صندوق النقد العربي
ARAB MONETARY FUND

Impact of Economic Instability and Governance Quality on the Sovereign Risk: Case of the Arab Region

Prepared by
Dr. Sofiene Gaaloul

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The AMF publishes these studies which survey issues pertinent to monetary, fiscal, banking, trade and capital market policies and their impact on Arab economies.

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Introduction

Deep understanding of sovereign credit risk is urgently needed after the global financial crisis, this risk increased dramatically all over the whole market triggered by turmoil of financial institutions.

Under such circumstances, measuring, understanding and analyzing the structure of sovereign credit risk is of great importance.

Sovereign credit ratings have long served as the most used proxy to measure credit risk linked to an economy. However, more and more criticism is being directed towards the rating agencies that determine the credit ratings. The critiques directed toward the use of credit ratings have raised the demand for a different and more accurate proxy of sovereign credit risk.

The **Sovereign Credit Default Swap (CDS)** spread is considered a potential substitute to the use of credit rating.

Besides a growing body of literature continues to search for the potential determinants of sovereign credit risk, with the sharp rise in sovereign default risk of many countries in the world, those studies identify a set of local and global variables: economic, financial and institutional.

Among several directions that literature has evolved the paper will focus essentially on three main directions:

- Providing an overview of the Sovereign risk and the concept of sovereign credit default swap (SCDS) as measure of sovereign risk.
- Focusing on fundamental determinants of sovereign risk: country-specific fundamentals and other related global variables unrelated to a country's economy,
- overviewing the impact of governance quality on the sovereign risk as an institutional variable.

Testing the propositions developed in the theoretical part both over time and across countries. We consider a panel regression on a sample of eleven Arab Countries in the period from Q1 2006 until Q4 2018.

Part 1: Sovereign Risk and sovereign CDS

It is important to specify the definition of **sovereign risk** that will be used throughout this study. By sovereign risk we mean the risk that a national government (sovereign borrower) will default, a concept that can be better specified as sovereign default risk or sovereign credit risk.

I. Measuring sovereign risk:

It is very important to measure and assess correctly the sovereign credit risk because of the impact it can have on financial systems and further is of a paramount importance to identify and acknowledge this measure for investors and political makers. So, we can have as measure:

1.1 Sovereign credit rating

A credit rating assesses the solvability of a corporate or sovereign bond. Sovereign credit ratings can have a significant influence on the terms for which a country can borrow on the international capital market (Mellios and Blanc 2006)[1] :

- the interest rate that the sovereign has to pay when it wants to obtain a new loan increased when the country gets a lowered credit rating (Reisen and Von Maltzan 2006)[2].
- Getting high credit ratings is very beneficiary for a country.

For their credit risk measurement rating agencies consider a lot of aspects into account including: political system, the solvency situation, social cohesion, and interdependence of a country with international financial systems and other many related determinante

[1] Mellios, C. and Paget-Blanc, E. (2006). *European Journal of Finance,* 12 (4), p361.
[2] Reisen, H. and Von Maltzan, J. (1998). *Intereconomics,* 33 (2), p7.

which are all seen as important in the derivation of the credit rating of a sovereign entity (Afonso 2003)[3].

Credit rating agencies don't want their ratings to fluctuate a lot. This is because quick rating reversals negatively affect the reputation of a rating agency.

Sovereign credit ratings have remained the most used credit risk indicator up to this point (Flannery 2010).[4]

1.2 Bond yield spread

The bond yield spread of a country is to be considered as another variable that can be used as an indicator of sovereign credit risk. Sovereign bond yield spread represents the risk premium that a nation has to pay to obtain loans (Baek et al. 2005)[5].

An increasing risk premium may indicate a high probability that the government might not be able to repay its future obligations. Therefore, the yield spread serves as a measure of sovereign credit risk.

Bond Yields spread is a market-assessed indicator. It adjusts relatively quickly to new information. So, it is considered as a proxy for credit ratings (Baek et al. (2005)[6]).

Bond yield spread are adjusted monthly frequency so are slower than CDS spread (daily frequency).

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[3] Afonso, A. (2003). *Journal of Economics and Finance,* 27 (1), p60.

[4] Flannery, M., Houston, J. and Partnoy, F. (2010). *University of Pennsylvania Law Review,* 158, p2087.

[5] Baek, I., Bandopadhyaya, A. and Du, Chan. (2005). *Journal of International Money & Finance,* 24, p534.

[6] Baek, I., Bandopadhyaya, A. and Du, Chan. (2005). *Journal of International Money & Finance,* 24, p535.

1.3 Sovereign Credit default Swap (SCDS)

Because CDS spread is a market-assessed indicator, unlike credit ratings, it adjusts more quicker to changing market conditions, since it is updated daily and because it is based on the supply and demand for the respective CDS contract (Flannery et al. 2010)[7].

Therefore, sovereign CDS spread could function as an efficient and credible measure of credit risk, CDS data can help alert regulators and financial institutions of any possible sovereign risks.

The most important function of CDS spread is to transfer the credit risk of potential default from the **buyer** (or lender) to **the seller**.

The protection buyer is then insured against a **credit event** of a specific government, which is called the r**eference** entity. The premium that the protection buyer has to pay is based on the likelihood that the reference entity is unable to fulfill its obligations toward their bond holders (Hull 2008)[8], This premium is called the CDS **spread**.

II. CDS as a measure of sovereign risk

Sovereign credit ratings have long served as the most used proxy to measure souverain credit risk. However, more and more criticism is being directed towards the rating agencies that determine the credit ratings. The critiques directed toward the use of credit ratings have raised the demand for a different and more accurate proxy of sovereign credit risk.

