 (-1.49)					
BUREAU	-	-	-0.0131*** (-5.63)	-	-	-	-
LAW	-	-	-	-0.0081*** (-5.79)	-	-	-
IPROFIL	-	-	-	-	-0.0034*** (-3.04)	-	-
MOODY	-	-	-	-	-	0.0035*** (7.36)	-
S&P	-	-	-	-	-	-	0.0032*** (6.37)
D2000	0.0179*** (3.84)						
D2001	0.0128*** (3.21)						
D2002	0.0174*** (4.75)						
D2003	0.0165*** (5.11)	See *F*-test	See *F*-test	See *F*-test	See *F*-test	See *F*-test	See *F*-test
D2004	0.0131*** (3.55)						
D2005	0.0068** (2.42)						
F-test Time *(p-value)*	4.83 (0.0001)	3.66 (0.0016)	3.36 (0.0032)	3.78 (0.0012)	3.14 (0.0051)	3.16 (0.0049)	4.13 (0.0005)
F-test Country effects *(p-value)*	26.08 (0.0000)	-	-	-	-	-	-
Nombre obs.	357	357	357	357	357	357	357
R2	0.8575	0.6779	0.5971	0.6050	0.5667	0.6495	0.6511

Notes: OLS estimation using White heteroscedasticity robust standard errors. Observations excluded when GovBond>0.4. Country fixed effects are excluded with the use of area effects, qualitative risk variables and the credit ratings. In parentheses below coefficient: *t*-statistics. * = significant at 10%; **=significant at 5%; ***= significant at 1%.

[20] In periods of strong economic growth, where the absorption rate in office space is generally higher than the pace of new supply, the vacancy rate will decrease rapidly putting upward pressure on rental rates.

of the following regressions in order to increase the efficiency of the country-individual effect estimations.

The fixed-effect (FE) results are presented in columns 3D and 4D. The noteworthy outcome is the absence of significance for the NOI growth proxies, except for the lagged GDP% in 4D (at the 10% level only). Rent growth proxies seem to be captured by the fixed country effect, as if investors are in fact assigning a fixed growth expectation (up to the time sample) to each national real estate market. The REIT dummy is also insignificant, but this zero-one indicator is mostly absorbed by the country dummies. In column 5D, we also print the random effect (RE) estimator, which can be compared to the FE estimator. The RE estimator would be more efficient, except if there is a correlation between the country effects and any of the X variables. The Hausman test shown in Table 7 compares the coefficients of the RE estimators (5D) with those of the FE estimators (4D). The Hausman test rejects the existence of any systematic differences between both sets of coefficients. Hence, the issue of endogeneity might not be too problematic in this case.

Further interesting results are presented in Table 8. We reprint again specification 4D, but showing the coefficients of the time effects which are all significant. In average, the cap rate has decreased considerably since 2002: it was, in average, 0.68 p.p. higher in 2005, 1.31 p.p. in 2004, 1.65 p.p. in 2003 and 1.74 p.p. in 2002.

In specification 1E, we include area effects, similarly to the CAP equation. Compared to the U.S. specific-effect (given by the constant), the 15 EU and Asian countries tend to post, in average, a lower cap rate of about 1.96 p.p. and 2.19 p.p. respectively while Latin American countries have, in average, a higher level of cap rate of about 1.75 p.p.. In the case of the EU enlargement countries (ENLARG), the cap rate tends to be higher (1.63 p.p.), but we note a sharp decrease in the cap rate from 2004 onward, e.g. from the year of entry into the EU. To show this, we have constructed a dummy equal to 1 from the first year of entry into the EU, and zero otherwise (EU-ENTRY). This indicator is negative and significant: the cap rate of EU enlargement countries tends to be 2.42 p.p. lower from the first year of official entry in the EU relatively to their pre-accession level.

The qualitative variables (specifications 2E, 3E and 4E) are all significant at the 1% level. Again, a country which is better rated tends to have a lower risk premium on the cap rate. Since the credit ratings are very good predictors of the risk premium, we have also tested the effect on the sovereign credit ratings in specifications 5E and 6E. Both ratings (MOODY and S&P) are highly significant and their coefficient is positive: a poor rating tends to increase a country's risk premium on the cap rate. Again, these sovereign credit ratings are composite indicators taking into account all types of risks, and some of these risks seem to affect also the real estate market.

