Department of Economics and Finance

Course of Empirical Finance

“ Asian Emerging Market sovereign spreads: balancing macroeconomic and global exposures ”

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Introduction

Recent times saw a world of slowing growth. In such scenario, Emerging Market economies are expanding more rapidly than developed ones and the gap is expected to widen in the years ahead. Dollar-denominated emerging market bonds have lately attracted large portfolio capital flows, perhaps because of both their resilience during the 2008-2009 global financial crisis and their post-crisis relatively favourable risk-return features. When backward looking at the path that Emerging Market sovereign spreads have been following globally, it seems like the deviation from US Treasury yields has narrowed. The reason for our investigation is to justify such phenomena and identify those factors affecting the spreads' dynamic. The main focus is on how macroeconomic fundamentals, global economic conditions and investors' risk appetite interact, assessing the contributions of both global and domestic factors on the evolution of sovereign spreads. The analysis covers eight Emerging Market economies located within the Asian continent, namely China, India, Indonesia, Korea, Malaysia, the The Philippines, Taiwan and Thailand. The selected time window goes from Q3-2004 to Q4-2018. Data are collected in a panel.

Section 1 gives an insight on the concept of creditworthiness, defines how to determine sovereign spreads and makes a digression on Emerging Market history. We also present macroeconomic factors that past literature usually accounts for when dealing with the universe of sovereign credit. Such factors will be our reference starting point.

Section 2 presents some descriptive statistics for macroeconomic data collected on selected countries and identifies the international factors that are included within the analysis, in order to give some context. We discuss stationarity and describe the necessary data manipulation applied for fixing related issues. While investigating the correlation in spreads across countries, we find ourselves dealing with a fragmented set, divided into three groups. Sovereign spreads for countries belonging to the first and second group moved in opposite directions, while correlation coefficients for the single country belonging to the third group were close to zero. The fragmented correlation in spreads' movements can be indicative of the different perception investors had.

Section 3 introduces the alternative estimation techniques described in past literature for modelling sovereign spread through panel data and linear regression models. We also show the role of Principal Components Analysis as a tool for detecting commonalities.

Section 4 presents the implementation of the fixed-effects regression model and the results achieved. We provide residual diagnostics for commenting on the reliability of the estimates. The main finding is that macroeconomic factors are statistically significant in explaining the dynamics of sovereign spreads over the time period under study, but with only a milder impact. The related coefficient estimates are close to zero. On the contrary, coefficient estimates for international variables were considerably and consistently different from zero, meaning they had a stronger impact on spreads' dynamics. Such finding is in line with the results provided by PCA: when exploring the commonalities within the sample, we find two common underlying factors, which seem to have been correlated both with LIBOR and yield on US Treasury Bills, even if with opposite sign.

We conclude that, in periods of abundant market liquidity as recent times, when the financial scenario is globally dominated by low-level yields and investors show high risk appetite, sovereign spreads narrow, showing a greater exposure to global shocks than domestic macroeconomic fundamentals.

1 Premise

1.1 A first insight into Creditworthiness

Imagine you are seated at the table, in the middle of a pleasant conversation with few humans in tie, talking about the financial world while handling a glass of whiskey. You would soon end up arguing about the broad concept of "creditworthiness". It is generally referred to as the judgment a lender passes on how likely the debt holder is to repay the loan by meeting the related financial obligations. Among others, what affects creditworthiness the most is the credit history, which is a record referring to how the borrower has handled credit and debt obligations up to a fixed point in time. When it comes to countries, creditworthiness should reflect the medium to long-term risk that the county will default on its outstanding sovereign debt. Such of a risk is affected by a wide range of economic variables as well as by both political and social factors, the latter being difficult to quantify though. All of the necessary information to represent the perceived creditworthiness of a specific country can be synthesized into an index. The *Institutional Investor's Creditworthiness Index*, for example, is a survey-based index which has been computed and published twice a year since 1979 in the March and September issues of the Institutional Investor magazine. The related survey represents the responses of almost 100 bankers, that are asked to rate each country on a scale from 0 to 100, where 100 stands for no risk of default. Each rating is weighted for the specific bank's credit analysis sophistication and level of global prominence, with the aim of computing a weighted

average. An alternative measure for creditworthiness is credit rating. In the specific case of sovereign debt, credit rating is a valuation of the economic, financial and political situation of the reference country, which also accounts for its level of development. To give a wider outlook, countries being assigned with a lower credit rating are associated with higher default risk and higher financing cost of the government. Even if the number of operating rating agencies is large enough, the market is dominated by Moody's Investors Service and Standard&Poor's. In fact, the two are in between them responsible for around 80 percent of the market.

1.2 The move from Creditworthiness to Sovereign Spread

One of the reasons why creditworthiness is relevant and broadly argued about is because it affects the financing cost through a reverse relation. The difference in yield between sovereign issues of different countries is defined as sovereign spread and it is normally expressed in basis points. In order to give a general outlook on market spreads, several indices are available. For what concerns Emerging Market sovereign issues, one could give a look at the *Emerging Markets Bond Index Global*, forthwith referred as "EMBI Global". The cited Emerging Markets bond index is used as a benchmark for bond performances. It measures dollar-denominated Brady bonds, which are some of the most liquid securities issued by developing countries, primarily by Latin American ones. Countries are selected on the basis of their sovereign rating through a formula that combines the World Bank-defined per-capita-income brackets and the debt-restructuring history of each individual country. The index is also able to control for unusual bond features, such as floating coupons, rolling interest guarantees and principal collaterals. The spread in yield between a specific Emerging Market sovereign issue and a U.S. Treasury of comparable maturity should relay on the higher excess return that investors

demand to handle a larger default risk. However, assessing the reason for movements in sovereign spreads is not trivial. Past records tell us that, even if the creditworthiness of the issuer remained unchanged, the same issue could trade at different spreads at different points in time. What could have changed in the meanwhile is the *market sentiment*, defined as the compensation demanded by investors to take on a unit of risk, something which is directly related to investors' risk aversion. In fact, when a country intends to borrow money in international markets, not only banks make evaluations of its creditworthiness and rating agencies decide what rating to assign to it, but also investors evaluate its economic fundamentals in order to decide how much to charge on the loan. When modelling investors' risk aversion and choosing which assumptions are supposed to hold, it is widely used to assume that investors apply the same risk model and charge the same risk premium to all countries having similar characteristics. As a consequence, here lay the basis for making the primary discrimination within the pool of countries between developed and developing ones. Generally, investors are also assumed to evaluate a minimum spread that a country's sovereign issue should pay in order to reward for the risk of holding such debt. This structural spread will be referred to as a "*bottom rock spread*". It is mainly dependant on the specific country's institutions, political regime, economic development, history and social stability, and its methodology of calculation was first developed by JPMorgan Chase.

When analysing the dynamics of sovereign spreads, there is one more variable that needs to be taken into account. Mónica Fuentes[(1)] and Sergio Godoy[(2)] (2005) investigated the behaviour of daily bond stripped spreads[(3)] on sovereign debt issues for 18 Emerging Market economies located in Asia, East Europe and Latin America from September 1997 to November 2002. Within the Emerging Market universe, financial crises occur more

(1) At the time, Mónica Fuentes worked at Goldman Sachs. She had been joining the "Markets Strategy Team" and the "Global Macro" desk for almost 8 years.
(2) At the time, Sergio Godoy was joining Banco Central de Chile.
(3) Stripped spreads are defined as the difference in basis points between the semi-annual yield of the non-collateralized country cash flow and the U.S. Treasury yield, calculated as the spread over the U.S. curve.

often than not. The question was whether these events, each associated with a particular country, spread to other countries, regardless of economic fundamentals at that specific point in time. Said in other words, they investigated if the co-movements observable in sovereign spreads across Emerging Market economies are linked to economic fundamentals. What is provided below is a synthetic description of the results of their analysis[(4)]:

- they found that correlation across countries is regionally dominated: spreads from sovereigns with high saving rates, low indebtedness and good credit ratings are less likely to co-move with spreads from sovereigns where financial crises are being originated;
- they argued that turbulences arise in countries with very low credit ratings, causing sovereign spreads with intermediate credit rating to be vulnerable to a shift in investors' sentiment but leaving countries with high credit ratings almost unaffected;
- they claimed that higher savings rates and lower indebtedness play a similar role to higher credit ratings when it comes to partially sheltering an Emerging Market from the effects of a crisis-event occurring in a different country.

1.3 Emerging Markets: a little history

The very last decade of the 20th century hosted the release of increasing amounts of emerging countries sovereign issues both in international and domestic markets. The main reason for this phenomena lies in the "lost decade" of the 1980s, when most Latin

(4) Mónica Fuentes, Sergio Godoy, *Sovereign Spread in Emerging Markets a Principal Component Analysis*, Working Papers N°333 (Central Bank of Chile, November 2005)

American economies, confronted by high interest rates and low commodities prices, defaulted on their commercial bank loans. Because many of these countries were then dependent on commercial bank financing, the resulting perception of uncreditworthiness led to a "lost decade" of economic stagnation, during which voluntary international credit and capital flows to these economies, particularly to their private sectors, were interrupted. The difficulties these countries experienced in meeting their debt obligations were believed to reflect just a momentary liquidity problem that would end as the economic cycle rebounded. At that time, the Brady Plan was put forward as a solution for these economies to regain access to international capital markets for meeting their financing needs. The Plan was structured as follows:

i. Bank creditors would grant debt relief in exchange for greater assurance of collectability in the form of principal and interest collateral;

ii. Debt relief needed to be linked to some assurance of economic reform;

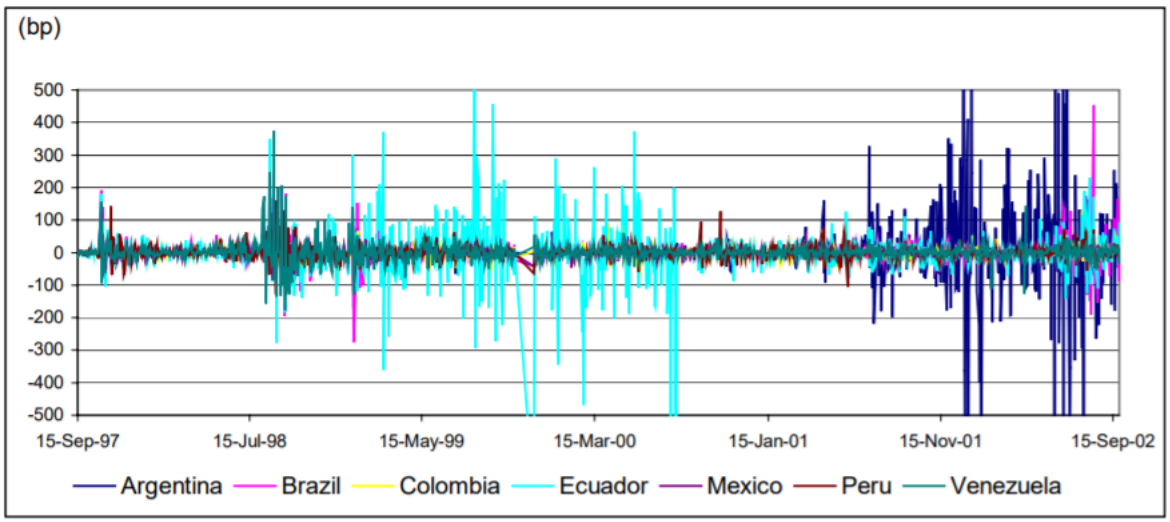
iii. The resulting debt should be more highly tradable, to allow bank creditors to diversify risk more widely throughout the financial and investment community.

It is believed that Emerging Market economies have become more vulnerable to experience "simultaneous" co-movements in asset prices since the birth of this Plan, which was successful in several respects. It allowed participating countries to negotiate substantial reductions in their overall levels of debt and debt service. It also succeeded in diversifying sovereign risk away from commercial bank portfolios throughout financial and investment communities. Moreover, it encouraged many Emerging Market countries to pursue ambitious economic reform programs. The growth of emerging markets trading volumes and asset values was interrupted soon after. The mid-1990s saw a sequence of crisis-events enhancing the riskiness of investing in developing countries. With the subsequent re-access to international capital market, the dominance of Brady bonds in

the emerging countries' debt markets started gradually to erode, as they were replaced by a wide variety of even more market-friendly instruments.

It could be useful to notice that, when plotting the first difference in stripped spreads, sovereign bond markets seem to respond to political and economic events, widening in the presence of chaotic events. Figures 1.1, 1.2 and 1.3 focus each on a different area, covering the time window from September 1997 to September 2002: the first is for Latin America, the second for Asia and the third for East Europe. The description below each figure tells some symbolic historical, socio-political and financial events dominating the scene at a specific point in time, in the effort of identifying each with a reason for spread widening.

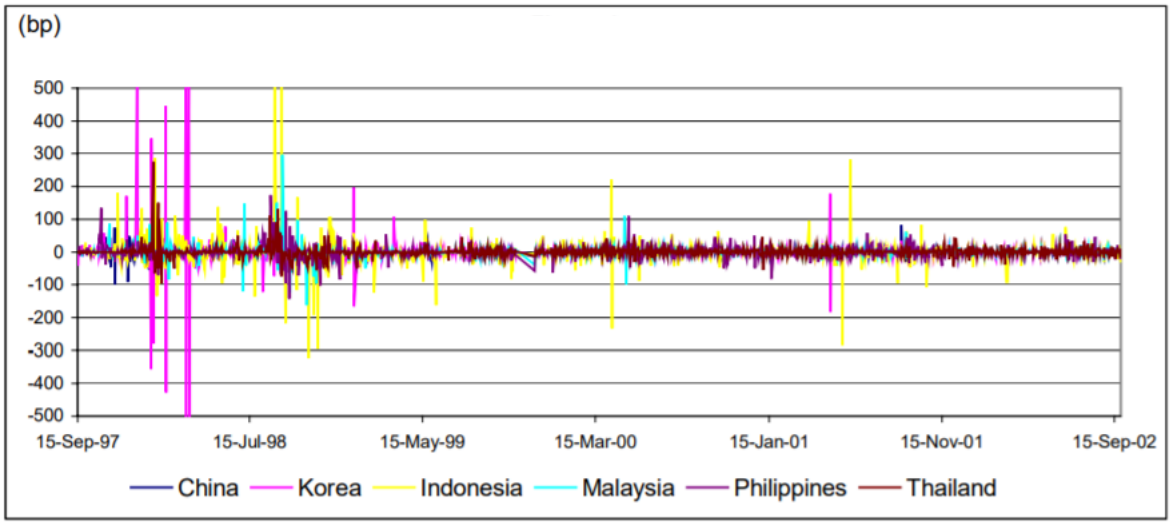
Figure 1.1: Emerging Market first difference stripped spreads – Latin America



By October 1997 the Brazilian stock market suffered after the market crash in Hong Kong. The central bank was forced to increase reserves to defend the currency and cut interest rates. In January 1998 Moody's described the Argentine financial system as weak and signalled the need for important reforms: it was just the heads-up of a much worse economic stress. In the meanwhile, Ecuador was suffering from heavy rains that caused El Nilo to disrupt fruit and vegetable crops, damaging the Country's business and

infrastructure. Later on, at the turn of 1998 and 1999, the Brazilian real undertook a great devaluation, while Ecuador was defaulting on its sovereign debt: bad loans started increasing 95% yearly, both the head and the board of the central bank resigned, addressing the banking crisis. Between 2000 and 2001, Argentina failed to meet its IMF[(5)]-package fiscal targets and deflation continued to roll over as the government was forced to cut spendings. Standard & Poor's lowered the sovereign credit rates of Argentina, with an IMF bailout package to prevent a debt crisis. The aid package did not have the desired effects and the country defaulted on its $155 billion of outstanding debt.