The sovereign Credit Default Swap (CDS) spread is considered a potential substitute to the use of credit ratings.

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[7] Flannery, M., Houston, J. and Partnoy, F. (2010). *University of Pennsylvania Law Review,* 158, p2088-2089.
[8] Hull, J. (2008). *Options, Futures, and other Derivatives,* p526-527.

2.1 CDS in general

The credit default swap (CDS) is in general a contract of **insurance** used to transfer credit risk of a reference entity from one party to another, it's a bilateral agreement. CDS are conceived to cover the risk of credit event caused by creditors and transfer it to other agent.

2.2 Functioning

There're three parties: a **protection buyer** (B*);* a **protection seller** (S*);* and a reference entity (R*).*[9]

The CDS allows to (B) to buy insurance against the risk of a default by borrower (R)*, on the other hand*(S) obtains payment for offering this protection.

If (B) buys a CDS on (R) from (S) for an amount of (*A).* *So* (B) is covered by the CDS against the risk of default by (R) from the day of purchase to maturity[10].

- (B) has to pay a premium, spread (c)[11] that is a percentage of the debt amount $(A \times c)$ to (S), Premium is in general paid quarterly , until or repayment, if default occurs during the period, if not for the term of agreement, from (t_0 to T). Premium (c) increases with probability of default.
- On the other hand (S) has to pay (B) a sum in the event of default that fully compensates loss incurred by (B).

[9] which is the underlying borrower and may be a company or a sovereign.

[10] In general, five years

[11] The spread is a premium quoted in basis points (bps) per year paid by the cds buyer to get an insurance against default.

Part 2. Impact of Economic instability on the sovereign risk

I. Literature Review

It is not surprising that a growing body of literature addresses the potential determinants of sovereign default risk, with the sharp rise in sovereign default risk of all over the world. The early studies (Frank & Cline, 1971; Saini & Bates, 1978; Sargen, 1977) are based on discriminant analysis, later papers employ logit and probit models (Feder and Just (1977), and Mayo and Barrett (1977)).

Edwards (1984) is viewed as the first study of sovereign yield spread determinants, where in his study logarithmized spread were regressed on many economic variables to describe sovereign default risk .

Eichengreen and Mody (1998) conclude that fundamental variables do not fully explain price spread, they emphasize that market sentiments play an important role in determining sovereign yield spread besides observable fundamental data. The author Min (1998) performs a similar analysis, using more recent data.

Intuitively, one would expect the fluctuations in sovereign spread to be driven by country-specific fundamentals. Yet, abundant evidence shows that a major fraction of the variation in sovereign CDS spread is determined by global variables unrelated to a country's economy.

Surveying the literature highlights the fact that the role of domestic risk factors tends to be more important in times of distress and for countries undergoing financial turmoil, while global risk factors tend to be favored in studies excluding distressed countries and typically outside crisis periods.

Future research is encouraged to focus on the time-varying properties of both sources of risk.

1.1 Global risk factors

In the literature and in practice, the sovereign credit risk is affected not only by local factors but also by global variables.

Sovereign CDS spreads co-move notably over time and they "jump" together when global events occur.

The globalization shaped polices and behaviors of countries and regions, which intensifies the dependences of open economies on global factors, because they interact together in the global market.

Pan and Singleton (2008) and Augustin and Tédongap (2014) at the daily frequency, and in Longstaff. et al. (2011), and Augustin (2013) at the monthly frequency.

Striking evidence on the role of global financial risk factors is given by Longsta. et al. (2011). Using 5-year CDS of 26 countries from October2000 to January 2010. The authors show that not only spread changes but also the expected loss component in spread are relatively better explained by U.S. bond market risk premia than by variables related to the local economy.

Among global factors that have been identified in the literature:

- ✓ **Global macroeconomic factors:**

We use relevant measures of **U.S. economy** in order to capture the broad movements of global economy general, as proxies as suggested by Longstaff et al. (2011)

eg the TED spread, which proxies for changes in global liquidity

- ✓ **The global financial market variables:**

The most commonly used global variables in empirical studies on sovereign risk are:

- **The yield on a long-term US Treasury bond**, which proxies for changes in the US economy.
- The **VIX index**, as proxy for volatility in global markets.

- **the default yield spread** presented as the spread between corporate bonds with low and high credit rating.
- **the returns on a US stock market index**, as proxy for the global economic condition and the global business cycle.

Additional evidence regarding the influence of the economic factors in the U.S. on global sovereign CDS premia is presented by Dooley and Hutchison (2009), who show negative and positive news from the U.S., both real and financial, were channeled to 14 geographically dispersed countries during the 2007–2009 subprime crisis.

(see; Hilscher and Nosbusch, 2010, Longstaff et al., 2011; Baldacci et al., 2011; Beck, 2001; Eichengreen and Mody, 2000; Gonzalez-Rozada and Levy-Yeyati, 2008).

- **Global Risk Premium,** several studies have decomposed bond spread into expected losses from default and the default risk premium. The latter is also referred as the price of default risk, which is the financial compensation required by investors for bearing relevant risks see Berndt et al. (2004) and Driessen (2005). The risk premiums is proxied by **Equity Risk Premium** such as the earnings price ratio on a stock market index, see Longstaff et al. (2011), in this study the earnings-price **(E/P) ratio of S&P 500 Index** is used as a proxy for equity risk premium.

✓ **<u>Regional Sovereign Spread:</u>**

Several studies argue close correlations between sovereign credit spread of countries from the same geographic region and indicate the potential impact of regional factors on sovereign CDS spread.