6.2 Second empirical strategy: SURE results

Finally, we implement the SURE procedure in Table 9. Time fixed effects are included in all regressions. In column 1F, we first estimate the fixed effect SURE. This estimator is efficient and unbiased since the inclusion of country dummies removes the fixed effect from the residuals, solving the autocorrelation and the endogeneity problem. Hence, with fixed effects, the SURE only considers the correlation between the remaining disturbances (idiosyncratic shocks). We indicate in the last lines of Table 9 the correlation between the residuals of both equations as well as the *p*-value. This correlation is negative (-0.094) and significant at the 10% level.

In column 2F, we present the random effect RE-SURE estimator, but without using any instruments to correct for endogeneity. Now, the correlation between both equations includes the correlation between the individual effects and the correlation between the remaining disturbances. The total correlation is quite low (0. 182) and not significant. However, if we take only the correlation between the individual effects, we obtain a positive and significant correlation of 0.148.

In column 3F, we implement the full Hausman-Taylor SURE random effect. For this procedure, we need to identify which variables are *doubly* exogenous and which ones are *singly* exogenous. Moreover, for identification, exogenous and endogenous time-invariant variables have to be also included in the regression[21]. There is no formal decision rule to identify which variables are singly or doubly exogenous. In the GovBond equation, the variables that seem to characterize the most the inter-temporal country risk perceptions are the interest payments (IDEBT), the level of the foreign debt (FOREIGNDEBT), the existence of IMF lending arrangements in the current and in the past two years (IMF5) and the response function (IMPULSE). In the CAP equation, as a rule, we set as endogenous the variables that are in level (GovBond, DENSITY and REIT), while the variables measuring the changes in time (GDP%, RENT) are assumed to be exogenous.

In both equations, we include as an exogenous time-invariant variable a dummy variable equal to one for emerging countries (EMERG) and zero otherwise (see Appendix 1). Emerging countries corresponds to high-risk countries (such as Argentina and Russia) but also to relatively low-risk and stable countries (such as Hong Kong, Taiwan, Singapore, etc.). Hence, it should be relatively exogenous to the specific country effect. As an endogenous time-invariant variable, we use IMF2, which equals 1 if the country has had any lending arrangements with the IMF between 1995 and 1999.

With the Hausman-Taylor SURE random effect, the correlation between the individual effects becomes surprisingly negative (-0.119). Recall that, in order to implement the Hausman-Taylor methodology, two time-invariant variables were added to the model (IMF2 and EMERG). The addition of these two

[21] The reader is referred to the paper of Hausman & Taylor (1981) for a more comprehensive explanation of the IV procedure.