Figure 1.2: Emerging Market first difference stripped spreads – Asia

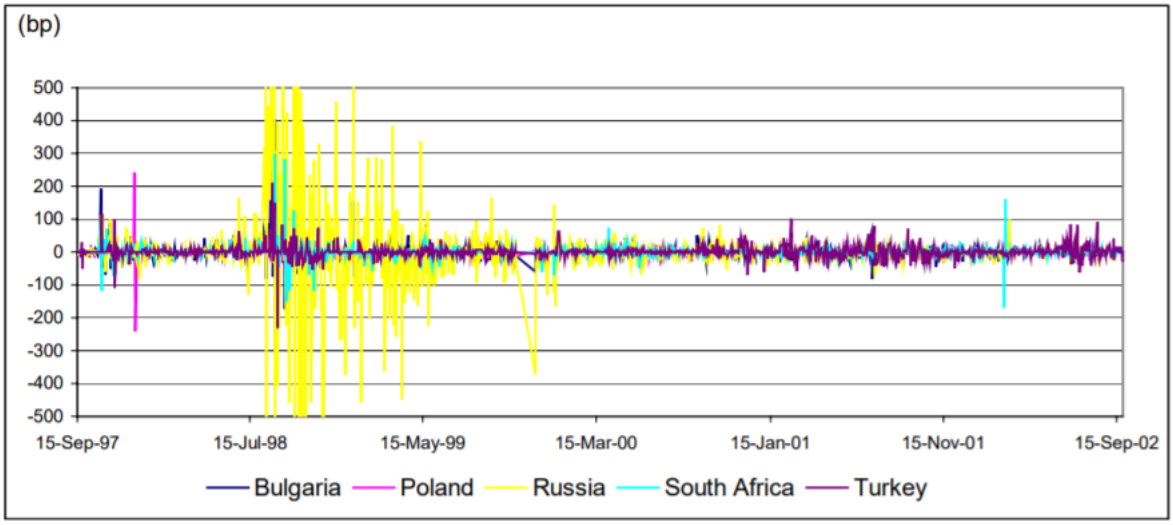


The deepest widening in stripped spreads in Asian markets was recorded between 1997 and 1998. It was mainly due to political events occurring in Thailand after the devaluation of the local currency: by October 1997 the Minister of Finance resigned and by November of the sawm year the Prime Minister Chavalit resigned as well. The effects of these events spreaded through the region: Asian currencies started experiencing a great weakening, central banks were forced to raise liquidity at the expense of reserves, local interest rates rose. As a natural consequence of the market perception deteriorating, credit rating

(5) International Monetary Fund.

agencies modified both the credit rating for the different asset classes and the outlook on these countries from stable to negative.

Figure 1.3: Emerging Market first difference stripped spreads – Latin America



The window covering the period from April to November 1998 was characterized by Russia's default. The government failed to collect sufficient funds through the auction of T-bills to repay its outstanding debt. A moratorium on debt repayments was declared in August, together with an almost 50% devaluation of the ruble and stock market crash. In October, sovereign spread reached its peak, exceeding 8,000 basis points. All the East European countries moved in tandem, but with milder impact.

Unfortunately, both political and social factors will not be included in the analysis as they are difficult to quantify.

While Brady bond trading accounted for 61% of total emerging markets debt outstanding in 1994, the same market share decreased to approximately 2% by 2005. By mid-2006, most Brady bonds had been exchanged or bought back by debtor nations in public or private secondary market transactions. The stock of tradable emerging market debt instruments grew by 17% per year since 2002, reaching 11.7 trillion US dollars in 2011 (Bank of America Merrill Lynch, 2012).

1.4 The identification of determinants

Previous studies have identified a wide number of variables as determinant when defining sovereign creditworthiness and sovereign spread consequently. These variables can be classified into solvency variables, liquidity variables and variables representing external shocks. What follows is a more detailed description of the different categories just mentioned.

Solvency variables relate to the specific country's ability to meet its financial obligation in the long run. Some of the variables belonging to this category are the current account balance, the stock of external debt and the gross domestic product. Let us now focus on how such variables affect the dynamic of creditworthiness. The current account balance is a record of all the international transactions between resident entities and the rest of the world, involving economic values other than financial items, over a specified period of time, i.e. a quarter or a year. Specifically, it accounts for the net trade in goods and services, the net earnings on cross-border investments and the net transfer payments. A large negative current account balance highlights a heavy reliance on funds from abroad. The weaker the current account position, the higher the possibility that foreign indebtedness becomes unsustainable in the long run. Focusing on the stock of external debt, the debt-to-GDP ratio represents the effort the country is required to make in order to service its obligation. The greater the debt burden, the higher the risk of default and the vulnerability to external shocks. For what concerns the real GDP growth rate: the higher the economic growth, the stronger the fiscal position, the easier the service of the debt over time.

Liquidity variables relate to the country's ability to meet its financial obligation in the short term. Debt service and international reserves are generally considered as two of the most pertinent variables. The amount of debt denominated in foreign currency has to be serviced out of international reserves. These reserves may also be used for direct financing of international payments imbalances, or for indirect regulation of the

magnitude of such imbalances via intervention in foreign exchange markets for affecting the exchange rate of the local currency. The lower the reserve level, the higher the risk of default. Exports is another important variable, since it normally generates the most part of foreign exchange earnings. Exports are usually expressed as a percentage of GDP, in order to ease the comparison between different countries. The larger the exports, the lower the vulnerability to externals shocks when it comes to debt servicing. The last but not the least to be put under attention is the inflation rate, playing a major role in the measurement of government discipline. Governments might exploit an inflationary finance of the fiscal deficit, instead of raising taxes or cutting spending. Such of an inflationary environment could be seen as indicative of financial structural problems and political instability, leading to a higher perceived risk of default.

For what concerns variables capturing external shocks to the economy, international interest rates play an important role in this sense, since they collaborate in determining international capital flows. Belonging to this category, the yield on US Treasury Bills and the London Inter-Bank Offering Rate are a good proxy for global liquidity conditions. The latter is considered by major global banks[6] as the reference rate for fixing the economic conditions when lending in the short-term to one another in the interbank market on an unsecured basis. The rate is calculated as an average, serving five currencies[7] and seven different maturities[8]. It accounts for the liquidity premiums that are included in the pricing of various instruments traded in the money market,

Table 1.1 summarizes the impact that the evolution of each of the previously described variables has on the exposure of a country to default risk. The relation is "Direct" whenever the variable and the sovereign risk of default move in the same direction. On

[6] Among the cited global major banks there are Bank of America, Barclays, Citibank, Deutsche Bank, JPMorgan Chase and UBS.
[7] The five currencies being cited are the euro, the British pound, the Swiss franc, the US dollar and the Japanese yen.
[8] The seven maturities are the overnight/spot next, one week, one month, two months, three months, six months and 12 months.

the contrary, the relation is “Inverse” whenever an increase in the variable level leads to a decrease in the exposure to default risk.

Table 1.1: How variables relate to sovereign default risk

VARIABLES	RELATION TO RISK OF DEFAULT
SOLVENCY VARIABLES	
Current account balance	Inverse
Debt / GDP	Direct
Real GDP growth rate	Inverse
LIQUIDITY VARIABLES	
International reserves	Inverse
Exports	Inverse
Inflation rate	Direct
VARIABLES REPRESENTING EXTERNAL SHOCKS	
Yield on US Treasury Bills	Direct
LIBOR	Direct

2 Asia on focus

The focus of our analysis is on 8 Emerging Market economies, all selected within Asian continent, namely China, India, Indonesia, South Korea, Malaysia, The Philippines, Taiwan and Thailand.

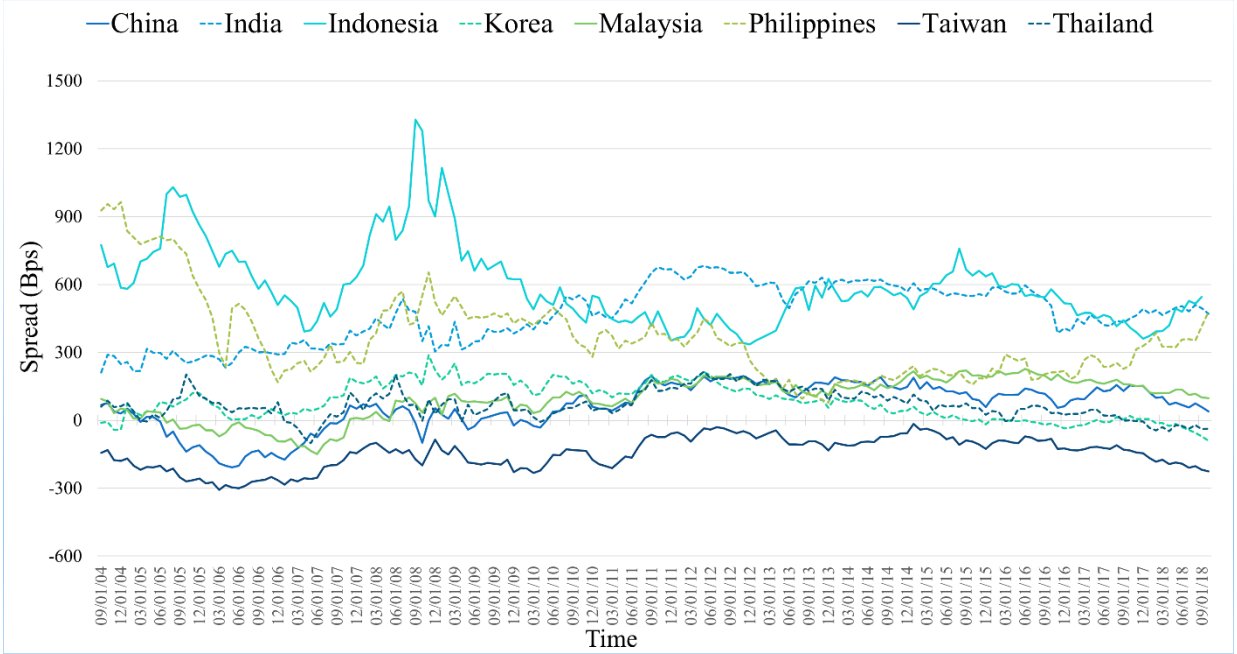
2.1 Some descriptive statistics

After an extended period of volatility, emerging market sovereign spreads have narrowed steadily since the first decade of the XXI century. The strengthening of sovereign debt performance is partially due to the improvement in global market sentiment that came after the resolution of the Euro Area debt crisis. Central banks took their role in announcing several liquidity-enhancing measures:

- the European Central Bank announced the Outright Monetary Transactions program for the conditional purchase of Euro Area sovereign bonds in unlimited amounts at the secondary market;
- the Federal Reserve announced bond-purchase programs and committed to keep interest rates at exceptionally low levels;
- the Bank of Japan announced additional monetary easing.

Industrial countries started experiencing exceptionally low yields and abundant liquidity market conditions. As a consequence, Emerging Market economies saw significant inflow of funds, pushing debt costs down.

Figure 2.1: Sovereign spreads on US 10-year Tbills

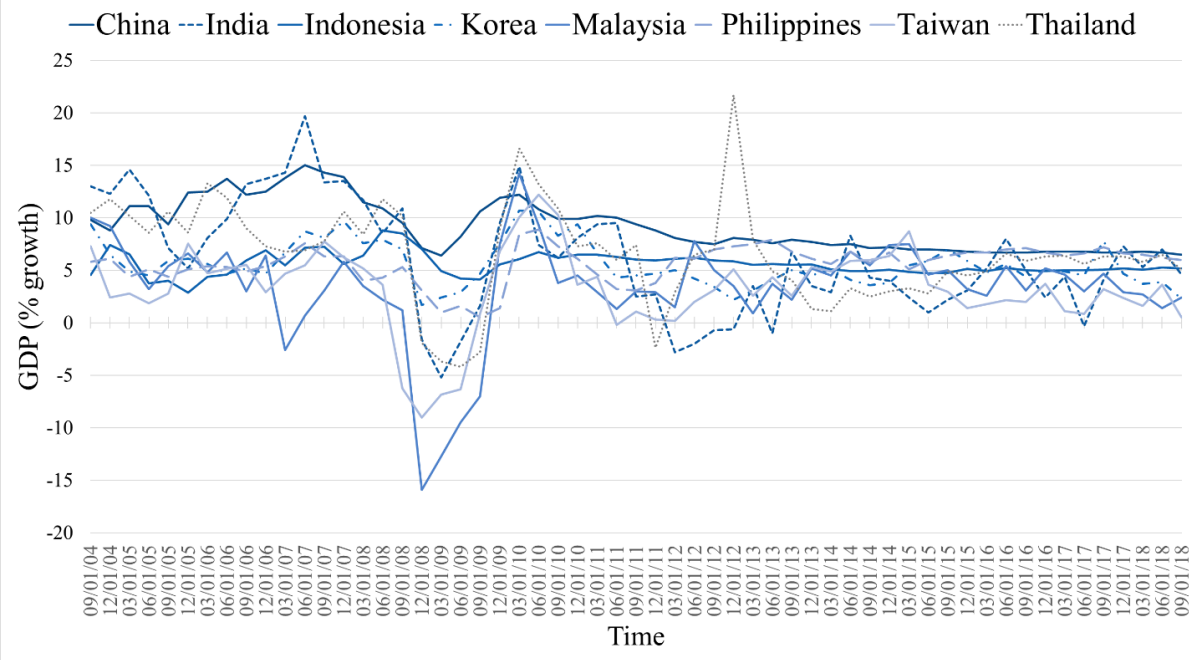


The eight Emerging Market economies selected for our analysis seem to follow the same path. Even if the starting-point level for each was different, the spread in yield on US 10-year T-bills decreased, as shown in figure 2.1. This narrowing trend was partially supported by significant reforms that some of these economies have been implementing: in Korea and Thailand, for example, banking sectors have been restructured, policies for keeping control of inflation have been adopted and more flexible exchange rate arrangements have been applied. Over the period under study, sovereign bond issues for Indonesia traded at the higher spread on average. Both, Indonesia and The Philippines recorded the higher volatility in sovereign spreads. A statistical summary is provided in the next table, reporting spread mean and standard deviation for each selected country:

Table 2.1: Statistical summary

Country	Label	Mean (Bps)	Standard Deviation (Bps)
China	CHI	60.66	101.79
India	IND	467.88	126.47
Indonesia	INS	591.56	177.91
Korea	KOR	80.51	81.71
Malaysia	MAL	96.25	89.82
The Philippines	PHI	357.85	181.97
Taiwan	TAW	-147.05	70.41
Thailand	THA	67.08	63.50
Total		**196.84**	**111.70**

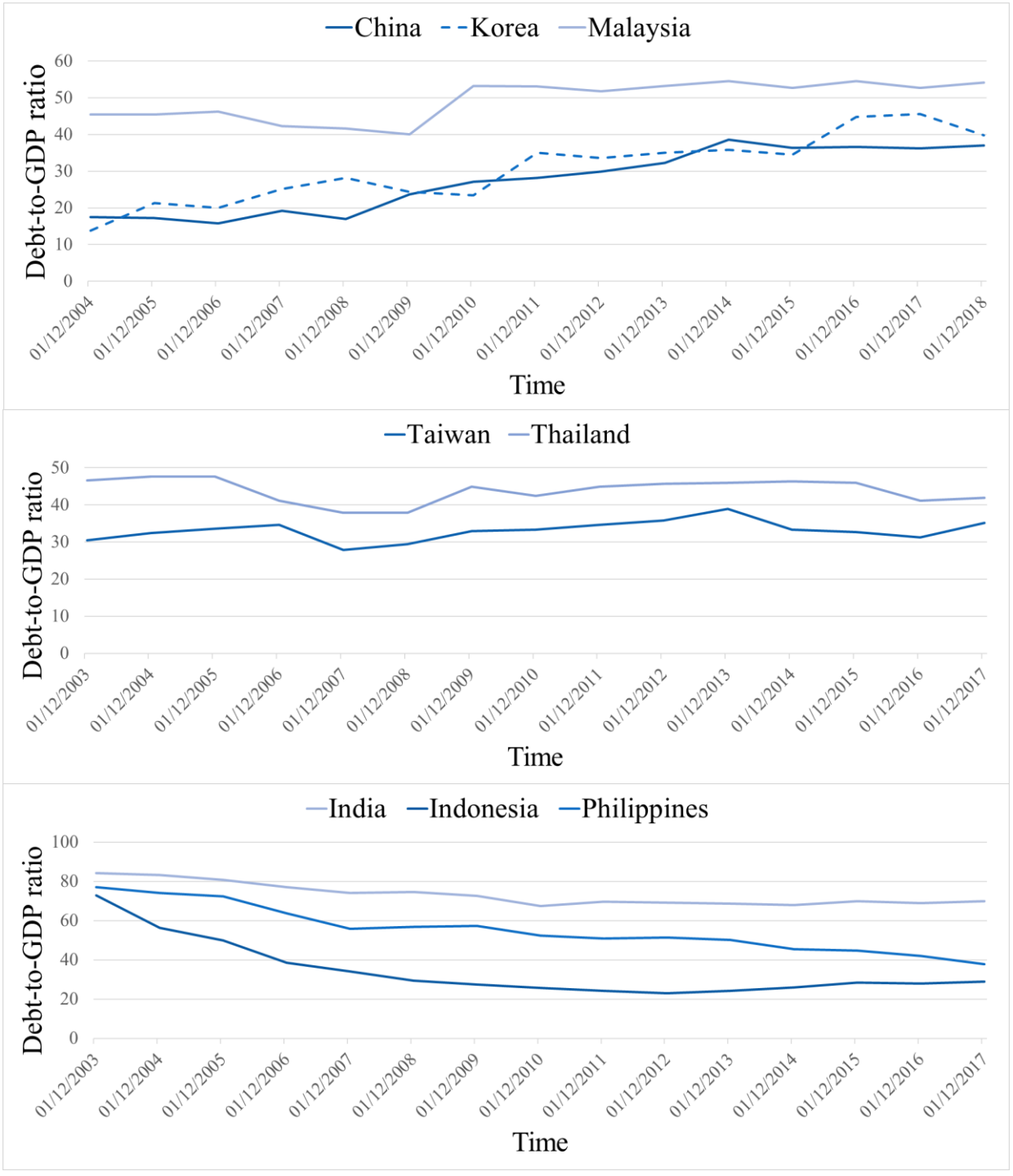
Figure 2.2: GDP growth rates



The strengthening of sovereign debt performance was also supported by good conditions in macroeconomic fundamentals. Figure 2.2 shows GDP growth rates taking on positive

values most of the time for each of the eight economies under study, except for India, Malaysia, Taiwan and Thailand: these four, in fact, experienced a negative growth in GDP around 2008 and 2009. Anyway, the expansion in economic activity seems to have started suffering from a general slowdown since 2010.