1.2 Country- Specific determinants (local risk factors)

As Longstaff et al. (2011) argued, because there are unlimited numbers of variables that may affect sovereign credit risks, one should be cautious about the selected variables. Although the literature varies widely in the choices of variables and methodologies, relevant economic factors actually have been identified in the literature as influencing sovereign credit risk including:

- ✓ **GDP growth:**

According to (Ephraim, C,and Konstantinos,K. 2015) many studies find that GDP growth is a significant determinant of sovereign spread since an increasing level of output shows a better capacity to service the economy's debt, (e.g. Baek et al., 2005; Beck, 2001; Gibson et al., 2012; Eichler and Maltritz, 2013).

- ✓ **Terms of trade** [12] as proxy of openness, is an important determinant of sovereign spread as it affects the economy's capacity to generate the foreign currency income that serve to cover foreign debt (Bulow and Rogoff, 1989).

  Hilscher and Nosbusch (2010) explored empirically this relationship on 31 emerging economies and obtains results showing that terms of trade and their volatility affect significantly sovereign spread.

  Min (1998), Baldacci et al. (2011) and Gibson et al. (2012) among others, also report that terms of trade have a significant, inverse relationship with sovereign spread. Eichler and Maltritz (2013) conclude that lower economic growth and greater openness, measured by the sum of exports and imports to GDP, increase sovereign default risk.

[12] price of exports relative to the price of imports

- ✓ **Trade balance**[13] and the current account balance are considered as proxies of the economy's capacity to generate foreign income to serve the country's debt. But the empirical results on their impact on sovereign spread are ambiguous; Eichler and Maltritz (2013) show that the trade balance influences only medium-to long term spread but not short term spread.

  Beck (2001) finds that current account surpluses are associated with higher or lower spread.

- ✓ **Inflation:** is a source of increased economic and financial uncertainty that can also affect spread, given its well-known effects on relative prices.

  Min (1998) lead his study on a number of Latin American and Asian countries and he points out that inflation is one among important macroeconomics drivers that affect sovereign spread. He shows that inflation can serve as a measure for economic management in the sense that well-managed economies experience low inflation rates. Beck (2001) also finds that inflation is a significant determinant of spread.

  However, Diaz and Gemmill (2006) who examine the global and local determinants of the creditworthiness of four Latin American economies, find that inflation is not a significant determinant of sovereign spread.

- ✓ **Debt to GDP** is the more important solvency indicator tested in most empirical studies on the determinants of sovereign spread (Hilscher and Nosbusch, 2010; Edwards, 1986; Min, 1998; Eichengreen and Mody, 2000; Eichler and Maltritz, 2013).
- ✓ **Reserves:** Hilscher and Nosbusch (2010), Min (1998), Diaz and Gemmill (2006), Baldacci et al. (2011), Cline and Barnes

[13] is the difference between the monetary value of a nation's exports and imports over a certain period

(1997), among others, find that reserves to GDP is a significant explanatory variable for sovereign spread.

- ✓ **Time to maturity:** Other studies, such as Bandiera et al. (2010), Bernoth et al. (2012), and Min (1998), use time to maturity as a determinant of a bond's risk.

- ✓ **Local Stock Market:** As it is well known, the stock market is affected by the economic state of the countries (Mankiw, 2011).

- ✓ **Exchange Rate:** An open economy is influenced significantly by its exchange rates, which measure the prices of these international transactions in international financial market or international product market (Mankiw, 2011).

- ✓ **The interest rates:** Several studies find a significant relationship between sovereign risk measured by CDS and interest rate.

  Skinner and Diaz (2003) analyzed the relationship between the sovereign CDS spread and macro-level variables. They suggested the sovereign CDS spread are significantly linked to the risk-free short-term rate, the yield of the reference obligation, the interest rate volatility and the time to maturity.

- ✓ **Other factors:** include:

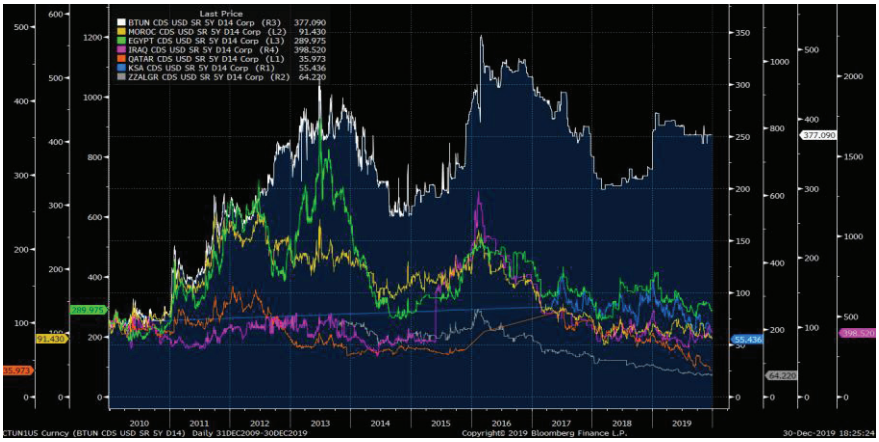
- Default history, figure prominently as important factors that can lead to financial crises, especially in developing countries. Reinhart et al. (2003) argue that a country's history of default is a key predictor of future default because some countries tend to be "serial defaulters". Therefore, countries with recent default episodes usually have higher spread.