Table 9: estimation results for the CAP equation – SURE regressions

	1F	2F	3F
	SURE FE	**SURE GLS RE**	**SURE Hausman-Taylor**
CAP equation			
GOVBOND	0.1961***	0.2830***	0.1912***
	(5.94)	(9.59)	(5.79)
DENSITY-HAT	-0.0123***	-0.0079***	-0.0114***
	(-4.27)	(-4.71)	(-4.01)
REIT	0.0044	-0.00157	0.0044
	(1.02)	(-0.42)	(1.01)
LN(RENTS)	0.0077	0.0137***	0.0074
	(1.58)	(2.65)	(1.52)
%GDP(-1)	0.0805***	0.0852***	0.0781**
	(2.58)	(2.57)	(2.47)
IMF2	-	-	0.01014
			(0.66)
EMERG	-	-	0.0129
			(0.56)
constant	0.0203	-0.0131	-0.0072
	(0.82)	(-0.53)	(-0.28)
F-Test Time	66.99	41.77	65.26
(*p-value*)	(0.0000)	(0.0000)	(0.0000)
F-Test Country effects	841.91	-	-
(*p-value*)	(0.0000)		
R^2	0.8617	0.7827	0.4926
GovBond equation			
IDEBT	0.4895***	0.3564***	0.4886***
	(11.64)	(11.80	(10.43)
FOREIGNDEBT	-0.0082	0.0089	-0.0063
	(-0.88)	(1.04)	(-0.45)
LIQUID	-0.0021***	-0.0017***	-0.0019***
	(-3.43)	(-3.60)	(-2.76)
EXP	-0.0011	-0.00027	0.0034
	(-0.06)	(-0.04)	(0.63)
GDP%	0.0210	0.02687	0.02154
	(0.41)	(0.52)	(0.36)
IMPULSE	0.0037***	0.0030***	0.0031***
	(10.27)	(8.16)	(7.63)
IMF5	0.01782***	0.0203***	0.01674***
	(4.40)	(4.62)	(3.49)
EMERG	-	-	-0.04113
			(-0.29)
IMF2	-	-	0.0254
			(1.11)
constant	0.0428	0.1079***	0.07242
	(1.09)	(7.55)	(1.37)
F-Test Time	19.08	67.09	22.67
(p-value)	(0.0040)	(0.0000)	(0.0019)
F-Test Country effects	1058.44	-	-
(p-value)	(0.0000)		
R^2	0.9064	0.7507	0.6070
Cross-equation correlation			
Total residuals: $E(z1_{it}\, z2_{it})$	-0.0949[1]	0.0824	-0.0719
(p-value)	(0.0732)	(0.1201)	(0.1750)
Individual effects: $E(u1_{it}\, u2_{it})$	-	0.1485	-0.1193
(p-value)		(0.0020)	(0.0131)
Nb. obs.	357	357	357

Observations excluded when GovBond>0.4. In parentheses below coefficient: *t*-statistics. * = significant at 10%; **=significant at 5%; ***= significant at 1%.
1. In the case of the FE estimator, the total residuals z corresponds to the regression residuals e, since the individual dummy variables are included in the model.

variables in each equation could have affected the cross-equation correlation. More generally, the efficiency of the Hausman-Taylor methodology relies on the quality of the instruments. Unfortunately, as already mentioned, it is not easy to find good instruments in the context of country risk evaluation. If the interest lies only in the estimate of unbiased coefficients, and not in investigating the correlation between the bond and real estate markets, then the results of the FE-SURE become the appropriate benchmark. Nevertheless, the coefficients of the Hausman-Taylor SURE-RE are remarkably close to those of the SURE-FE. In fact, they are not too far apart from the benchmark single equation FE estimator 4D (Table 7), except for the long-term bond yield. For the bond yield, we have used the fitted values in the single FE equation, while the actual values are tested in the SURE estimations. Second, by considering the cross-equation correlation, the SURE procedure takes into account another channel linking the long-term bond interest rate and the cap rate.

Examining now the coefficient of GovBond obtained from the Hausman-Taylor SURE-RE, we do find a positive and significant relationship between these two yields, as predicted by the CAPM model. We can estimate that a 1 percentage point increase in the 10-year bond yield rate will raise the cap rate by about 0.19 percentage point. This point estimate may seem low, but it should be remembered that the Hausman-Taylor SURE-RE already includes country specific risk effects. The effect of the risk premium on the bond market is to be added to these permanent country risk assessments.

Looking at the GovBond equation, all the variables have the expected sign, except FOREIGNDEBT, EXP and GDP% which are not significant though. For the variables that remain significant, the coefficients are more or less close to the single equation FE estimation (specification 6A of Table 4), which is our unbiased single equation benchmark.

More generally, in both the 10-yr government bond yield and the cap rate models, the country specific risk effects are highly significant and they reveal the existence of time-invariant country characteristics or permanent risk perception that affects the risk premiums. This may indicate for example that investors develop for each country a fixed or preconceived risk assessment which may or may not be related to the country's actual economic situation.

Conclusion

In this paper, we have attempted to investigate the determinants of the real estate capitalization rate by using a sample of developed and emerging countries. Our assumption, based on a Capital Asset Pricing Model (CAPM), is that the capitalization rate should be at least proportional to the country's risk perception, as measured by the risk premium on the 10-year government bond yield.