Figure 2.3: Debt-to-GDP ratios



When it comes to describing the level of debt-to-GDP ratios, selected countries need to be collected into three different groups. The first one is for countries whose debt as a percentage of GDP has significantly grown: China and Korea are representative examples, with debt-to-GDP ratios boosting from around 15% to almost 40%. The second group is for countries that have been keeping the ratios almost stable throughout the years: for Thailand the level of debt oscillated between 30% and 40%, while for Taiwan between 40% and 50%. The third group is for countries whose debt ratio has decreased over time: The Philippines and Indonesia experienced major drops, with the stock of debt passing from around 75% of GDP to around 30%.

2.2 The dataset

Before moving on, here is a brief description of the data that have been collected for the implementation of the analysis. The latter is conducted through the time window from September 2004 to December 2018, on a monthly basis for sovereign bond yields and on a quarterly basis for macroeconomic variables. The decision on how to structure the time window was dependent on the availability and the length of historical time series for macroeconomic data of each country, which have been downloaded from Bloomberg.

For what concerns country-specifics, variables included are:

- spreads have been calculated as the difference in yield between (i) each Asian emerging country's sovereign debt issues and (ii) US Treasury Bills, both with 10 years maturity. To be more precise:

  $$S_{i,t} = Y_{i,t} - Y_{US,t}$$

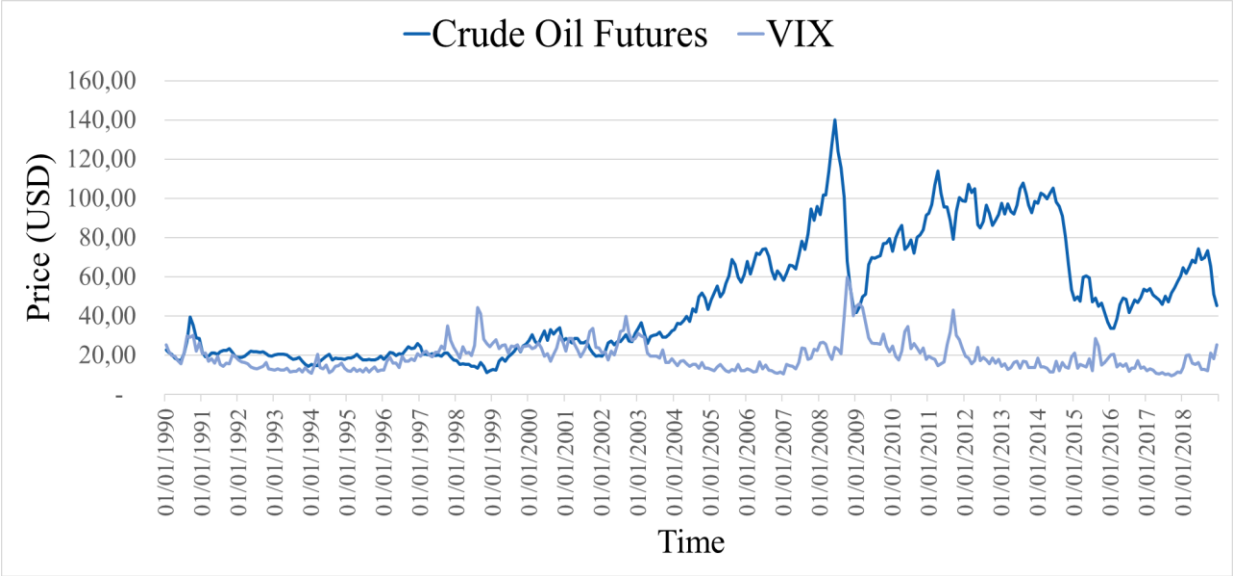
  where $S_{i,t}$ and $Y_{i,t}$ represent sovereign spread and sovereign bond yield for country $i-th$ at time t.

- GDP in real terms, valued at constant price, taken as a growth rate from one year to another.
- Exports from local sources, converted to USD currency using average exchange rate for a specific period (quarter).
- International reserves converted to USD currency.
- Current account balance as a percentage of GDP.
- Consumer price index taken as a growth rate year-on-year.
- Debt as a percentage of GDP.

For what concerns variables representing global financial conditions, those included are the historical prices for VIX, S&P 500 and crude oil futures, the quotations for LIBOR, EUR/USD exchange rate and the yield on US 3-months T-Bills.

VIX is often referred to as a good proxy market sentiment, perceived volatility and investors' risk appetite, the S&P 500 as the best gauge of US large-cap equities providing a quick look at global economy. The yield on US 10-years T-Bills is taken as a good proxy for global liquidity conditions, LIBOR as the reference rate when lending in the short-term. Prices of crude oil futures are considered as representative for market expectations on future inflation trend. Figures 2.4 and 2.5 are reported aiming at giving the bigger picture on global financial condition.

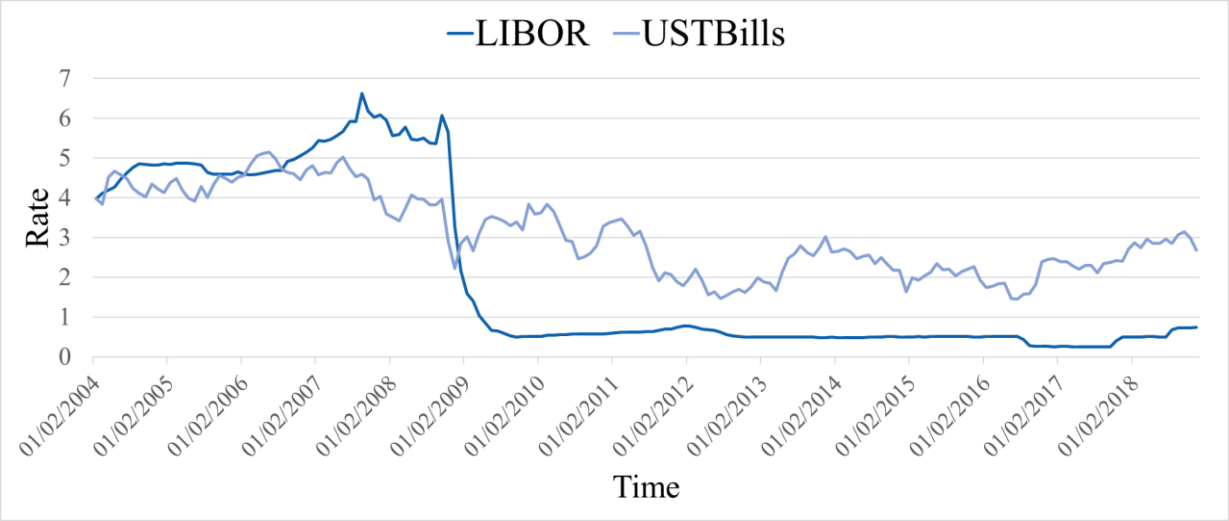
Figure 2.4: Historical prices for crude oil futures and VIX



The Volatility Index is a measure for market's expectation of short-term volatility, which is derived from the price inputs of the S&P500 index options. It is generally referred to as representative of market sentiment and investors' risk appetite. Positive deviations are a signal of financial markets tightening, while negative deviations are a signal of financial markets loosening. The peak recorder between 2008 and 2009 identifies the Great Recession that started from the collapse of the real estate market in the U.S.A., spreading both on the market economy through the lack of valuable assets and on the financial sector thought the breakdown of the banking system. For what concerns crude oil, it is believed that prices are sensitive to demand factors. A worldwide growth in output, especially in emerging markets, could be the main driver for pushing oil prices up, even if it has been proved that small shocks to oil supply or demand can result in large price movements over time[(9)].

[9] R. Arezki, Z. Jakab, D. Laxton, A. Matsumoto, A. Nurbekyan, H. Wang, J. Yao, *Oil prices and the global economy*, Working Paper WP/17/15 (International Monetary Fund, January 2017)

Figure 2.5: Historical rates for LIBOR and US T-Bills



As mentioned above, LIBOR is often referred to as a good proxy for global liquidity market conditions. The rate has steadily declined since 2010, on the heels of several quantitative easing announcements and liquidity-boost oriented monetary policies. It seems it has started rising in recent years. Increasing the supply of any good on the marketplace lowers its cost: the same happens to money. Increasing money supply lowers the cost of money, which means interest rates are lower as well. This is the reason why LIBOR and US T-Bills seem to follow the same path.

2.3 Stationarity

The information on whether a series is stationary or nonstationary is important whenever implementing an economic analysis. Stationarity requires the statistical properties of the series to be independent on the time at which the series is observed. If a series is nonstationary, conventional hypothesis tests, confidence intervals can be misleading. With the aim of finding a proper answer, the Kwiatkowski-Phillips-Schmidt-Shin test (forthwith referred to as KPSS test) has been performed on MATLAB through

the command "`kpsstest(__)`". The test returns a logical value for the rejection decision and the related p-value. The null hypothesis is that the series is trend stationary, against the alternative hypothesis that the series is unit root nonstationary. The test can be repeated over a range of lags. As suggested by Kwiatkowski et. al (1992), the number of lags should equal $\sqrt{T}$, where T stands for the length of the time series. Whenever the test gives back the value "0", it means there is not sufficient evidence for rejecting the null hypothesis at the specified confident level.

After performing the test, the null hypothesis of trend stationarity was rejected for several lags at significant confident levels for the following variables:

- Exports from local sources, converted to USD currency;
- International reserves converted to USD currency;
- Debt as a percentage of GDP;
- VIX;
- S&P500;
- Crude oil futures.

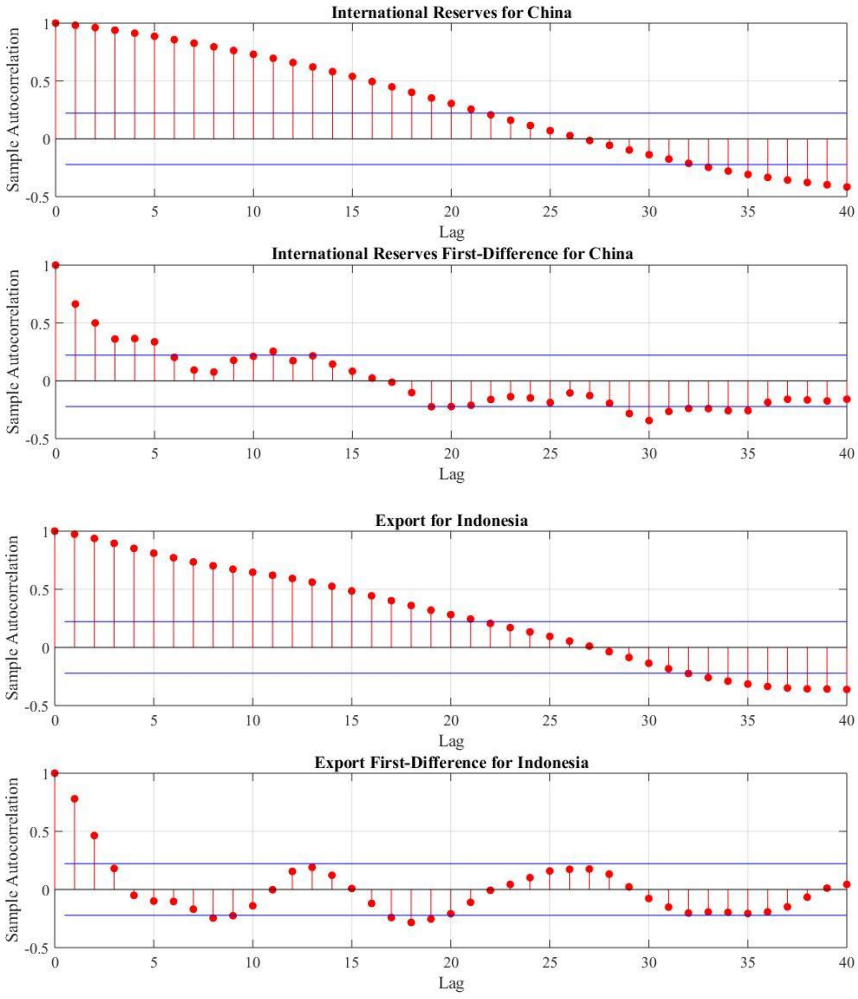
In order to make up for nonstationary macroeconomic series, those same series were manipulated by taking the first difference between consecutive observations. This technique is known as differencing. It can help stabilize the mean by removing changes in the level of the series, therefore reducing trend and seasonality. It was applied also for VIX. In order to make up nonstationary series of variables representing global financial conditions, prices for S&P500 and crude oil futures were transformed into rates of return as follows:

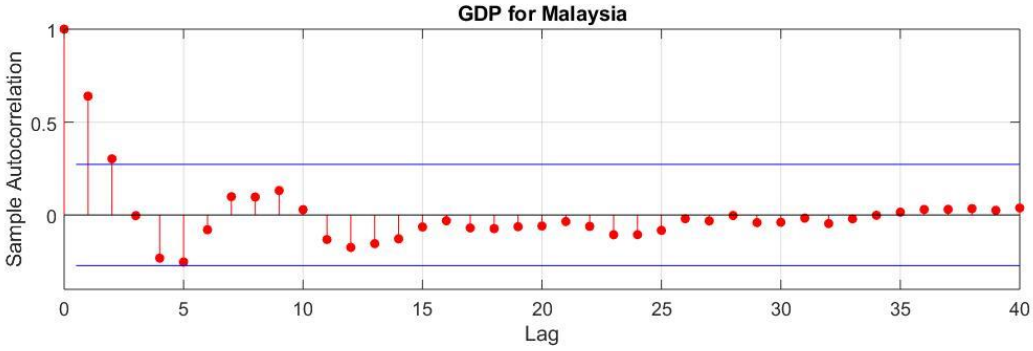
$$r_t = \frac{P_t - P_{t-1}}{P_{t-1}} .$$

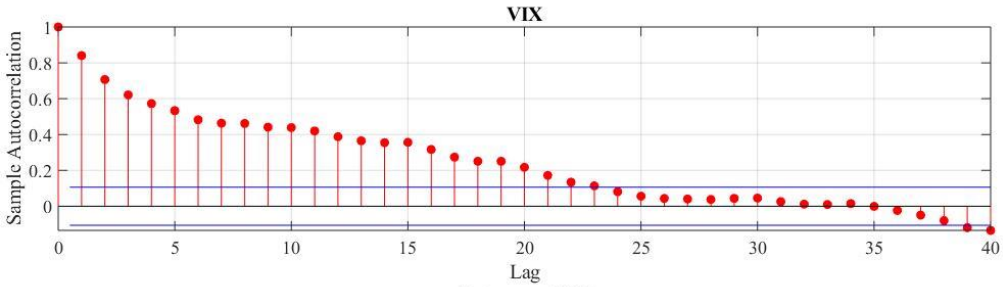
Apart from the variables cited above, the remaining series were not manipulated since no severe issues raised, even if with a statistical certainty above the 0.05 default confident level. The test was not run on the spread series since they are assumed to be stationary. By construction, the spread is defined as the difference in yield between two different securities, representing the excess return of one security on the other. A similar argument can be made for LIBOR, EUR/USD exchange rate and yield on US T-Bills.