- Currency mismatches: the discrepancy between the currency composition of a nation's assets and liabilities creates currency risk and can contribute to financial crises in firms as well as countries (e.g. Caballero and Krishnamurthy, 2005; Catao and Sutton, 2002; Duffie et al., 2003; Gibson and Sundaresan, 2001; Gray et al., 2007; Havrylyshyn and Beddies, 2003; Hilscher and Nosbusch, 2010; Longstaff et al., 2011; Diaz and Gemmill, 2006).

II. Empirical validation

According to McGuire and Schrijver's (2003), the spread co-movements on bond debt across countries suggests that they are driven by one or more common factors. This is consistent with the analyses in this part, which provide the evidence of strong commonality among the changes of sovereign credit spread(fig.1). In this part, the study tried to explore the sources of this commonality, using a similar exploration to the one presented by Longstaff al. (2011), we introduce a combination set of local economic variables and global macroeconomic factors, and investigate their influences on sovereign credit risk proxied by sovereign CDS spread.

Figure 1: co movement of sovereign CDS spread of Arab countries



Source: Bloomberg from 18-03-2010 to 30-12-2019 – own details.

2.1 Empirical strategy

In the empirical part the study tests the propositions developed in the previous section and investigate how the macroeconomic and financial variables affects the study of sovereign default risk across countries, but also over time.

We examine the role of these variables in sovereign CDS for a sample of 11 countries between 2006 Q1 and 2018 Q4. To do so, we estimate a random and fixed-effect panel to explain sovereign CDS.

2.1.1 Data and methodology

First of all, we will begin by describing the data considered in this study: sovereign CDS spread and the set of potential fundamental determinants of sovereign risk: domestic and global variables.

We use unbalanced quarterly panel data for 11 Arab Countries[14], in the period 2006 to 2018 to identify determinants of CDS.

2.1.2 Descriptive of the data

The set of variables tested in this study are presented in table1 with précising their sources. Table2 presents their descriptive statistics. The average sovereign spread is 291 basis points. More detailed information is provided in the Appendix.

[14] Algeria, Bahrain, Egypt, Iraq, Lebanon, Morocco, Qatar, Saudi Arabia, Tunisia, UAE, Kuwait.

Table 1: Definitions and sources of the variables

Variable	Definition	Source
CDS	Credit default swaps are available for government bonds, we use 5-year CDS sovereign risk.	Bloomberg
	Domestic variables	
Public _debt	Public debt stock to GDP	WDI
CPI	Quarterly-over Quarterly percentage change of the consumer price index	
GDP growth	GDP annual growth rate	WDI
Exp	the expenditure to GDP ratio	IMF
Openness	Exports plus imports to GDP	IMF
Res_imp	Foreign exchange reserves	IMF
Cr_ acc_ bl	Current account balance to GDP	IMF
Unemp	Unemployment	IMF
REER	Reel effective exchange rate	IMF
SAV	Government saving	IMF
Revn	Government Revenue to GDP ratio	IMF
Ext_debt	External Debt	IMF
Gdp_percap	GDP per capital in 1000USD	WDI
	External variables	
VIX	Weighted average of the implied volatilities of eight put and call options written on the S&P 500 index	Chicago Board Options Exchange, Datastream
Brent	Oil Price	IMF
Usa_bnd	10-year U.S. Treasury rate	Department of the Treasury
AMF program	Dummy = 1, if AMF loans or facilities is received by member countries; 0 otherwise	AMF

Should be noted that where quarterly series were not available, we converted them using linear interpolation, a method often adopted in high-frequency studies on sovereign spread (Goldman Sachs ,2000[15], Bellas et al, 2010[16]).

Table 2 displays the characteristics of the variables used in this section using a selection of key dimensions. Series are quarterly observations from 2006 to 2018 and cover 11 countries.

Table2: Variables characteristics.

VARIABLE	*OBS*	*MIN*	*MAX*	*MEAN*	*STD-DVT*
CDS	*460*	*10*	1800	291.6	271.8
CPI	420	53.6	288.1	108.5	28.6
PUB-DEBT	421	1.5	162.2	42.5	33.8
CR_ACC_BL	427	-27	45.6	2.6	14.4
EXP	427	16.6	62	33	7.2
REVN	427	12.4	72.4	33	13.2
PUB-BL	427	-25.8	34.9	0.9	10.5
UNEMP	416	0.3	18.9	7.5	4.45
SAV	427	3.4	66.2	26.4	16.3
GDP-GW	423	-8.3	28.2	4.5	4.7
EXT-DEB	218	2.5	80.8	39.1	16.4
RES-IMP	378	1	37	8	8
REER	364	69.1	176	104	18.5
OPNESS	370	26.8	178.6	71.4	36.9
BRENT	427	44.4	121.4	89.7	23.4
VIX	427	11.4	44.1	21.2	9.5
USA-BND	427	1.6	5.1	2.8	0.8

The Table 3 presents the pair wise correlation coefficients between the more important variables used in the analysis.

[15] Goldman Sachs (2000), "A new framework for assessing fair value in EMs hard currency debt", Global Economics Paper, No. 45.

[16] Bellas D., Papaioannou M. and I. Petrova (2010), "Determinants of Emerging Market Sovereign Bond Spread: Fundamentals vs. Financial Stress", AMF Working Paper 10/281.