Our results show that government bond yield is the main determinant of the cap rate. It explains alone 41% to 44% of the capitalization rate level. Based on a Hausman-Taylor random effect SURE estimator, we estimate that a 1 percentage point increase in the government bond yield will raise the capitalization rate by about 0.19 percentage point.

Real estate variables play also a role, but to a lesser extent. The depth and the density of property inventory have a significant and negative effect on the real estate risk premium, as investors prefer to operate in larger markets in order to minimize transaction costs, hedge out price variability and exploit the availability of a larger pool of exit strategies. The results regarding rental growth expectations (rent index, changes in the vacancy rate and GDP growth) are less conclusive. These variables do not have a high and consistent explanatory power on the capitalization rate, especially when fixed country effects are included in the regression as if investors are in fact assigning a fixed growth expectation to each country. However, the mere fact that they appear as being significant in some regressions might be an indication that real estate prices are not necessarily adjusting instantly to changes in the net operating income of the office building.

Our empirical strategy also required the estimation of a model explaining the 10-year bond yield. Macroeconomic fundamentals are significant determinants of the risk premium on the bond market, but the crucial determinant is the country's capacity to honor short-term financial engagements. But these fundamentals are not sufficient to completely explain the bond yield: the country's risk history is also a very important determinant. Past crises have a long-term effect on the investors' current risk perception, independently of the country's actual macroeconomic situation.

Finally, we show that both real estate and long-term bond yields are characterized by a fixed country risk component and that these country effects might be correlated between these two markets. Hence, by using the SURE estimator, we are able to take into account this cross-equation correlation.

Future research on the determinants of the real estate capitalization rate – and its relationship with the risk premium on the bond market – will depend crucially on the availability of real estate data, especially for emerging countries. The next step would be to investigate this issue at the city level, which is more relevant for understanding real estate markets than national data. As already mentioned, it would also be interesting to consider longer time-series, since the capitalization rate seems to obey to particular stochastic processes, and in particular the mean-reverting properties of the real estate yield. Finally, another line of research would be to examine how investors structure their risk assessment when investing in emerging property markets compared to developed ones. Across developed countries, differences in country risk levels are marginal. One can assume then that investors will grant more importance to real estate fundamentals than the level of country risk when conducting a due diligence in a developed country's property market compared to an emerging country. Inversely, investors might be much more sensitive to the higher investment risks associated to most emerging countries, which might outweigh any favorable real estate conditions. Second, because emerging markets are mostly demand-driven, changes in the new office supply curve might have a lesser effect on foreign investment decisions. Therefore, when investing in an emerging property market, the investor will mostly focus its analysis on the economic growth rate potential (the demand) and the investment risks (level of transparency, political stability and profit repatriation) rather than real estate cycle.

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Appendix 1: list of countries

List of countries in the sample, and their classification into emerging countries (EMERG) - as opposed to developed countries, European Union member-states before enlargements (15 countries), the EU membership candidates that joined the EU in 2004 or 2007, the Asian countries and the Latino American countries.

	Emerg.	EU15	EU Candi-dates	Asia	Latin-Amer.			Emerg.	EU15	EU Candi-dates	Asia	Latin-Amer.
Argentina	*				*		Lithuania	*		*		
Australia							Luxembourg		*			
Austria		*					Malaysia	*			*	
Belgium		*					Mexico	*				*
Brazil	*				*		Netherlands		*			
Bulgaria			*				New Zealand					
Canada							Norway					
Chile	*				*		Peru	*				
China	*			*			Philippines	*			*	
Colombia	*				*		Poland	*		*		
Czech	*		*				Portugal		*			
Denmark		*					Romania	*		*		
Estonia	*		*				Russia	*				
Finland		*					Singapore	*			*	
France		*					Slovakia	*		*		
Germany		*					South Africa					
Greece		*					Spain		*			
Hong Kong				*			Sweden		*			
Hungary	*		*				Switzerland					