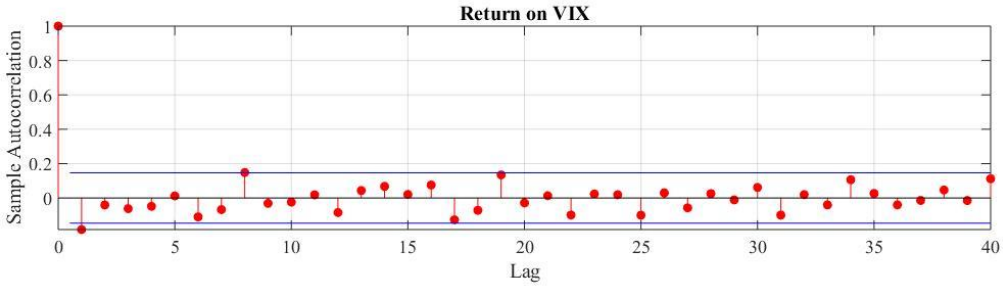
Apart from KPSS test, another way of assessing stationarity is looking at the ACF plot. For a stationary time series, the ACF drops to zero relatively quickly. In order to understand the impact of data manipulation on stationarity, few examples of ACF plot are reported below.

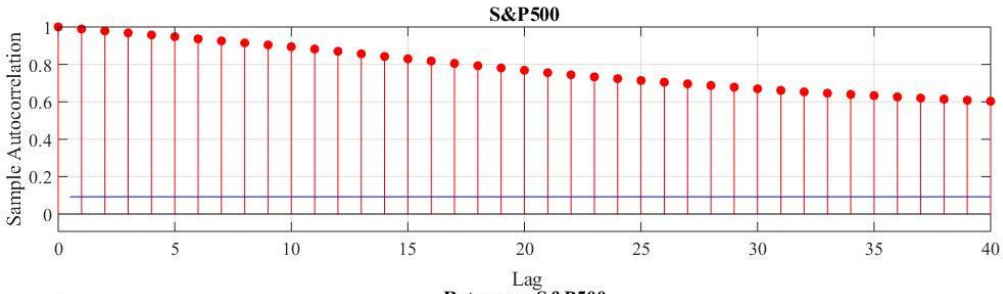
Figure 2.6: ACF plots




GDP for Malaysia
Sample Autocorrelation
Lag


VIX
Sample Autocorrelation
Lag


Return on VIX
Sample Autocorrelation
Lag


S&P500
Sample Autocorrelation
Lag


Return on S&P500
Sample Autocorrelation
Lag

2.4 Correlation in spreads

In order to understand better the dataset we are dealing with, it could be useful to analyse the correlation in sovereign spreads between the Emerging Market economies on focus.

Table 2.2: Correlation for spreads

Country	CHI	IND	INS	KOR	MAL	PHI	TAW	THA
CHI	**1.00**	0.84	-0.49	0.02	0.85	-0.40	0.91	0.35
IND	0.84	**1.00**	-0.48	0.10	0.78	-0.56	0.82	0.45
INS	-0.49	-0.48	**1.00**	0.25	-0.31	0.51	-0.30	0.06
KOR	0.02	0.10	0.25	**1.00**	-0.13	0.20	0.16	0.57
MAL	0.85	0.78	-0.31	-0.13	**1.00**	-0.36	0.82	0.25
PHI	-0.40	-0.56	0.51	0.20	-0.36	**1.00**	-0.40	-0.03
TAW	0.91	0.82	-0.30	0.16	0.82	-0.40	**1.00**	0.50
THA	0.35	0.45	0.06	0.57	0.25	-0.03	0.50	**1.00**

Let us leave a comment on the correlation coefficients reported in table 2.2: China shows a strong positive correlation with India, Malaysia and Taiwan, a significant positive correlation with Thailand, a negative correlation with Indonesia e The Philippines. Korea shows low correlation with the rest of the group, except for Thailand. Taiwan shows a significant positive correlation with Thailand, and a little negative correlation with Indonesia and The Philippines. Well, it is not necessary to move further before understanding that the framework is quite fragmented.

When evaluating co-movements in sovereign spreads over the stated time horizon, three groups arises.

1. The first group comprises China, India, Malaysia, Taiwan and Thailand.

Country	CHI	IND	MAL	TAW	THA
CHI	**1.00**	0.84	0.85	0.91	0.35
IND	0.84	**1.00**	0.78	0.82	0.45
MAL	0.85	0.78	**1.00**	0.82	0.25
TAW	0.91	0.82	0.82	**1.00**	0.50
THA	0.35	0.45	0.25	0.50	**1.00**

2. The second group includes Indonesia and The Philippines.

Country	INS	PHI
INS	**1.00**	0.51
PHI	0.51	**1.00**

When implementing single-country regressions[(10)], few insights arise. The estimated β*s* for both Indonesia and The Philippines highlight two a heavy reliance of sovereign spreads on GDP growth rate: growth of domestic product for these two economies attained at ~5% on average and was the most stable ones over the time window under study. Regarding the others, the impact GDP had on sovereign spreads was not remarkable. Another noteworthy fact is that these two economies experienced the greatest reductions in debt-to-GDP ratio: such fundamental seems to have had a strong significant positive impact on sovereign spreads.

[(10)] Single-country regressions were singularly implemented for every country, considering the sovereign spread as dependent variable and each of the six macroeconomic factors as regressors. Residuals os such regressions are provided in the Appendix-Figure A.

3. The third group is for Korea, showing very little correlation with the rest, except for Thailand.

Country	CHI	IND	INS	KOR	MAL	PHI	TAW	THA
KOR	0.02	0.10	0.25	**1.00**	-0.13	0.20	0.16	0.57

For countries belonging to the same group, sovereign spreads move in the same direction, with correlation coefficients between 0.84 and 0.91 for the first, and 0.51 for the second.

Country	CHI	IND	MAL	TAW	THA
INS	-0.49	-0.48	-0.31	-0.30	0.06
PHI	-0.40	-0.56	-0.36	-0.40	-0.03

When looking at intragroup co-movements, spreads for countries belonging to the first and second group move in the opposite direction, with correlation coefficients between negative 0.30 and negative 0.56, while spreads for Korea seem to stand by their own. It could be indicative of the different perception investors have of the different countries. Let us consider the following: in recent years, South Korea saw considerable inflows of foreign investments into local government bonds' market, careless of persistent political tensions around Northern region. Market seems to retain a stable outlook on the country's economic fundamentals and credit rating, on the heels of the position taken by Fitch Rating. In fact, the agency placed Korea above China and Japan when assigning its own rate. In this scenario, trading war between USA and China might have played a relevant role.

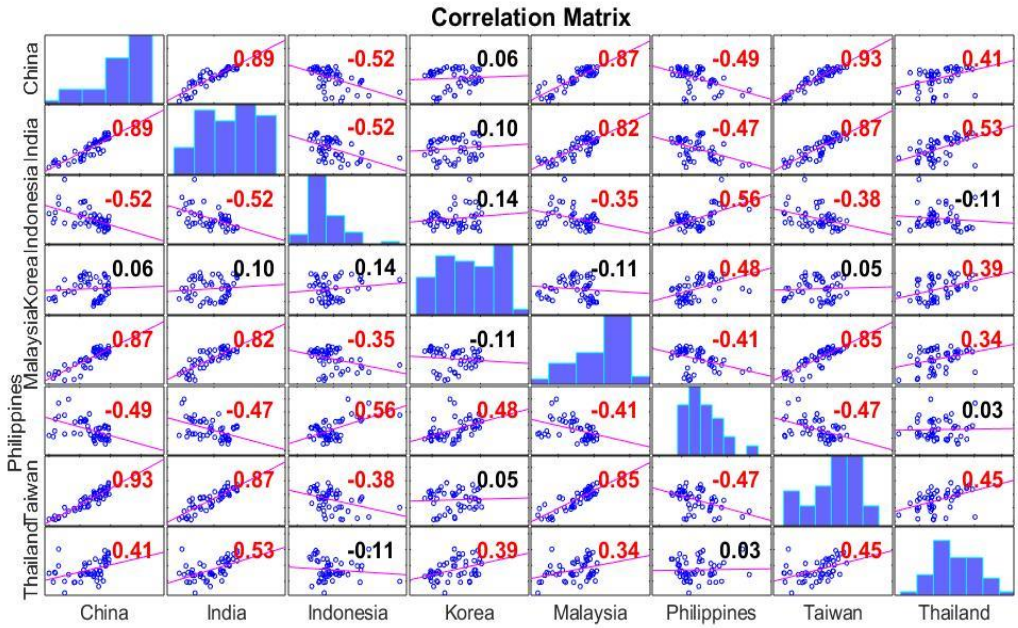
The table below summarizes recently released sovereign ratings.

Table 2.3: Sovereign ratings from main agencies

Country	Moody's	S&P	Fitch
China	A1	A+	A+
India	Baa2	BBB-	BBB-
Indonesia	Baa2	BBB	BBB
Korea	Aa2	AA	AA-
Malaysia	A3	A-	A-
The Philippines	Baa2	BBB+	BBB
Taiwan	Aa3	AA-	AA-
Thailand	Baa1	BBB+	BBB+

Figure 2.7 provide the same data on spreads correlation already provided in table 2.2, with the additional information of significance tests indicator. Significant correlations at the default confidence level of 0.05 are highlighted in red in the correlation matrix plot.

Figure 2.7: Correlation Matrix for spreads



3 The definition of the econometric framework

3.1 A guideline through the choice of determinants

When it comes to defining which determinants affect sovereign spreads the most, there are various different approaches one could opt for, in order to conduct the empirical analysis. Among others, panel data, also known as longitudinal data, seem to perform well when applied, since they collect the pooling of observation on a cross-section of units[(11)], surveyed over several time periods. Despite other approaches, panel data control for individual heterogeneity so as to reduce the possibility of both suffering from misspecification and obtaining biased results. It is efficient in providing more reliable parameter estimates, since the cross-section dimension adds more information so as to give less collinearity. It is better suited for studying the dynamics of change, since it allows for the estimation of inter-temporal estimation. Panels allow for the construction and testing of more complicated models, alleviating aggregation bias. However, this estimation technique is not exempt from weaknesses. Few assumptions are required in order to overcome such deficiencies. Among others, the necessary assumption to be made for the asymptotical arguments to hold is that the number of individuals tends to infinity.

[(11)] The agents usually being surveyed are firms, industries and countries. In this case, cross-sectional units are countries.

The model[12] to be considered as the starting-point is the following:

$$Y_{it} = \alpha_{1it} + \sum_{k=2}^{K} \alpha_{kit} X_{kit} + u_{it}$$

where $i = 1,2, \dots, N$ refers to the different countries serving as the cross-sectional unit, $t = 1,2, \dots, T$ refers to a given time period, and $k = 1,2, \dots, K$ identifies the specific explanatory variables. Accordingly, Y_{it} is the value of sovereign spread or creditworthiness for the *i*th country at time *t*, both serving as dependent variable. Moving on, X_{kit} is the value of the *k*th non-stochastic determinant for individual *i* at time *t*. The stochastic error term u_{it} is assumed to have zero mean and constant variance. The term α_{kit} needs a more detailed examination: it represents the unknown response coefficients. There are several restrictions that can be imposed on these coefficients, depending on whether the different behaviour of the agents is reflected in the intercept only or not. One could assume to keep all coefficients constant, letting the differences over time and individuals be captured by the disturbances. Or else, one could assume to keep just the slope coefficients constant, letting the intercept vary over individuals, or over individuals and time. One could furthermore let all coefficients vary over time, or over time and individuals.

When the assumption to be made is that all coefficients are constant, it means that individual components are suppose not to exist and differences are captured by the disturbance terms. In such of a framework, OLS is the best linear unbiased estimator.

Once the framework described above has been rejected, the next question to be answered is whether to assume a constant or variable intercept. The decision can be made with the support of the Hausman test[13], where the null hypothesis is that the individual effects are random. An alternative could be to follow Judge et. al. suggestion: if the individual

[12] The model follows Judge et. al. (1985).
[13] The Hausman test is a statistical hypothesis test used in econometrics in order to evaluate the consistency of an estimator when compared to an alternative one, which is already known to be consistent but less efficient, in terms of minimum variance unbiased estimator.

effect from unit *i* is correlated with the explanatory variable of unit *i* and this happens for all *i*, then the best choice are fixed effects.

Once one has chosen between a constant or variable intercept, the next question to be answered is whether the slope coefficients are fixed or variable. Once again, the decision can be made by previously determining whether or not there is correlation between the response coefficient and the explanatory variable both assigned with unit *i*, this holding for all *i*. When assuming fixed response coefficients, the "Seemingly Unrelated Regression" model seems to be appropriate for the estimation. On the other hand, when assuming variable slope coefficients, a random coefficient model should be more efficient, since it allows for additional information.

Table 3.1 synthetically represents all of the possible estimation techniques with regard to the different settings.

Table 3.1: Possible estimation in a panel data framework

Is the different behaviour of the agents only reflected in the intercept?	
Yes - Intercept approach	No - Slope approach
• *OLS*, when coefficients are all constant • *Dummy variable model*, when the intercept is constant • *Error components model*, when the intercept is variable	• *SUR*, when slope coefficients are fixed • *Random coefficients model*, when slope coefficients are variable

Several different authors have been writing papers on the problem of identifying the relevant determinants when using empirical analysis and yet no one knows for sure the *true* regression. No one knows exactly how many variables or which variables to include. In fact, each paper typically reports a sample of regressions ran by the researchers with different conclusions.

3.2 The role of Principal Component Analysis

Principal component analysis, forthwith referred as PCA, is a mathematical methodology for analysing time series' statistical properties. Claiming a very long history, the first to write about it were Pearson (1901) and Hotelling (1933), even if Litterman and Scheinkman (1991) were the first to apply PCA to financial data. Their scope was to calculate the first three principal components from the excess returns over the overnight interest rate for U.S. bonds for different maturities up to 30-year. They gave the general name of "factors" to the principal components they found, and then they better specified the name of the first factor as "*level*", the second factor as "*steepness*" and the third factor as "*curvature*". Their paper has been very influential in the subsequent literature on curve structure models and these latent factors have become standards for the fast-growing literature in this area. PCA has also been applied to different financial asset classes: U.S. Treasury bond yield spreads, Emerging markets sovereign spreads, corporate spreads, stock returns, swap rates, exchange rates and derivatives to be mentioned among others.

The methodology has three main purposes: (i) the transformation of a set of correlated variables into a set of uncorrelated variables; (ii) the search for a linear combination of variables with relatively large or small variability; and (iii) the dimensionality reduction of a dataset of correlated variables, while keeping as much of the variability as possible.

These purposes are achieved by applying an orthogonal linear transformation to the original variables. The outputs of the linear transformation take the name of *principal components* and they form a coordinate system in such a way of having the greatest variance lying on the first principal component, the second greatest variance on the second principal components, and so on and so forth. Said in another way, the analysis turns out to be mainly relevant for delivering a lower-dimensional picture of the data from its most informative perspective.

In algebraic notation, consider the dataset as represented by the random vector

$$\hat{X} = [X_1\ X_2\ \dots X_N].$$

The variance-covariance matrix of $\hat{X}$ is

$$Var(\hat{X}) = E\left[(\hat{X}\ -\ \mu_{\hat{X}})(\hat{X}\ -\ \mu_{\hat{X}})^T\right] = \hat{\Sigma}. \qquad (1)$$

The first principal component is a column vector $(Nx1)$ derived from the linear function of $\hat{X}$, defined as

$$PC_1 = \beta_1{}' * \hat{X}.$$

Such of a function maximizes

$$Var(\beta_1{}' * \hat{X}) = \beta_1{}' * \hat{\Sigma} * \beta_1, \qquad (2)$$

subject to constraint

$$\beta_1{}' * \hat{\Sigma} * \beta_1 = 1. \qquad (3)$$

This implies that β_1 is the eigenvector[(14)] corresponding to the largest eigenvalue[(15)] of $\hat{\Sigma}$, say λ_1. Geometrically, the eigenvector points in the direction that is stretched by the

[(14)] The eigenvector of a linear transformation is a non-zero vector that changes by only a scalar factor when the linear transformation is applied to it. In essence, an eigenvector v of a linear transformation T is a non-zero vector that, when T is applied to it, does not change direction.

[(15)] In linear algebra, eigenvalues are a set of scalars associated with a linear system of equations. They are sometimes also known as characteristic roots. Each eigenvalue is paired with a corresponding eigenvector. The

transformation and the eigenvalue is the factor by which it is stretched. In this framework, eigenvalues represent the total amount of variance that can be explained by a given principal component: eigenvalues close to zero imply multicollinearity among items, since all the variance can be taken up by the first component. Each eigenvalue is associated with a vector of weights, called the eigenvector: the eigenvector times the square root of the eigenvalue gives the component loadings, which can be interpreted as the correlation of each item with the principal component.

To obtain the second principal component,

$$PC_2 = \beta_2' * \hat{X},$$

it is necessary to follow the same former procedure, with the addition of a new constraint as to impose that PC_1 and PC_2 are uncorrelated, that is

$$\beta_2' * \beta_1 = 0. \qquad (4)$$

It is clear that β_2 is the eigenvector corresponding to the second largest eigenvalue of $\hat{\Sigma}$, say λ_2.