Table3. Correlations between variables

```
. correlate CPI pub_deb cr_acc_bl exp unemp gdp_gw res_imp reer opnes brent
(obs=325)

             |      CPI  pub_deb cr_acc~l      exp    unemp   gdp_gw  res_imp     reer    opnes    brent
-------------+------------------------------------------------------------------------------------------
         CPI |   1.0000
     pub_deb |  -0.0447   1.0000
  cr_acc_bl  |  -0.0094  -0.5859   1.0000
         exp |   0.1640  -0.3361   0.1766   1.0000
       unemp |   0.0547   0.2150  -0.6531   0.1323   1.0000
      gdp_gw |  -0.0865  -0.0357   0.1759  -0.1302  -0.4150   1.0000
     res_imp |   0.0249  -0.3093   0.3082   0.4347  -0.2108   0.1545   1.0000
        reer |   0.3002  -0.3726   0.0951   0.2740  -0.1095   0.1029   0.0576   1.0000
       opnes |  -0.0130  -0.2251   0.4392  -0.0063  -0.3301   0.0670  -0.1299  -0.4545   1.0000
       brent |   0.4029  -0.0486   0.1384   0.0336   0.0361   0.0594   0.0104  -0.0060   0.1275   1.0000
```

In order to avoid problems with multicollinearity, we have excluded identical variables highly correlated. Most of the variables in the dataset are deflated by nominal GDP in order to remove time trends as explained. Nevertheless, this rescaling is not sufficient as graphical inspections of the panel data show that most of the time series are stationary.

It suggests that unit root tests to panel data are the way forward. Breitung and Pesaran (2008) summarise four popular types of panel unit root tests: Levin, Lin, and Chu (2002), Im, Pesaran, and Shin (2003), and Fisher-type tests. The null hypo study is the presence of a unit root whereas the alternative hypo study is that at least one of the cross-section units in the panel is stationary. The first test assumes a"common root" whereas the latter two allow for individual unit root processes so that the AR coefficients may vary across countries.

Table 4 presents the results of the panel unit root tests for some selected explained and explanatory variables.

Table 4: Panel Unit Root Tests

Test for unit root in level	CPI	pub_deb	cr_acc_bl	CDS	Exp	Unemp	gdp_gwt
Null: Unit root (assumes common ur)							
Levin,Lin et Chu	9,6***	12***	5,7***	2,9***	3,2***	9,3***	12***
Null: Unit root(assumes indi. ur)							
Im, Pesaran and shin	13,4***	15***	11***	5,6***	6,7***	5,24***	6,8***
Fisher-Type	199***	132***	147***	111***	119***	113***	62***

Note: *,**,***, denote Significance at the 10%,5%,1% level respectively.

The panel unit roots test indicates that the most of variables are stationary at the 1% significance level.

2.2 Econometric specification

$$CDS_{it} = c + \theta\, y_{i,t} + \varepsilon_{i,t}$$

where the CDS spread of country $_i$ in year $_t$, $Spread_{it}$, is regressed on the selected variable, y_{it}, θ is the coefficients to be estimated, and ε_{it} is the error term

$y_{i,t} = Control\ variables$;

This study considers both the cross-country and the temporal dimensions. This model considers a panel data estimation, the vector Controls includes variables that have a potential fundamental determinant of sovereign CDS spread (the logarithm of the sovereign credit spread is the dependent variable). These variables are classified on variables that control for aggregate macroeconomic and financial domestic factors, and other global factors that give specify the market sentiment.

This study is primarily interested in the marginal impact of global and domestic variables on sovereign spread.

2.2.1 Hypothesis

We include several variables frequently used in the literature on sovereign default risk. Higher levels of debt to GDP should increase sovereign default risk as a higher level of indebtedness reduces the ability of the government to repay its debt.

In order to capture the state of the economy we control for GDP growth and the expenditure to GDP ratio. Economies that grow fast today or in the future are better able to make required debt service payments due to higher public revenues.

We also consider openness defined as the sum of exports and imports to GDP. More open countries may suffer more from losing access to international capital markets after a possible sovereign default are should thus have lower sovereign default risk.

A shortage of foreign exchange reserves may increase the risk of default on external sovereign debt. We therefore assume that higher foreign exchange reserves to imports and a higher current account balance reduce sovereign default risk.

We also account for consumer price index. Higher inflation rates may reduce sovereign default risk by depressing the real value of domestic sovereign debt. Higher inflation rates may, however, also be associated with higher sovereign default risk as a depreciation of the domestic currency against the foreign currency.

Moreover, we use three indicators that account for global risk factors. The VIX index is calculated as an average of the implied volatilities of eight put and call options written on the S&P 500 index. These implied volatilities are a measure for the expected volatility of the S&P 500, which is interpreted as the riskiness of global financial markets in the future, the Brent Price on dollars.

We use, an AMF support dummy is included in order to test for the impact of the implementation of an AMF lending or facilities arrangement (loans and facilities addressed to BOP imbalances or loans addressed to supporting structural reforms) on sovereign Credit Default.

2.2.2 Empirical analysis

In order to analyze the impact of economic and financial variables on sovereign CDS spread, the study use fixed effects panel regressions.

$$CDS_{it} = \sum_{j=1}^{p} \lambda_{ij}\, y_{i,t} + \mu_i + \varepsilon_{it}$$

where the CDS spread of country $_i$ in year $_t$, $Spread_{it}$, is regressed on the selected variable, y_{it}, λ_{ij} is the coefficients to be estimated, and ε_{it} is the error term.

The fixed effects estimator is used in order to account for an unobserved time invariant country specific impact on sovereign default risk, such as country-specific investor preferences for sovereign bonds. The fixed effects estimator accounts for such country-specific effects and guarantees consistent coefficient estimates. I have also performed robustness checks using the random effects estimator.