India	*				
Indonesia	*			*	
Ireland		*			
Israel					
Italy		*			
Japan				*	
Korea	*			*	
Latvia	*		*		
Lithuania	*		*		
Taiwan	*			*	
Thailand	*			*	
Turkey	*				
UK		*			
USA					
Ukraine	*				
Venezuela	*				*

Appendix 2: list of cities

Country	Available cities
Argentina	Buenos Aires
Australia	Melbourne
	Perth
	Sydney
Austria	Vienna
Belgium	Antwerp
	Brussels
Brazil	Rio de Janeiro
	Sao Paulo
Bulgaria	Sofia
Canada	Calgary
	Montreal
	Ottawa
	Toronto
	Vancouver
Chile	Santiago
China	Beijing
	Guangzhou
	Shanghai
Colombia	Bogota
Czech	Prague
Denmark	Copenhagen
Estonia	Tallinn
Finland	Helsinki
France	Paris
Germany	Berlin
	Düsseldorf
	Frankfurt
	Hamburg
	Munich
	Stuttgart
Greece	Athens
Hong Kong	Hong Kong
Hungary	Budapest
India	Bangalore
	Chennai
	Delhi
	Mumbai
Indonesia	Jakarta
Ireland	Dublin
Italy	Milan
	Rome
Japan	Tokyo
Korea	Seoul
Latvia	Riga
Lithuania	Vilnius
Luxembourg	Luxembourg City
Malaysia	Kuala Lumpur
Mexico	Mexico City
Netherlands	Amsterdam
New Zealand	Auckland
	Wellington
Norway	Oslo
Peru	Lima
Philippines	Manila
Poland	Warsaw
Portugal	Lisbon
Romania	Bucharest
Russia	Moscow
Singapore	Singapore
Slovakia	Bratislava
South Africa	Cape Town
	Durban
	Johannesburg
Spain	Barcelona
	Madrid
Sweden	Stockholm
Switzerland	Geneva
	Zurich
Taiwan	Taipei
Thailand	Bangkok
Turkey	Istanbul
UK	London
USA	Atlanta
	Boston
	Chicago
	Cleveland
	Dallas
	Denver
	Detroit
	Houston
	Los Angeles
	Miami
	Minneapolis
	New York
	Philadelphia
	Phoenix
	Pittsburgh
	San Francisco
	San Jose
	Seattle
	St. Louis
	Washington
Ukraine	Kiev
Venezuela	Caracas

Appendix 3: Sources of data

Variables	Source
Interest rates	
→ 10-year treasury bond interest rate or equivalent long-term interest rate.	Datastream; Bloomberg; Eurostat.
→ Monthly short-term interest rate	Datastream
Solvency variables	
→ Government Debt (% of GDP)	Moody's Country Credit Statistical Handbook
→ External Debt (%GDP)	ICRG/PRS Group
→ Government Debt/Government Revenue	Moody's Country Credit Statistical Handbook
→ Short-term debt (% of exports of goods, services and income)	World Bank: World Development Indicator
→ Total debt service (% of exports of goods, services and income)	World Bank: World Development Indicator
→ Government budget balance (%GDP)	World Economic Outlook; European Central Bank
→ International liquidities as months of import cover	ICRG/PRS Group
→ Government Interest Payment/Government Revenue	Moody's Country Credit Statistical Handbook
→ Official Foreign Exchange Reserves (US$)	Moody's Country Credit Statistical Handbook
External trade variables	
→ Current account balance (in US$)	World Economic Outlook
→ Current account balance in % of GDP	World Economic Outlook
→ Exports of goods and services (current US$)	World Bank: World Development Indicator; EIU
→ Exports of goods and services (% of GDP)	World Bank: World Development Indicator; EIU
→ Imports of goods and services (% of GDP)	World Bank: World Development Indicator; EIU
→ Trade balance (in US$)	EIU
→ Openness of the Economy (%GDP)	Moody's Country Credit Statistical Handbook
GDP variables	
→ GDP (current US$)	World Economic Outlook
→ GDP per capita (constant 2000 US$)	World Economic Outlook
→ Growth of GDP in real term (annual % change)	World Economic Outlook
→ Growth of GDP per capita in real term (annual % change)	World Economic Outlook
Other variables	
→ Inflation, consumer price (annual % change)	World Economic Outlook
\ Existence of financial arrangements with IMF	International Monetary Fund
→ US New York stock exchange composite share price index	Datastream
→ Country population	World Bank; World Development Indicator
Qualitative index	
→ Bureaucracy Quality	ICRG/PRS Group
→ Government Stability	ICRG/PRS Group
→ Investment Profile	ICRG/PRS Group
→ Moody's Credit Ratings	Moody's Sovereign Ratings List
→ Standard & Poor's Credit Ratings	S&P_Sovereign Ratings History
Real estate variables	
→ Capitalization rate by city	Colliers: Office Global Insights 2000-2006; DTZ Property Market Analysis; Bentall; REIS; Ober Haus Real Estate Adivsors Property Management Association
→ Vacancy rate by city	Idem
→ Inventory by city (Sq.ft/yr)	Idem
→ Rents by city (€/Sq.m/yr or US$/Sq.ft/yr)	Idem
→ Population by city PMA	www.citypopulation.com; REIS; Colliers; Australian bureau of statistics; National Statistical Institute of Bulgaria; National Statistical Office of Austria; National Institute of Statistics of Belgium Statistics South Africa
→ Existence of Real Estate Investment Trusts (REIT)	Bloomberg
→ City area (km²)	