This same procedure continues until one obtains the N^{th} principal component. In the end,

$$PC = [PC_1\ PC_2 \ldots PC_N]$$

it is the matrix whose columns are all the "ordered" principal components. By definition,

$$PC = \beta' * \hat{X} \quad (\text{where } \beta = [\beta_1\ \beta_2 \ldots \beta_N]) \qquad (5)$$

determination of eigenvalues and the associated eigenvectors of a linear system is equivalent to matrix diagonalization and arises in such common applications as stability analysis. Let us consider T to be a linear transformation from a vector space V over the field F into itself. Let $v \in V$ be a non-zero vector. Then, v is an eigenvector of T if the following condition holds:

$$T(v) = \lambda v,$$

where λ is a scalar in the field F, known as eigenvalue.

β is the matrix whose columns are the "ordered" eigenvectors, that is β_1 is the eigenvector corresponding to the largest eigenvalues of $\hat{\Sigma}$, β_2 is the eigenvector corresponding to the second largest eigenvalues of $\hat{\Sigma}$ and so on until β_N.

It is possible to prove that

$$Var(PC) = \beta' * \hat{\Sigma} * \beta = \Lambda \quad \text{where } \Lambda = diag[\lambda_1\ \lambda_2 \ldots \lambda_N]) \qquad (6)$$

Λ is the matrix having on its diagonal, ordered by size, the eigenvalues corresponding to $\hat{\Sigma}$ and zero-elements elsewhere.

The ultimate goals that PCA is mainly performed for are conducting explanatory data analysis and making predictive models. Once the data have been collected, the analysis can be done through two alternative methods: (i) the eigenvalue decomposition of either the covariance or the correlation matrix, or else (ii) through the singular value decomposition of the data matrix itself, which is also known as the classical PCA.

After the analysis is completed, there comes the time to discuss the results: the transformed variable observations are usually referred to as *factor scores*, while *factor loadings* represent the weight that each initial observation is multiplied for in order to get the scores. When running a classical PCA, given that the columns of the matrix responsible for the linear transformation are made of factor loadings, their eigenvalues represent the variance of each principal component.

4 The empirical results

4.1 Fixed effects regression model

Consider the panel regression model

$$Y_{it} = \alpha_i + \sum_{k=1}^{K} \beta_k X_{k,it} + u_{it}$$

for $i = 1, \ldots, n$ representing the number of the Asian emerging countries under study, $k = 1, \ldots, m$ representing the number of both macroeconomic and international variables, and $t = 1, \ldots, t$, representing the time-series length. The dependent variable Y_{it} identifies the sovereign spread, the regressors $X_{k,it}$ identify both macroeconomic and international variables. The coefficients α_i represent the country-specific intercept capturing heterogeneities across countries. The coefficients β_k measure the effect on the dependent variable of changes in the regressors. The u_{it} capture the disturbance terms: it is a catch-all for differences between predicted and observed values of the dependent variable. The model is a static one, in the sense that the system is represented as responding exclusively to current events.

In such framework, estimates are computed through "Ordinary Least Squares". The assumptions that need to hold in order for OLS to provide unbiased estimates normally distributed in large samples are listed below:

i. The error terms u_{it} are uncorrelated with all observations of X for the entity i over time, meaning they have conditional mean equal to zero:

$$\mathrm{E}(u_{it} | X_{1,it}, X_{2,it}, \ldots, X_{k,it}) = 0.$$

ii. $(X_{1,it},\ X_{2,it}, \ldots,\ X_{k,it},\ u_{i1},\ u_{2t}, \ldots,\ u_{iT})$ are i.i.d draws from their joint distribution. Both the X_{it} and the u_{it} are allowed to be autocorrelated within entities[16].

iii. $(X_{k,it},\ u_{it})$ have nonzero finite fourth moments.

iv. There is no perfect multicollinearity.

Whenever these assumptions hold, the Gauss-Markov theorem states that OLS coefficients' estimates are BLUE, meaning the linear unbiased estimators with the minimum variance. If the innovations u_{it} are normally distributes, the β_k will be normally distributed as well: such condition allows the β_k to achieve the Cramér-Rao lower bound, with estimates equal to the maximum likelihood estimator, the most efficient achievable in terms of minimum variance. Let us now present the model implementation and comment on the results achieved[17].

The initial regression was run on six macroeconomic variables (namely GDP growth rate, exports, international reserves, current account balance, consumer price index and amount of debt) and six international variables (namely VIX, S&P 500, LIBOR, crude oil futures, EUR/USD exchange rate and US 3-months T-Bills yield). Some of these variables resulted to be not statistically significant for explaining the dynamics of sovereign spreads, so they were excluded once at the time. This same procedure was iterated until a robust set was found. The variables being ultimately excluded are: exports, international reserves, crude oil futures and EUR/USD exchange rate.

[16] This is a common property of time series data.
[17] The model was implemented in Gretl.

Over the time period from September 2004 to December 2018, across the selected Asian Emerging Market economies, sovereign spreads seem to have been affected by movements in global financial conditions with a stronger impact than macroeconomic fundamentals. Macroeconomic factors result statistically significant in explaining the dynamics of sovereign spreads indeed, but with only a milder impact. The related coefficient estimates are all close to zero. On the other side, the marginal contribution of each regressor related to the international economic scenario is relevant, except for VIX. Regression results are reported in table 4.1.

Table 4.1: Regression results in details

Model: Fixed-effects, using 408 observations
Included 8 cross-sectional units
Time-series length = 51
Dependent variable: Spread

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
Intercept	−0.955	0.4053	−2.356	0.0190	**
GDP	−0.029	0.0143	−2.024	0.0437	**
CAB	−0.095	0.0179	−5.336	<0.0001	***
CPI	−3.394e-07	2.0862e-06	−1.627	0.1045	
Debt	0.072	0.0080	9.062	<0.0001	***
VIX	0.0192	0.0069	2.794	0.0055	***
SP500	−1.709	1.0624	−1.609	0.1084	
LIBOR	0.234	0.0591	3.959	<0.0001	***
USTBills	−0.387	0.0721	−5.366	<0.0001	***

Mean dependent var	1.954346	S.D. dependent var	2.567824
Sum squared resid	367.8738	S.E. of regression	0.968738
LSDV R-squared	0.862920	Within R-squared	0.333052
LSDV F(15. 392)	164.5096	P-value(F)	1.3e-158

The level of debt-to-GDP is traditionally considered as one of the leading drivers of the cost of debt for governments. For assessing the impact that such variable had on sovereign

spread, it is necessary to look at the single-country regressions. The coefficient estimates are remarkable only for India ($+0.929$) and the The Philippines ($+0.433$): IMF rated India as the 10^{th} global economy in nominal terms and global markets seem to have prised the nation for its improvements.

Perhaps, one of the most interesting results is that the $\hat{\beta}$ for the returns on the S&P 500 is statistically different from zero at around 0.1 confident level: the returns on the index seem to have negatively affected sovereign spreads, with a marginal contribution of -1.709. This result is in line with the findings of Longstaff et al. (2011): throughout his works, he found evidence that shocks in the US financial markets are transmitted globally. In fact, it is thought that US security prices embrace information on economic fundamentals and market liquidity that is relevant on a broad cross-section of countries located worldwide. An insight on the sign of the relation could be the following: increasing returns on the index generally signal improved risk appetite, leading to a narrowing in sovereign spreads. Such argument is supported also by the results on VIX. As expected, VIX was positively associated with spreads, even if the magnitude of the impact was close to zero. The index is commonly known as "Fear index": when its value increases, it means the volatility perceived by investors' increases as well, so we have higher risk aversion on the market tighter (looser) liquidity caused sovereign spreads to widen and vice versa.

The yield on US 3-months T-Bills resulted as having a statistically significant negative relation to sovereign spreads. The related $\hat{\beta}$ takes the value of -0.387. If considering the yield as a measure of global liquidity, one should expect the relation to be positive, since abundant liquidity conditions (i.e. low short-term interest rates on US Treasuries) are expected to reduce sovereign spreads, and vice versa. The meaning of the negative relation needs to be found elsewhere. One could argue, for instance, that in periods of abundant global liquidity, low global interest rate environment leads to an excess supply of bonds and hence higher sovereign spreads. Or else, as stated above, one could take the yield on US T-Bills as a measure of market sentiment: the higher the risk aversion, the

lower the yield and so the higher the spread.

There is sufficient statistical evidence for stating that the London Interbank Offered Rate played its role in defining the dynamics of sovereign spreads, with an estimated coefficient of around 0.23. LIBOR's movements seem to have pushed sovereign spreads in the same direction. If considering the rate as representative of the yields-level in industrial countries, sovereign debt costs for our eight Asian emerging countries seem to have followed the same heels.

4.2 Estimates reliability

It is important to mention that economic data usually have limited frequency, low variability and strong interdependencies. The researcher can often find himself dealing with several practical limitations, leading to issues with the reliability of OLS estimates and standard statistical techniques applied to model specification. When this happens, practical solutions can be limited but a careful analysis can help to identify the sources and degree of the problem. Our main goal here is to identify the boundary lines where the framework works.

Useful information is provided by the *R*-squared or coefficient of determination, which is a measure assessing how well the model describes the data. To be more precise, it represents the percentage of variability in the response being explained by regressors. It is calculated as the ratio of the explained sum of squares to the total sum of squares, namely

$$R^2 = \frac{ESS}{TSS}.$$

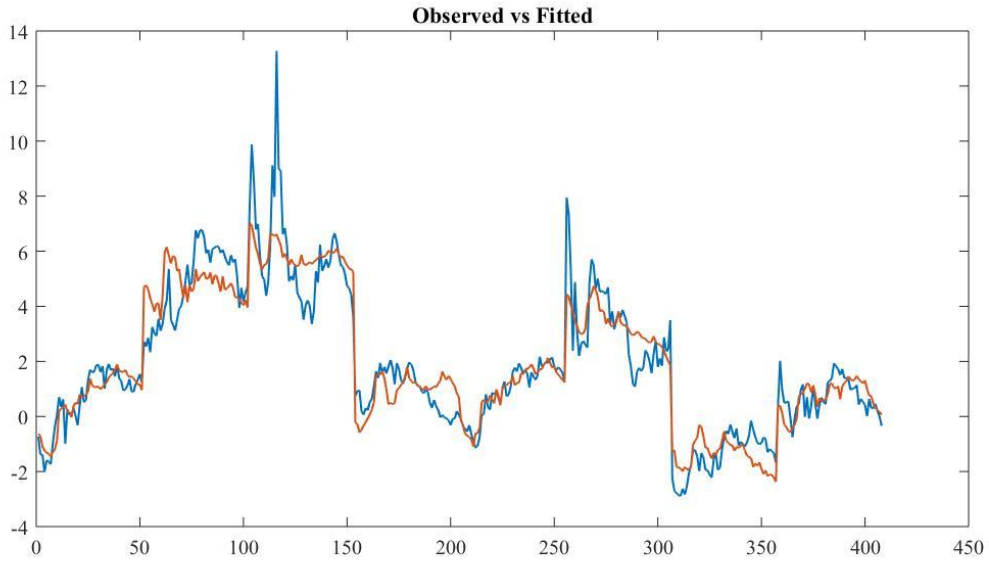
It can also be expressed as

$$R^2 = 1 - \frac{SSR}{TSS},$$

where SSR is the sum of squared residuals, a measure assessing the variability in the response variable that is not explained by the regressors but all other factors. Another way of looking at the same object is through the F-statistic: the larger the value taken by the statistic, the larger the ratio of explained variability to unexplained variability.

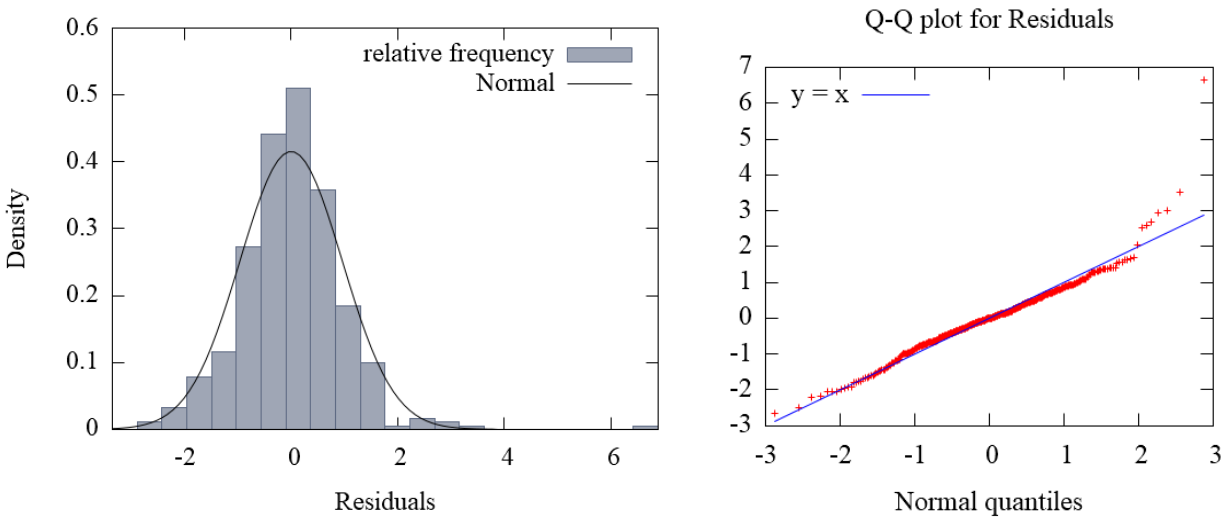
For what concerns our regression, the explanatory variables are able to assess more than 86% of the variability in the response, with a standard error of ~0.969. It is useful to look at the standard error of the regression for assessing the magnitude of a typical deviation from the regression line. Figure 4.1 helps visualising how well the model fit the data.

Figure 4.1: Observed versus Fitted



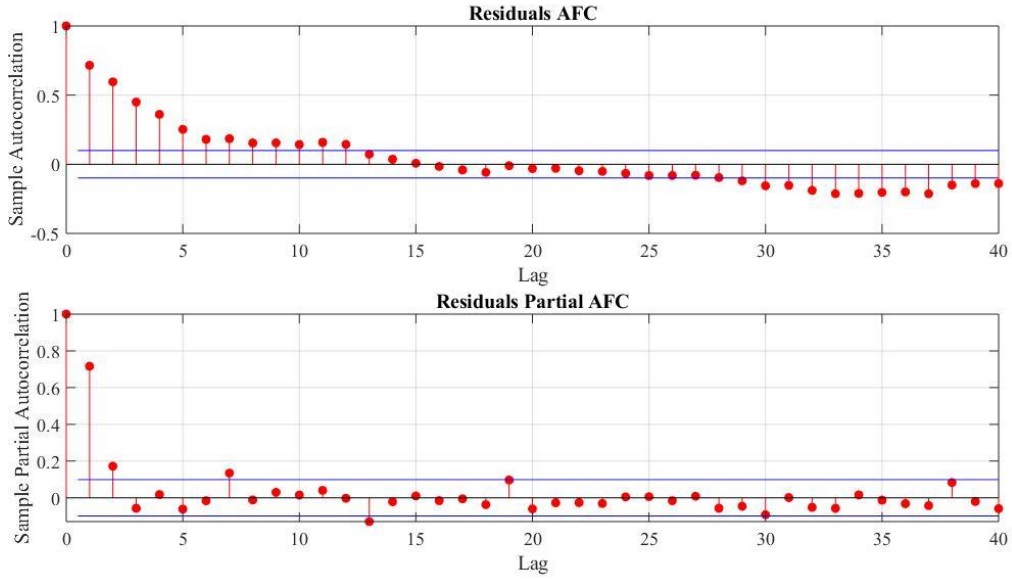
The residuals embrace useful information on the reliability of our model as well. Let us exploit such information through residuals diagnostics.