Table 5: Hausman specification test

	fixed	rand	Difference	S.E.
CPI	-.0128932	.547067	-.5599602	.
pub_deb	.3016915	.2397503	.0619412	.0453655
cr_acc_bl	.738411	1.41284	-.6744293	.1723922
exp	.9223715	.2088402	.7135313	.2287524
unemp	-.7618453	-.0036772	-.7581682	.1441617
gdp_gw	-.7522354	-1.649289	.8970537	.
res_imp	-.5910676	-.4288755	-.1621921	.074304
reer	-1.381373	-3.836028	2.454655	.3386982
opnes	-.5013338	-.5169302	.0155964	.182219
brent	-.3088882	-.426811	.1179228	.
vix	.0098823	.0120876	-.0022053	.
usa_bnd	-.5590935	-.5642563	.0051628	.
AMF_pgm	- .0448949	.2586351	-.1837402	.

b = consistent under Ho and Ha; obtained from xtreg

B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(14) = (b-B)'[(V_b-V_B)^(-1)](b-B)

= 459.73

Prob>chi2 = 0.0000

The Hausman (1978) specification test indicates that the random effects estimator would not be consistent, and thus I use the fixed effects estimator. The t-values are calculated based on heteroskedasticity-and autocorrelation-robust standard errors clustered on the country level in order to guarantee a reliable assessment of the significance of the results (Stock and Watson, 2008).

Table 6 : ***Déterminants of CDS***

	Coef	**Std. Err**	**P>t**
CPI	-.012	(-0.08)	0.940
pub_deb	.30***	(4.27)	0.000
cr_acc_bl	.73 ***	(3.07)	0.002
Exp	.92***	(3.13)	0.002
Unemp	-.76***	(-4.9)	0.000
gdp_gw	-.75**	(-2.85)	0.005
res_imp	-.59***	(-6.34)	0.000
Reer	-1.3***	(-3)	0.003
Opness	-.50***	(-2.6)	0.010
Brent	-.30**	(-2.8)	0.005
Vix	.09	(0.13)	0.894
usa_bnd	-.55***	(-4.6)	0.000
AMF_pgm	-.04 **	(2.04)	0.042
Constant	2.6***	(4.8)	0.000
R^2 within	.55		
R^2 between	.40		
R^2 overall	.44		
F-test	15.9***		
Nb of obs	324		

*Note: the table reports country fixed effects estimations.t-values (in parentheses) are based on robust standard errors clustered on the country level. We report t-statistics using Hubber-White heteroskedasticity-robust standard errors adjusted for county clustering, in parentheses below the coefficient estimates. Significance at the 10%,5%,1% level is indicated by *, **, ***, respectively.*

Table 6 presents the estimation results for the economic and financial variables confirm several hypotheses. Our model for the entire sample

shows that the public debt, current account balance, expenditure budget balance and GDP growth are statically significant and have the expected signs. A 1percentage point increase in the openness reduces the CDS level by 0.5 percentage point (column 1). Meanwhile, a 1p.p rise in GDP growth produces a 0.7 percentage point reduction in the CDS.

- ✓ **Higher levels of public debt to GDP** significantly increase sovereign default risk suggesting that higher levels of indebt reduce the ability of the government to honor its obligations in the future.

- ✓ **GDP growth** is significant and significantly reduces sovereign default risk in most specifications suggesting that economic growth perspectives are more important to bondholders than current economic growth. Meanwhile, a 1p.p rise in **GDP growth** produces a 0.7% reduction in the CDS.

  We find significant impact for **openness**, indicating that the incentive to default is different for relatively open and closed societies.
  A 1pp increase in **the openness** reduces the CDS level by 0.5 % (column 1).

  For the variables measuring the availability of **foreign exchange reserves**, we find that a higher stock of foreign exchange reserves and a higher **current account balance** significantly reduce sovereign CDS spread in most specifications.

- ✓ **The inflation rate** is based on the consumer price index (CPI). Inflation indicators reflect economic stability and

consumer welfare, high or unpredictable inflation rates are commonly regarded as harmful to an overall economy. Again, the expected sign for the relationship with the CDS spread is ambiguous, as it can have negative and positive effects on the macroeconomy. The negative effects of inflation include decreasing the real value of money and other monetary items, discouraging investment and saving and redistributing purchasing power domestically and internationally, for our case we have a negative impact but not significant.

- ✓ **The real effective exchange rate (REER)** is used as the measure of the exchange rate. The REER is a trade-weighted index of exchange rates, and is a well-known measure of international competitiveness. Furthermore, since exchange rates play a major role in determining the cost of countries' imports and exports, exchange rates can have a big impact on the wider macro-economy through this transmission mechanism. On the real effective exchange rate, we obtain the expected sign, a 10percentage point rise in the real effective exchange rate (Win competitiveness) produces an 5% decrease in the CDS level, as should be the case.

- ✓ **The unemployment** rate reflects the overall health of the macroeconomy, and a high rate of long-term unemployment may impact negatively on a country's economic growth potential (Figlewski et al., 2006) as well as its fiscal position as more transfer payments are required. So we would expect a positive relationship as increased unemployment would increase the riskiness of the fiscal position and macroeconomy as a whole.

- ✓ For the global risk variables, we find that evidence that a higher **U.S. interest rate** significantly decrease sovereign default risk, while the **VIX index** is largely insignificant.

- ✓ For the AMF-Supported Programs, the effect of these lending arrangements on sovereign default risk help the government to cope with liquidity constraints. The AMF program dummy is also statically significant at 5% suggesting (easing short run liquidity constraints) and having the expected sign. The AMF support may be considered as guaranty reflecting the ability of government to honor its obligation in the future from the viewpoint of investors.

Part III: Sovereign risk and governance quality

I. Theoretical overviews

Sovereign risk needs to be evaluated with taking into consideration economic, financial determinants and governance quality as well.