Appendix 4: correlation matrix

Table A1: Correlation matrix for the determinants of the 10-years Government bond interest rate.

	INFL									
IDEBT	**0,44**	IDEBT								
FOREIGNDEBT	0,21	0,18	FOREIGNDEBT							
BUDGETBAL	-0,12	**-0,47**	-0,08	BUDGETBAL						
EXP	-0,18	-0,32	-0,17	0,27	EXP					
ACCOUNT	-0,06	-0,09	-0,23	**0,36**	**0,46**	CACCOUNTP				
LIQUID	0,04	0,08	-0,09	-0,10	-0,10	0,30	LIQUID			
RESERVESP	-0,10	-0,12	-0,01	0,11	**0,67**	**0,39**	0,41	RESERVESP		
GDP%	-0,09	-0,03	-0,04	0,13	0,21	-0,01	-0,04	0,23	GDP%(-1)	
MOODY	**0,55**	**0,51**	**0,35**	-0,25	-0,18	-0,05	0,26	0,13	0,20	MOODY
SP	**0,55**	**0,51**	**0,39**	-0,30	-0,22	-0,14	0,23	0,09	0,27	0,94

Table A2: Correlation matrix for the qualitative variables, credit ratings and GDP per capita.

	MOODY					
SP	**0,942**	SP				
BUREAU	**-0,770**	**-0,791**	BUREAU			
LAW	**-0,732**	**-0,768**	**0,693**	LAW		
IPROFIL	**-0,713**	**-0,687**	**0,575**	**0,480**	IPROFIl	
GDPCAP	**-0,782**	**-0,805**	**0,732**	**0,686**	**0,589**	GDPCAP
IDEBT	**0,509**	**0,508**	-0,257	**-0,488**	**-0,399**	**-0,454**

Table A3: Correlation matrix for the determinants of the CAP equation, plus GDP per capita and Moody's credit rating

MOODY	MOODY							
GDPCAP	**-0,775**	GDPCAP						
INTEREST	**0,729**	**-0,509**	INTEREST					
DEPTH	**-0,748**	**0,762**	**-0,466**	DEPTH				
DENSITY	**-0,559**	**0,624**	**-0,352**	**0,892**	DENSITY			
REIT	-0,279	**0,354**	-0,151	0,257	0,227	REIT		
RENT	0,112	-0,144	0,073	-0,233	-0,241	0,060	RENT	
VACANCY%	-0,267	0,234	-0,162	0,278	0,276	0,014	-0,084	VACANCY%
GDP%(-1)	0,245	-0,287	0,094	**-0,419**	**-0,390**	-0,187	0,224	-0,162

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