Figure 4.2 and 4.3: Assessing residuals' normality



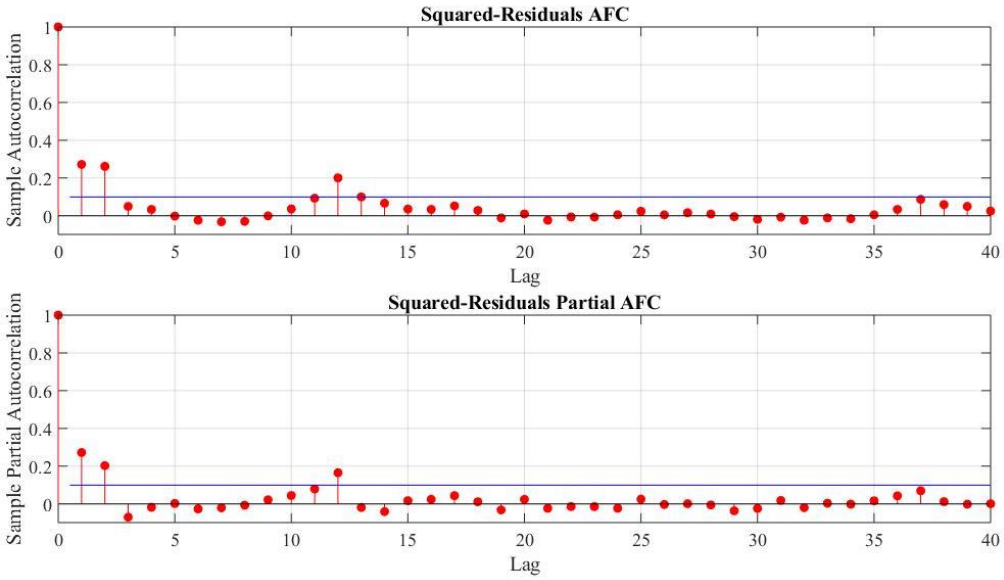
As already stated, a common assumption of time series models is a Gaussian innovation distribution. Figures 4.2 and 4.3 seem to suggest our residuals are distributed approximately alike the normal distribution.

Figure 4.4: Assessing residuals' autocorrelation



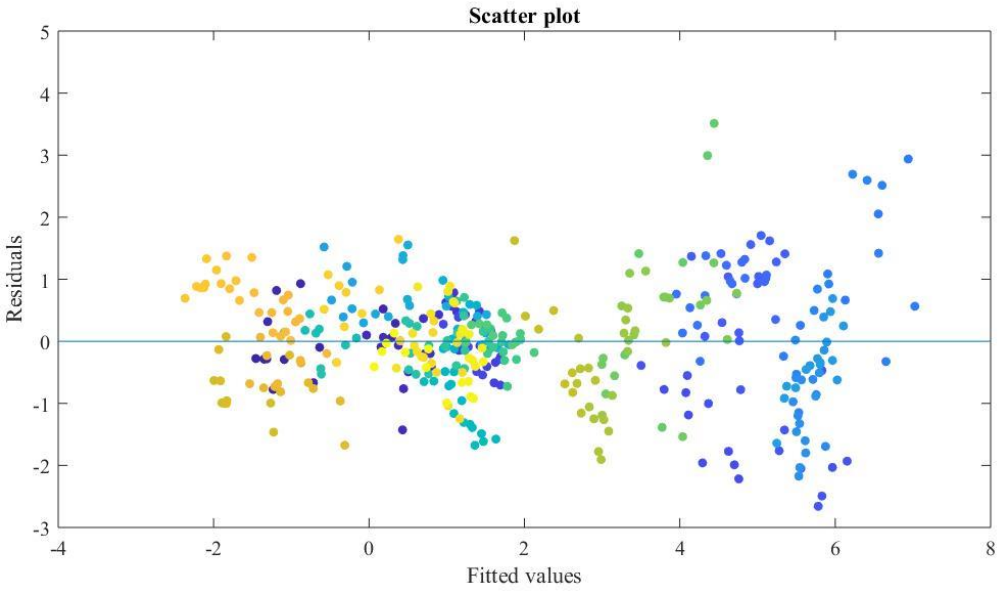
Plotting the sample autocorrelation function and partial autocorrelation function is an informal way to check for residuals' autocorrelation. They show little autocorrelation.

Figure 4.5: Assessing residuals' heteroskedastcity



Plotting the sample ACF and partial ACF of the squared residuals is an informal way to infer residuals and checking them for heteroskedasticity. An alternative way is to look at the scatter plot of residuals over fitted values, displayed in figure 4.6.

Figure 4.6: Assessing residuals' heteroskedasticity



Heteroskedasticity can be interpreted as a systematic change in residuals' variance, which is assumed to be constant instead. While it does not cause the coefficient estimates to be

biased, it does affect their precision and tends to produce *p*-values that are smaller than they should be. OLS is not performed for detecting heteroskedasticity: when the variance of coefficient estimates is higher, OLS calculates the F-values using an underestimated amount of variance. Anyways, by looking at the plot, it seems the variance of the residuals to be quite constant across the range of fitted values.

4.3 Commonalities

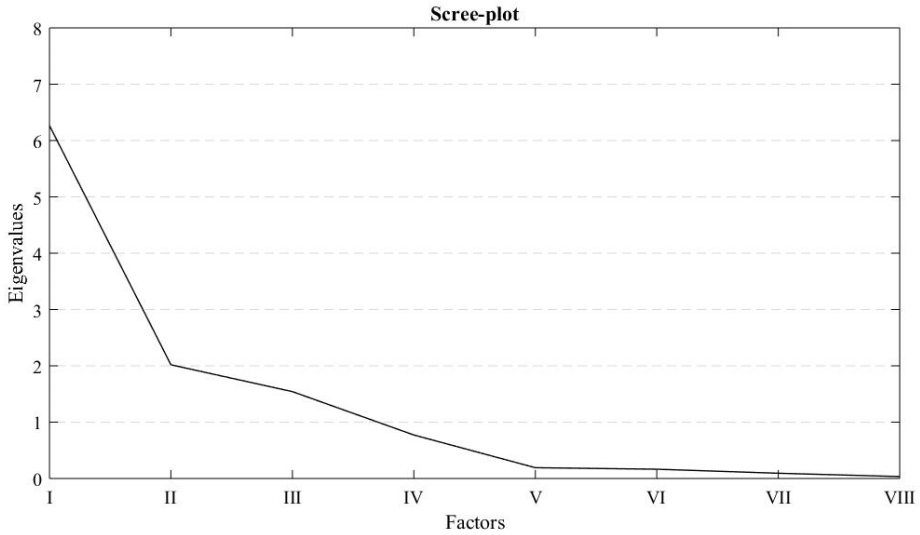
Classical PCA was run through MATLAB code "`pca(__)`". Let us leave a comment on the results achieved. Table 4.2 reported below suggests that the first and the second principal components explain around 56% and 18% of the spread respectively. If summed together, they explain around 75% of the spread. When it comes to fixing the number of common factors, a common approach is to simply look at the number of eigenvalues larger than one.

Table 4.2: Summary of PCA on spreads matrix

Principal Component	Explained	Eigenvalues
I	56.53%	6.27
II	18.21%	2.02
III	13.92%	1.54
IV	6.97%	0.77
V	1.73%	0.19
VI	1.49%	0.16
VII	0.84%	0.09
VII	0.31%	0.03

Another common approach is to generate a scree-plot, which is a graph with factors on the x-axis and eigenvalues on the y-axis, and then to look at when they start to level off. The number of the last eigenvalue before such thing happens is considered to be the needed one. The scree-plot for our analysis is reported in figure 4.7.

Figure 4.7: Scree-plot



All of these approaches converge in suggesting the existence of two common factors that are fruitful for explaining a significant percentage of the correlation in the underlying spreads, over the period under study.

Figure 4.8: PCA factor loadings

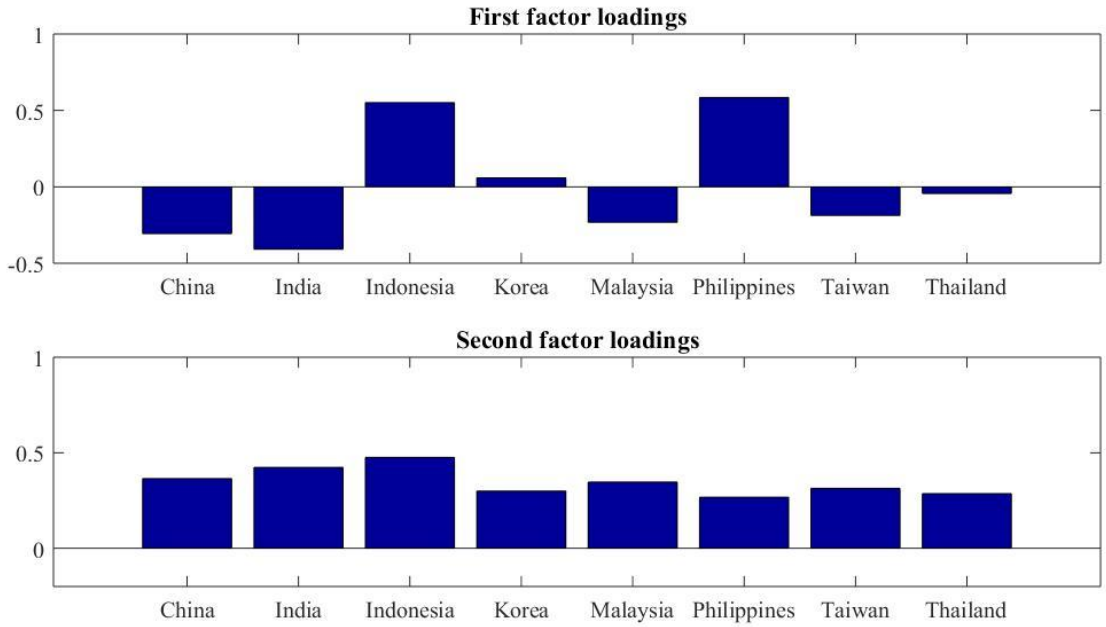


Figure 4.8 displays the factor loading for each of the 8 Asian emerging countries. For the first principal component, it seems that commonalities arise in three distinct groups. The first group is composed of Indonesia and the The Philippines, which seem to be responsible for most of the variability and move in the same direction. The second group is composed of China, India, Malaysia and Taiwan. The remaining two are Korea and Thailand, which seem to remain almost unaffected. The second principal component seems to catch strong commonalities throughout the entire sample, even if with slightly different magnitudes.

The common factors, despite not having a proper economic meaning, are considered to be determinant for the variability of our emerging countries' sovereign spreads. In order to investigate whether the two common factors are somehow related to the global economic and financial system, the correlation between each factor and the matrix variables representing global financial conditions is calculated.

Table 4.3: Correlation coefficients for common factors on international variables

Global Financial System	CF 1	CF 2
VIX	0.04	0.03
S&P500	-0.17 (*)	-0.19 (*)
Crude oil futures	-0.02	-0.19 (*)
LIBOR	0.71 (*))	-0.24 (*)
EUR/USD	0.20 (*))	0.11 (***)
US T-Bills	0.75 (*))	-0.50 (*)

The first principal component shows a significant positive correlation with LIBOR and US T-Bills, with coefficients of 0,71 and 0,75 respectively. The intuition beyond such numbers is that variations in both the reference rate for short-term borrowing and the yield on US T-bills can have, through the common factor, a significant effect on spreads. The second principal component also shows a significant correlation with both LIBOR and US T-Bills, with coefficients of -0,24 and -0,50 respectively. Compared to the first one, the correlation for the second common factor is smaller in magnitude and opposite in sign.

Let us try to find a reason for such phenomena. On one side, the positive correlation could relate to the fact that US Treasury yields are a good proxy for global liquidity conditions: the higher the market liquidity, the lower both the yield and the spread, and vice versa. On the other side, the negative correlation could relate to the fact that US Treasury yields are mainly driven by both US monetary policy and global risk aversion. In the sense that the lower the risk aversion, the higher the yield investors demand, the lower the spread and vice versa. The two factors seem to separately catch these two opposite effects. While

(*) Significantly different from zero at the 5% level.
(***) Significantly different from zero at the 15% level.

the first effect seems to have the most impact on Indonesia and the The Philippines, the second one seems to have almost the same impact on all of the 8 countries.

It is worth it to highlight the significant negative correlation with the returns on the S&P 500. Increasing returns on the S&P 500 could signal an improved risk appetite, with an expected smoothing impact on spreads.

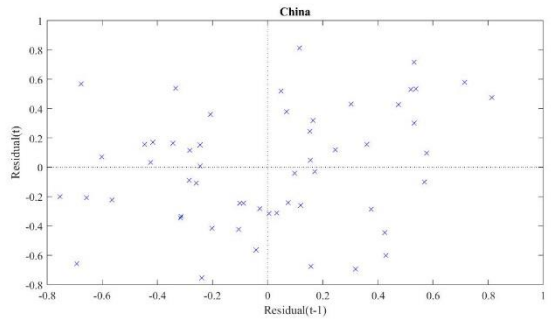
Conclusions

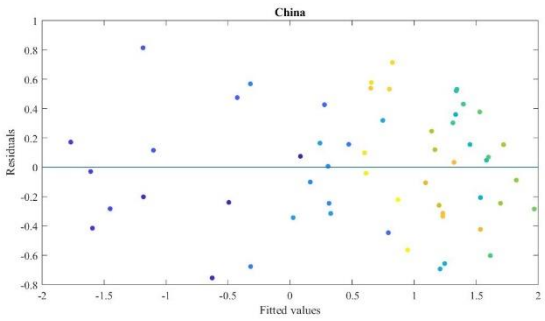
The analysis is focused on assessing the importance of domestic fundamentals versus global conditions in determining emerging market sovereign spreads for the eight Asian economies (China, India, Indonesia, Korea, Malaysia, the The Philippines, Taiwan and Thailand) over the time period from September 2004 to December 2018. The implementation of the fixed-effects linear regression model provided the following results: macroeconomic variables show statistical significance in explaining movements in sovereign spreads, but the magnitude of the relation was low. The dynamics of sovereign spreads suffered from a major exposure to global financial conditions. By looking at the sign of coefficient estimates for the S&P 500, the yield on US 3-months T-Bills and LIBOR the conclude that sovereign spreads narrowed in conditions of low perceived volatility, high risk appetite, abundant liquidity and low yields-level in industrial countries. We also find commonalities among countries. The common factors that could have been serving as transmission channel for global shocks seem to detect the double effect that US Treasuries had on sovereign spreads. One the one hand, to depress the spreads when liquidity market conditions are looser. On the other hand, to boost the spreads when investors perceive high market volatility and show high risk aversion. Dollar-denominated emerging market bonds have lately attracted large portfolio capital flows, perhaps as a sign of both the wealth redistribution on a global dimension and the search for investments' diversification. In a world of slowing growth, Emerging Market economies are expanding more rapidly than developed ones. Despite the improving macroeconomic scenario, global fundamentals played a major role in drawing the path of sovereign spreads.

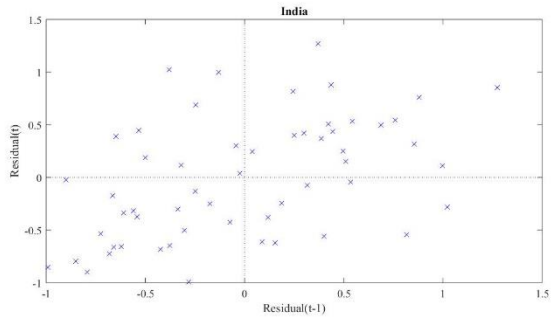
Appendix

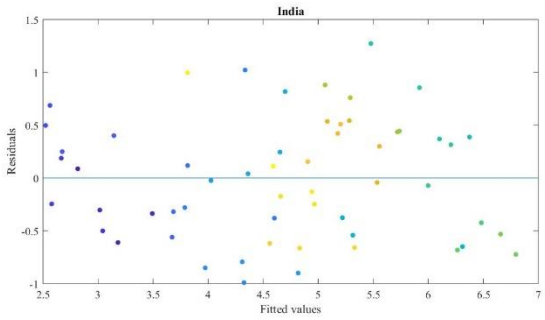
For better understanding the dataset and providing useful insight supported by statistical evidence, single-country regressions have been run. Related residuals are reported below.