This part surveys the literature that discusses how the government quality could affect the country solvability through improving economic state.

(La Porta, Lopez-de Silanes, Shleifer, and Vishny, 1999), were pioneer in demonstrating the relevant impact of governance quality on economic development that lead to reducing risk, providing efficiency thus obtaining a performant economic. Similarly, Easterly and Levine (1997) argue the strong relation between economic development and institutional quality.

However, considering governance quality as direct determinant of sovereign solvency didn't received a main attention from researchers;

Among the rare studies that discussed this issue was Butler and Fauver (2006), who focused on the link between government effectiveness and sovereign default risk measured by country credit rating. They found a positive and significant impact on sovereign credit risk.

when we talk about government effectiveness, we can't avoid speaking about corruption as one of dimension of governance. Corruption have received the most attention from researchers, the most studies have obtained a positive correlation with sovereign credit risk as it worsens private investment, and deters the public investment see : (Mauro ,1995) , (Svensson, 2005), (Ciocchini et al., 2003);(Butters et al., 2011).

II. Empirical validation

2.1 Empirical strategy

In the empirical part, we test investigate how the government quality affect the valuation of sovereign CDS spread, over time and across countries.

2.1.1 Data

To test the potential effect of institutional variables on the sovereign credit risk we need a set of data:

- Sovereign CDS spread as proxy to the sovereign credit risk, CDS maturity is 5 years
- List of variables that describe the governance quality
- Several macroeconomic variables to control their effect on the sovereign risk in the model

  Bellow in the Table7 ` we summarize the list of variables

Table 7: Definitions and sources of the variables.

Variable	Definition	Source
CDS	Credit default swaps for government bonds, CDS maturity is 5 years	Bloomberg
	Quality of governance	
Rule of law ; *gv_law*	Index shows the degree of confidence in the rule of law in social, police, court, Also give idea about the probability of crime increasing index indicate more efficient legal system	Worldwide Governance Indicators, World Bank, Kaufmann et al. (2010)
Regulatory quality *gv_qual*	Index shows that government is implementing regulations that encourage private sector increasing index indicate a good regulatory quality	Worldwide Governance Indicators, World Bank, Kaufmann et al. (2010)
Government effectiveness *Gv-Effect*	Index shows the state of public service and efficiency of policy formulation and implementation, increasing index indicate more efficient government policies	Worldwide Governance Indicators, World Bank, Kaufmann et al. (2010)
Control of corruption *Gv-Corrup*	Control of corruption captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests.	Worldwide Governance Indicators, World Bank, Kaufmann et al. (2010)

2.1.2 Descriptive statistics

It suggests that unit root tests to panel data are the way forward. Breitung and Pesaran (2008) presente the different types of panel unit root tests: Levin, Lin, and Chu (2002), Im, Pesaran, and Shin (2003),

and Fisher-type tests. The unit roots test indicates all variables are stationary at the 1% significance level.

2.2 Econometric specification

$$CDS_{it} = c + \theta\, y_{i,t} + \delta x_{i,t} + \varepsilon_{i,t}$$

$y_{i,t} = Control\ variables$;

$x_{i,t}$ = Institutional variables ;

We first describe the model specification before presenting the results. The dependent variable is the logarithm of the sovereign credit spread. We are primarily interested in the marginal impact of institutional indicator on sovereign spread.

2.2.1 Hypotheses

We use unbalanced quarterly panel data for Arabic Countries, in the period 2006 to 2018 to specify the impact of institutional variables on sovereign CDS. However, to quantify sovereign default risk, we use CDS spread as proxy taken from Bloomberg.

We choice different sets of institutional variables: the quality of governance, as which may impact the level of sovereign default risk. we use four variables measuring different aspects the quality of governance, summarized by the rule of law, regulatory quality, government effectiveness and control of corruption.

Higher degree of respect of rule of law and higher regulatory quality lead to a better functioning of the legal system, to higher fiscal revenues as it may lead to higher tax compliance , to higher economic stability, hence it may reduce the public debt and the sovereign risk .

We include several control variables (macroeconomic variables) already tested in the first model frequently used in the literature on sovereign default risk.

2.2.2 Empirical analysis

In order to apply the impact of institutional variables above mentioned on sovereign CDS spread, we use fixed effects panel regressions.

$$CDS_{it} = \sum_{j=1}^{p} \lambda_{ij}\, y_{i,t} + \sum_{j=1}^{q} \delta'_{ij}\, x_{i,t} + \mu_i + \varepsilon_{it}$$

where the CDS spread of country $_i$ in year $_t$, $Spread_{it}$, is regressed on the institutional variables, y_{it}, a set of country-specific control variables, x_{it}, and a set of three global variables λ_{ij} , δ'_{ij} are the coefficients that we will estimate, and ε_{it} is the error term.

The fixed effects estimator accounts for such country-specific effects and guarantees consistent coefficient estimates. We have also performed robustness checks using the random effects estimator. However, the Hausman specification test indicates that the random effects estimator would be rejected, and hence we select the fixed effects estimator.

The Table 8 presents coefficient estimates of regression that examine the impact of governance quality on sovereign risk. The dependent variable is the logarithm of sovereign credit risk.

The majority of column displays a negative relation between a country's level of government effectiveness and its sovereign credit spread.

The results indicate robust evidence that a higher quality of governance, as measured by higher degree of respect of rule of law and regulatory quality is associated with lower sovereign default risk.

These relations are highly significant. The explanatory power of quality of governance is substantial; it explains at minimum 44% of the total variation in sovereign credit spread in our sample. This result confirms the model prediction that better-governed countries offer less

default risk and, consequently, bear a smaller sovereign credit risk premium.