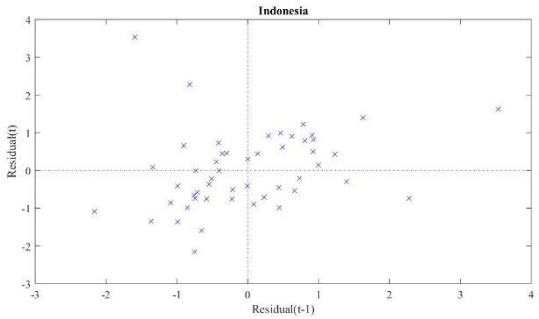
Figure A: Single-country regressions residuals

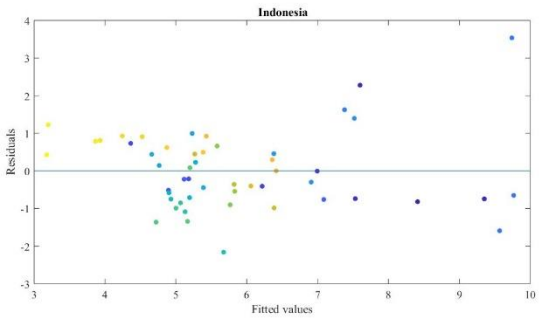


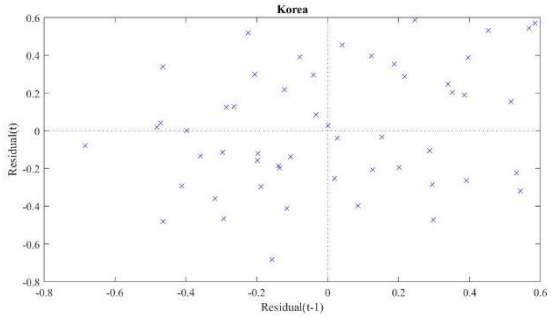


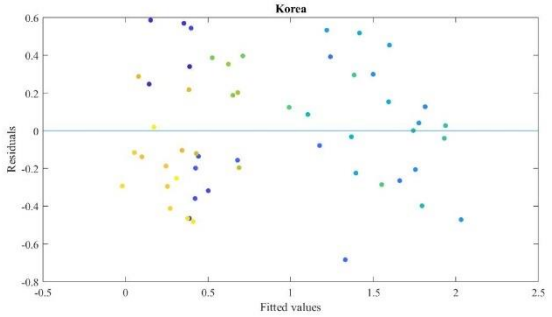


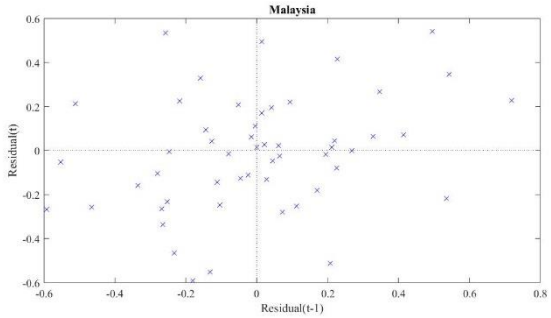


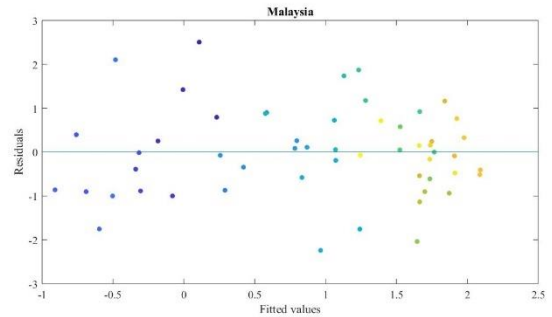


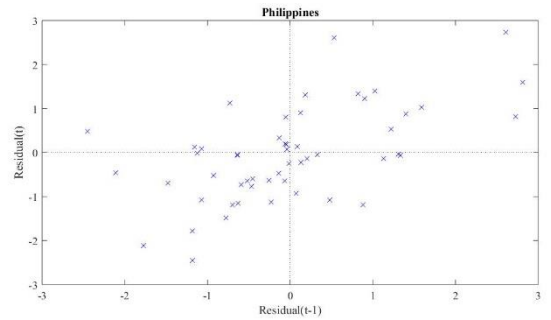


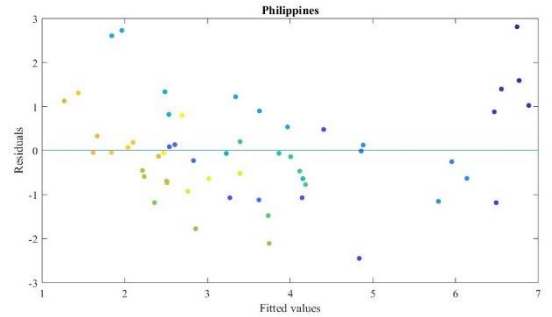

Korea
Residual(t)
Residual(t-1)

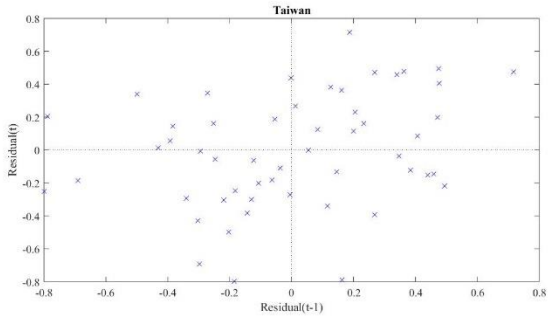

Korea
Residuals
Fitted values

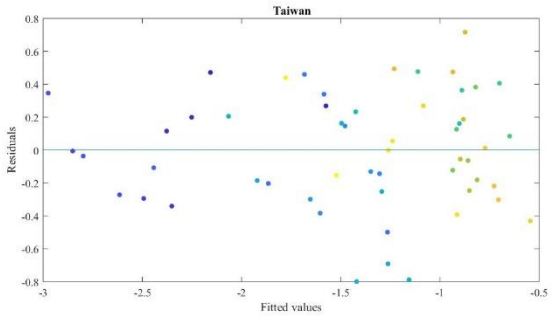

Malaysia
Residual(t)
Residual(t-1)

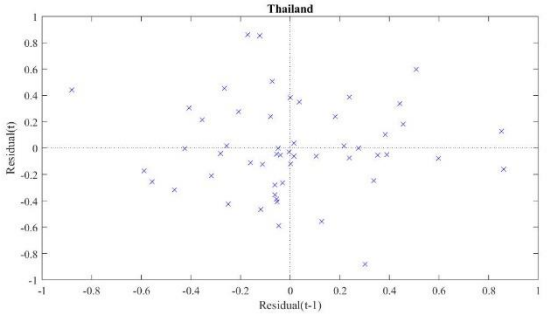

Malaysia
Residuals
Fitted values

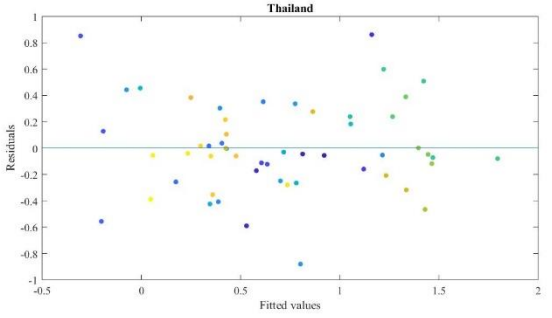

Philippines
Residual(t)
Residual(t-1)


Philippines
Residuals
Fitted values


Taiwan
Residual(t)
Residual(t-1)


Taiwan
Residuals
Fitted values


Thailand
Residual(t)
Residual(t-1)


Thailand
Residuals
Fitted values

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Department of Economics and Finance

Course of Empirical Finance

“ Asian Emerging Market sovereign spreads: balancing macroeconomic and global exposures ”

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Master's degree in Economics and Finance

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Academic year 2018/2019

Introduction

Recent times saw a world of slowing growth. In such scenario, Emerging Market economies are expanding more rapidly than developed ones and the gap is expected to widen in the years ahead. Dollar-denominated emerging market bonds have lately attracted large portfolio capital flows, perhaps because of both their resilience during the 2008-2009 global financial crisis and their post-crisis relatively favourable risk-return features. When backward looking at the path that Emerging Market sovereign spreads have been following globally, it seems like the deviation from US Treasury yields has narrowed. The reason for our investigation is to justify such phenomena and identify those factors affecting the spreads' dynamic. The main focus is on how macroeconomic fundamentals, global economic conditions and investors' risk appetite interact, assessing the contributions of both global and domestic factors on the evolution of sovereign spreads. The analysis covers eight Emerging Market economies located within the Asian continent, namely China, India, Indonesia, Korea, Malaysia, the The Philippines, Taiwan and Thailand. The selected time window goes from Q3-2004 to Q4-2018. Data are collected in a panel.

Section 1 gives an insight on the concept of creditworthiness, defines how to determine sovereign spreads and makes a digression on Emerging Market history. We also present macroeconomic factors that past literature usually accounts for when dealing with the universe of sovereign credit. Such factors will be our reference starting point.

Section 2 presents some descriptive statistics for macroeconomic data collected on selected countries and identifies the international factors that are included within the analysis, in order to give some context. We discuss stationarity and describe the necessary data manipulation applied for fixing related issues. While investigating the correlation in spreads across countries, we find ourselves dealing with a fragmented set, divided into three groups. Sovereign spreads for countries belonging to the first and second group moved in opposite directions, while correlation coefficients for the single country belonging to the third group were close to zero. The fragmented correlation in spreads' movements can be indicative of the different perception investors had.

Section 3 introduces the alternative estimation techniques described in past literature for modelling sovereign spread through panel data and linear regression models. We also show the role of Principal Components Analysis as a tool for detecting commonalities.

Section 4 presents the implementation of the fixed-effects regression model and the results achieved. We provide residual diagnostics for commenting on the reliability of the estimates. The main finding is that macroeconomic factors are statistically significant in explaining the dynamics of sovereign spreads over the time period under study, but with only a milder impact. The related coefficient estimates are close to zero. On the contrary, coefficient estimates for international variables were considerably and consistently different from zero, meaning they had a stronger impact on spreads' dynamics. Such finding is in line with the results provided by PCA: when exploring the commonalities within the sample, we find two common underlying factors, which seem to have been correlated both with LIBOR and yield on US Treasury Bills, even if with opposite sign.

We conclude that, in periods of abundant market liquidity as recent times, when the financial scenario is globally dominated by low-level yields and investors show high risk appetite, sovereign spreads narrow, showing a greater exposure to global shocks than domestic macroeconomic fundamentals.

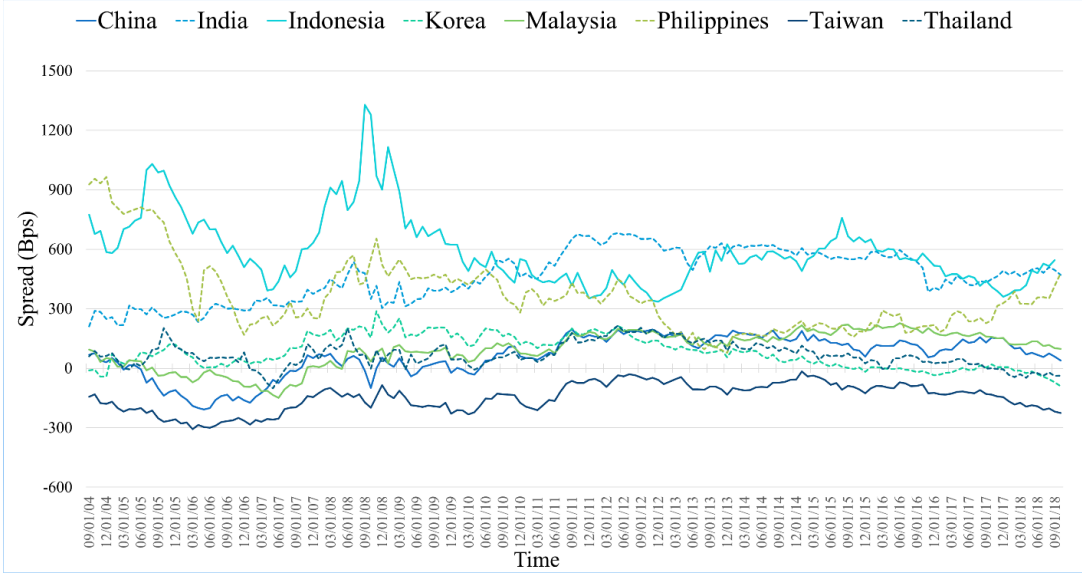
1 Asia on focus

1.1 Some descriptive statistics

After an extended period of volatility, emerging market sovereign spreads have narrowed steadily since the first decade of the XXI century. The strengthening of sovereign debt performance is partially due to the improvement in global market sentiment that came after the resolution of the Euro Area debt crisis. Central banks took their role in announcing several liquidity-enhancing measures.

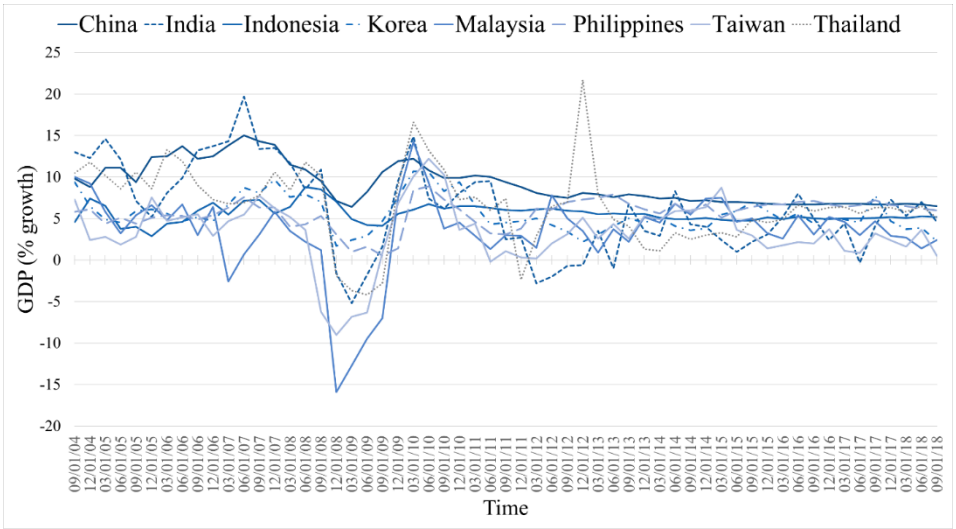
Industrial countries started experiencing exceptionally low yields and abundant liquidity market conditions. As a consequence, Emerging Market economies saw significant inflow of funds, pushing debt costs down.

Figure 1.1: Sovereign spreads on US 10-year Tbills



The eight Emerging Market economies selected for our analysis seem to follow the same path. Even if the starting-point level for each was different, the spread in yield on US 10-year T-bills decreased, as shown in figure 1.1. This narrowing trend was partially supported by significant reforms that some of these economies have been implementing: in Korea and Thailand, for example, banking sectors have been restructured, policies for keeping control of inflation have been adopted and more flexible exchange rate arrangements have been applied. Over the period under study, sovereign bond issues for Indonesia traded at the higher spread on average. Both, Indonesia and The Philippines recorded the higher volatility in sovereign spreads.

Figure 1.2: GDP growth rates



The strengthening of sovereign debt performance was also supported by good conditions in macroeconomic fundamentals. Figure 1.2 shows GDP growth rates taking on positive values most of the time for each of the eight economies under study, except for India, Malaysia, Taiwan and Thailand: these four, in fact, experienced a negative growth in GDP around 2008 and 2009. Anyway, the expansion in economic activity seems to have started suffering from a general slowdown since 2010.

When it comes to describing the level of debt-to-GDP ratios, selected countries need to be collected into three different groups. The first one is for countries whose debt as a percentage of GDP has significantly grown: China and Korea are representative examples, with debt-to-GDP ratios boosting from around 15% to almost 40%. The second group is for countries that have been keeping the ratios almost stable throughout the years: for Thailand the level of debt oscillated between 30% and 40%, while for Taiwan between 40% and 50%. The third group is for countries whose debt ratio has decreased over time: The Philippines and Indonesia experienced major drops, with the stock of debt passing from around 75% of GDP to around 30%.

1.2 The dataset

Before moving on, here is a brief description of the data that have been collected for the implementation of the analysis. The latter is conducted through the time window from September 2004 to December 2018, on a monthly basis for sovereign bond yields and on a quarterly basis for macroeconomic variables. The decision on how to structure the time window was dependent on the availability and the length of historical time series for macroeconomic data of each country, which have been downloaded from Bloomberg.

For what concerns country-specifics, variables included are:

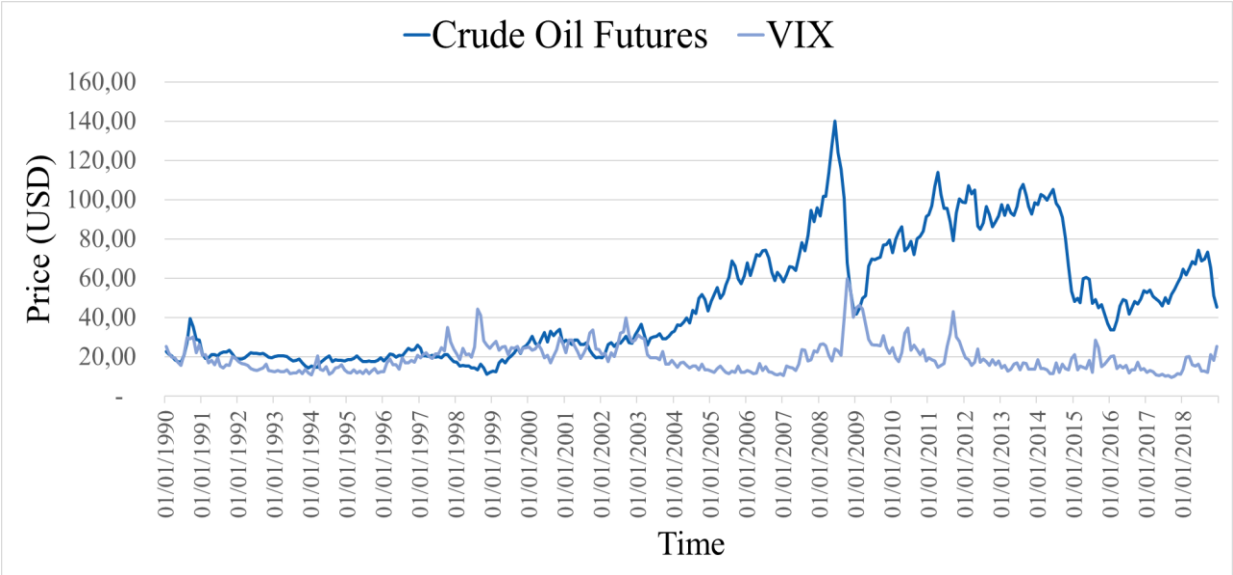
- spreads have been calculated as the difference in yield between (i) each Asian emerging country's sovereign debt issues and (ii) US Treasury Bills, both with 10 years maturity.

- GDP in real terms, valued at constant price, taken as a growth rate from one year to another.
- Exports from local sources, converted to USD currency using average exchange rate for a specific period (quarter).
- International reserves converted to USD currency.
- Current account balance as a percentage of GDP.
- Consumer price index taken as a growth rate year-on-year.
- Debt as a percentage of GDP.

For what concerns variables representing global financial conditions, those included are the historical prices for VIX, S&P 500 and crude oil futures, the quotations for LIBOR, EUR/USD exchange rate and the yield on US 3-months T-Bills.

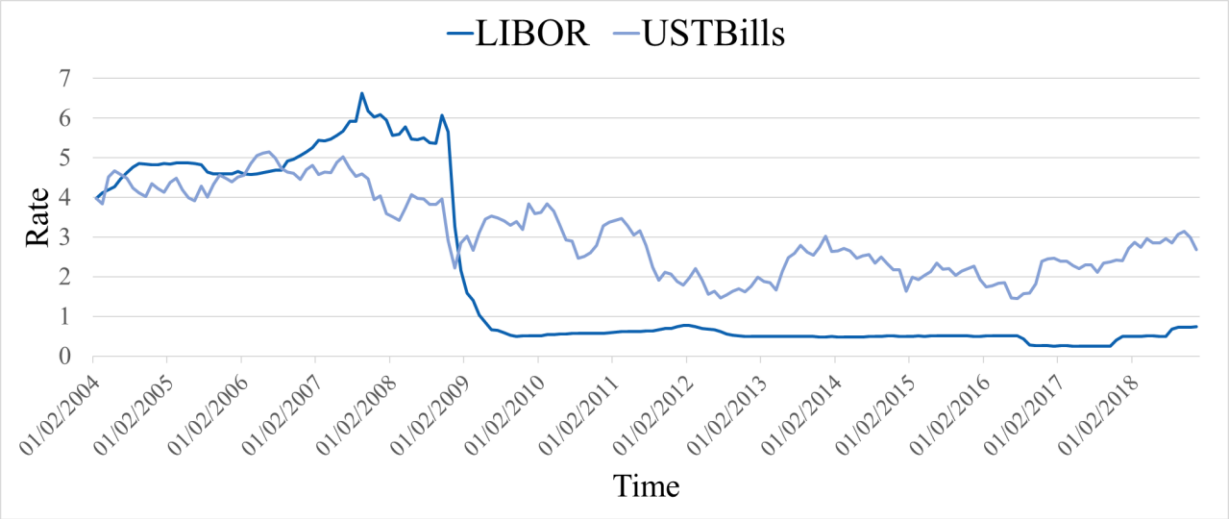
VIX is often referred to as a good proxy market sentiment, perceived volatility and investors' risk appetite, the S&P 500 as the best gauge of US large-cap equities providing a quick look at global economy. The yield on US 10-years T-Bills is taken as a good proxy for global liquidity conditions, LIBOR as the reference rate when lending in the short-term. Prices of crude oil futures are considered as representative for market expectations on future inflation trend. Figures 1.3 and 1.4 are reported aiming at giving the bigger picture on global financial condition.

Figure 1.3: Historical prices for crude oil futures and VIX



The Volatility Index is a measure for market's expectation of short-term volatility, which is derived from the price inputs of the S&P500 index options. It is generally referred to as representative of market sentiment and investors' risk appetite. Positive deviations are a signal of financial markets tightening, while negative deviations are a signal of financial markets loosening. The peak recorder between 2008 and 2009 identifies the Great Recession that started from the collapse of the real estate market in the U.S.A., spreading both on the market economy through the lack of valuable assets and on the financial sector thought the breakdown of the banking system. For what concerns crude oil, it is believed that prices are sensitive to demand factors. A worldwide growth in output, especially in emerging markets, could be the main driver for pushing oil prices up, even if it has been proved that small shocks to oil supply or demand can result in large price movements over time[18].

Figure 1.4: Historical rates for LIBOR and US T-Bills



As mentioned above, LIBOR is often referred to as a good proxy for global liquidity market conditions. The rate has steadily declined since 2010, on the heels of several quantitative easing announcements and liquidity-boost oriented monetary policies. It seems it has started rising in recent years. Increasing the supply of any good on the marketplace lowers its cost: the same happens to money. Increasing money supply lowers

[18] R. Arezki, Z. Jakab, D. Laxton, A. Matsumoto, A. Nurbekyan, H. Wang, J. Yao, *Oil prices and the global economy*, Working Paper WP/17/15 (International Monetary Fund, January 2017)

the cost of money, which means interest rates are lower as well. This is the reason why LIBOR and US T-Bills seem to follow the same path.

1.3 Correlation in spreads

In order to understand better the dataset we are dealing with, it could be useful to analyse the correlation in sovereign spreads between the Emerging Market economies on focus, over the stated time horizon. Three groups arises.

I. The first group comprises China, India, Malaysia, Taiwan and Thailand.

II. The second group includes Indonesia and The Philippines. When implementing single-country regressions[19], few insights arise. The estimated βs for both Indonesia and The Philippines highlight two a heavy reliance of sovereign spreads on GDP growth rate: growth of domestic product for these two economies attained at ~5% on average and was the most stable ones over the time window under study. Regarding the others, the impact GDP had on sovereign spreads was not remarkable. Another noteworthy fact is that these two economies experienced the greatest reductions in debt-to-GDP ratio: such fundamental seems to have had a strong significant positive impact on sovereign spreads.

III. The third group is for Korea, showing very little correlation with the rest, except for Thailand.

For countries belonging to the same group, sovereign spreads move in the same direction, with correlation coefficients between 0.84 and 0.91 for the first, and 0.51 for the second. When looking at intragroup co-movements, spreads for countries belonging to the first and second group move in the opposite direction, with correlation coefficients between negative 0.30 and negative 0.56, while spreads for Korea seem to stand by their own. It could be indicative of the different perception investors have of the different countries. Let us consider the following: in recent years, South Korea saw considerable inflows of

[19] Single-country regressions were singularly implemented for every country, considering the sovereign spread as dependent variable and each of the six macroeconomic factors as regressors. Residuals os such regressions are provided in the Appendix-Figure A.

foreign investments into local government bonds' market, careless of persistent political tensions around Northern region. Market seems to retain a stable outlook on the country's economic fundamentals and credit rating, on the heels of the position taken by Fitch Rating. In fact, the agency placed Korea above China and Japan when assigning its own rate. In this scenario, trading war between USA and China might have played a relevant role.

2 The empirical results

2.1 Fixed effects regression model

Consider the panel regression model

$$Y_{it} = \alpha_i + \sum_{k=1}^{K} \beta_k X_{k,it} + u_{it}$$

for $i = 1, \ldots, n$ representing the number of the Asian emerging countries under study, $k = 1, \ldots, m$ representing the number of both macroeconomic and international variables, and $t = 1, \ldots, t$, representing the time-series length. The initial regression was run on six macroeconomic variables (namely GDP growth rate, exports, international reserves, current account balance, consumer price index and amount of debt) and six international variables (namely VIX, S&P 500, LIBOR, crude oil futures, EUR/USD exchange rate and US 3-months T-Bills yield). Some of these variables resulted to be not statistically significant for explaining the dynamics of sovereign spreads, so they were excluded once at the time. This same procedure was iterated until a robust set was found. The variables being ultimately excluded are: exports, international reserves, crude oil futures and EUR/USD exchange rate.

Over the time period from September 2004 to December 2018, across the selected Asian Emerging Market economies, sovereign spreads seem to have been affected by movements in global financial conditions with a stronger impact than macroeconomic fundamentals. Macroeconomic factors result statistically significant in explaining the dynamics of sovereign spreads indeed, but with only a milder impact. The related

coefficient estimates are all close to zero. On the other side, the marginal contribution of each regressor related to the international economic scenario is relevant, except for VIX.

The level of debt-to-GDP is traditionally considered as one of the leading drivers of the cost of debt for governments. For assessing the impact that such variable had on sovereign spread, it is necessary to look at the single-country regressions. The coefficient estimates are remarkable only for India ($+0.929$) and the The Philippines ($+0.433$): IMF rated India as the 10^{th} global economy in nominal terms and global markets seem to have prised the nation for its improvements.

Perhaps, one of the most interesting results is that the $\hat{\beta}$ for the returns on the S&P 500 is statistically different from zero at around 0.1 confident level: the returns on the index seem to have negatively affected sovereign spreads, with a marginal contribution of -1.709. This result is in line with the findings of Longstaff et al. (2011): throughout his works, he found evidence that shocks in the US financial markets are transmitted globally. In fact, it is thought that US security prices embrace information on economic fundamentals and market liquidity that is relevant on a broad cross-section of countries located worldwide. An insight on the sign of the relation could be the following: increasing returns on the index generally signal improved risk appetite, leading to a narrowing in sovereign spreads. Such argument is supported also by the results on VIX. As expected, VIX was positively associated with spreads, even if the magnitude of the impact was close to zero. The index is commonly known as "Fear index": when its value increases, it means the volatility perceived by investors' increases as well, so we have higher risk aversion on the market tighter (looser) liquidity caused sovereign spreads to widen and vice versa.

The yield on US 3-months T-Bills resulted as having a statistically significant negative relation to sovereign spreads. The related $\hat{\beta}$ takes the value of -0.387. If considering the yield as a measure of global liquidity, one should expect the relation to be positive, since abundant liquidity conditions (i.e. low short-term interest rates on US Treasuries) are expected to reduce sovereign spreads, and vice versa. The meaning of the negative relation needs to be found elsewhere. One could argue, for instance, that in periods of abundant global liquidity, low global interest rate environment leads to an excess supply of bonds and hence higher sovereign spreads. Or else, as stated above, one could take the yield on US T-Bills as a measure of market sentiment: the higher the risk aversion, the

lower the yield and so the higher the spread.

There is sufficient statistical evidence for stating that the London Interbank Offered Rate played its role in defining the dynamics of sovereign spreads, with an estimated coefficient of around 0.23. LIBOR's movements seem to have pushed sovereign spreads in the same direction. If considering the rate as representative of the yields-level in industrial countries, sovereign debt costs for our eight Asian emerging countries seem to have followed the same heels.

For what concerns our regression, the explanatory variables are able to assess more than 86% of the variability in the response, with a standard error of ~0.969. No severe issues of autocorrelation or heteroskedasticity in residuals are found. Date manipulation required for fixing non-stationarity related issues were applied.

2.1 Commonalities

Several presented approaches converge in suggesting the existence of two common factors that are fruitful for explaining a significant percentage of the correlation in the underlying spreads, over the period under study.

Figure 2.1: PCA factor loadings

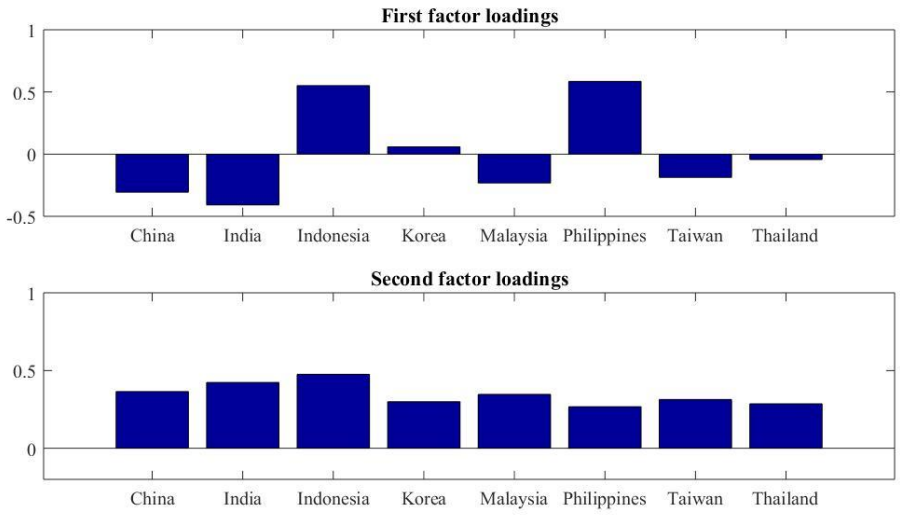


Figure 2.1 displays the factor loading for each of the 8 Asian emerging countries. For the first principal component, it seems that commonalities arise in three distinct groups. The first group is composed of Indonesia and the The Philippines, which seem to be responsible for most of the variability and move in the same direction. The second group is composed of China, India, Malaysia and Taiwan. The remaining two are Korea and Thailand, which seem to remain almost unaffected. The second principal component seems to catch strong commonalities throughout the entire sample, even if with slightly different magnitudes.

The common factors, despite not having a proper economic meaning, are considered to be determinant for the variability of our emerging countries' sovereign spreads. In order to investigate whether the two common factors are somehow related to the global economic and financial system, the correlation between each factor and the matrix variables representing global financial conditions is calculated.

The first principal component shows a significant positive correlation with LIBOR and US T-Bills, with coefficients of 0,71 and 0,75 respectively. The intuition beyond such numbers is that variations in both the reference rate for short-term borrowing and the yield on US T-bills can have, through the common factor, a significant effect on spreads. The second principal component also shows a significant correlation with both LIBOR and US T-Bills, with coefficients of -0,24 and -0,50 respectively. Compared to the first one, the correlation for the second common factor is smaller in magnitude and opposite in sign. Let us try to find a reason for such phenomena. On one side, the positive correlation could relate to the fact that US Treasury yields are a good proxy for global liquidity conditions: the higher the market liquidity, the lower both the yield and the spread, and vice versa. On the other side, the negative correlation could relate to the fact that US Treasury yields are mainly driven by both US monetary policy and global risk aversion. In the sense that the lower the risk aversion, the higher the yield investors demand, the lower the spread and vice versa. The two factors seem to separately catch these two opposite effects. While the first effect seems to have the most impact on Indonesia and the The Philippines, the second one seems to have almost the same impact on all of the 8 countries.

It is worth it to highlight the significant negative correlation with the returns on the S&P 500. Increasing returns on the S&P 500 could signal an improved risk appetite, with an expected smoothing impact on spreads.

Conclusions

The analysis is focused on assessing the importance of domestic fundamentals versus global conditions in determining emerging market sovereign spreads for the eight Asian economies (China, India, Indonesia, Korea, Malaysia, the The Philippines, Taiwan and Thailand) over the time period from September 2004 to December 2018. The implementation of the fixed-effects linear regression model provided the following results: macroeconomic variables show statistical significance in explaining movements in sovereign spreads but the magnitude of the relation was low. The dynamics of sovereign spreads suffered from a major exposure to global financial conditions. By looking at the sign of coefficient estimates for the S&P 500, the yield on US 3-months T-Bills and LIBOR the conclude that sovereign spreads narrowed in conditions of low perceived volatility, high risk appetite, abundant liquidity and low yields-level in industrial countries. We also find commonalities among countries. The common factors that could have been serving as transmission channel for global shocks seem to detect the double effect that US Treasuries had on sovereign spreads. One the one hand, to depress the spreads when liquidity market conditions are looser. On the other hand, to boost the spreads when investors perceive high market volatility and show high risk aversion. Dollar-denominated emerging market bonds have lately attracted large portfolio capital flows, perhaps as a sign of both the wealth redistribution on a global dimension and the search for investments' diversification. In a world of slowing growth, Emerging Market economies are expanding more rapidly than developed ones. Despite the improving macroeconomic scenario, global fundamentals played a major role in drawing the path of sovereign spreads.

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