The reason is that government effectiveness is associated with increase in the economy growth, reduce tax evasion, a higher ability to pay, less default incentive, and an incitation to avoid excessive debt accumulation.

Besides with a higher effectiveness of the administration and the legal system, the government may ameliorate the effectiveness of budget consolidation measures and, thus, convince financial investors that a sovereign default will not happen.

For government effectiveness, no significant impact on sovereign CDS spread is detected, higher levels of effectiveness may increase the cost of doing business and economic uncertainty thus harming economic development and sovereign solvency.

The results for the control variables confirm several hypotheses presented in the previous part.

Table 8. Quality of Governance

Regulatory quality		**-.93*** (-4.63)**				
Rule of law			-.79*** (-2.86)			
Govt effectiveness				-.13 (0.24)		
Control of corruption					-.63***(-4.12)	
CPI	-.012 (-0.08)	.022 (1.29)	-.13 (-0.79)	.02 (-0.17)	.06 (0.41)	-.05 (0.33)
pub_deb	.30*** (4.27)	.37*** (5.3)	.29*** (4.26)	.29***(4.23)	.3*** (4.4)	.31***(4.47)
cr_acc_bl	.73 *** (3.07)	.65** (2.81)	.87*** (3.2)	.72*** (2.98)	.68***(2.92)	.74***(3.14)
Exp	.92*** (3.13)	.71*** (2.4)	.93*** (3.2)	.91***(3.11)	.86*** (3)	.69*** (2.29)
Unemp	-.76*** (-4.9)	-1.03*** (-6)	-.87*** (-5.5)	-.77***(-5)	-.91*** (-5.9)	-.81*** (-5.3)
gdp_gw	-.75** (-2.85)	-.72** (-2.8)	-.74***(-2.85)	-.75***(-2.85)	-.75***(-2.94)	-.72***(-2.76)
res_imp	-.59*** (-6.34)	-.58*** (-6.4)	-.59***(-6.49)	-.58***(-6.14)	-.61***(-6.76)	-.54*** (-5.7)
Reer	-1.3**(-3)	-1.22*** (-2.7)	-1.21**(-2.9)	-1.36*** (-3)	-2.07***(-4.4)	-1.27**(-2.8)
Opness	-.50*** (-2.6)	-.19 (-0.99)	-.51*** (-2.71)	-.49*** (-2.53)	-.5*** (-2.99)	-.42**(-2.22)
Brent	-.30*** (-2.8)	-.39*** (-3.37)	-.33*** (-3.08)	-.31*** (-2.87)	-.31***(-2.98)	-.34*** (-3.18)
Vix	.09 (0.13)	.06 (0.84)	.011*** (0.16)	.09 (0.13)	-.01 (0.13)	.02 (0.28)
usa_bnd	-.55*** (-4.6)	-.44*** (-3.8)	-.6** (-5.06)	-.55*** (-4.7)	-.55*** (-4.7)	-.56*** (-4.7)
AMF_pgm	-.04 ** (2.04)	.04 (1.1)	.07** (1.9)	.06* (1.8)	.03 (1.08)	.05 (1.48)
Constant	2.6*** (4.8)	3.9*** (6.57)	4.3 (5.26)	2.9*** (3.98)	3.8*** (6.35)	2.5*** (4.58)
R^2 within	.55	.46	.44	.42	.46	.44
R^2 between	.40	.34	.11	.25	.17	.31
R^2 overall	.44	.2	.12	.13	.22	.16
F-test	15.9***	17.3***	15.67***	14.86***	16.8***	14.8***
Nb of obs	324	324	324	324	324	324

*Note: the table exposes fixed effects estimations. We report t-statistics using Hubber-White heteroskedasticity-robust standard errors adjusted for county clustering, in parentheses below the coefficient estimates. Significance at the 10%,5%,1% level is indicated by *,**,***, respectively.*

The majority of variables (rule of law, regulatory quality and control of corruption) displays a negative relation between a country's level of government quality and its sovereign credit spread. These relations are highly significant. This result confirms the model prediction that

better-governed countries offer less default risk and, consequently, bear a smaller sovereign credit risk premium.

Conclusion

Through this study, we have tried to contribute to a better understanding of the mechanisms behind sovereign default risk in the Arab region, motivated by a context of elevated complexity triggered by turmoil of financial. Besides we were motivated by the Arab CDS market that is relatively young market, which has not been the subject of a great deal of research so far.

We finally built up our own dataset of individual sovereign CDS of 11 Arab countries and corresponding macroeconomics, financial, and institutional variables with quarterly frequency data information.

Therefore, this study consists of two empirical contributions that seek to find answers to some research question regarding the concept of sovereign risk, in order to do so, we have structured 2 empirical works which examines the sovereign risk from different angles, however, the results of each part can be linked:

We have obtained encouraging results: the estimation results confirm several hypotheses, and present the expected signs and effects, we found strong evidence that the majority of variables are statistically significant.

In addition, our project dealt with a fast-evolving landscape. While this study has the added value of being one of the recent studies of the Arab region sovereign risk, and it's implied added difficulty in formulating theoretical expectations and carrying out empirical verifications.

As a result, considerable challenges, and difficulties have hampered our analysis along the way. These efforts led to a set of key results that provide both a contribution to ongoing debates and a framework for future analysis

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Appendix

Appendix A1

A.1.1 Countries

Countries	Period
Qatar	2006 :Q1 - 2018:Q4
Kuweit	2008 :Q4 - 2018:Q4
UAE	2008 :Q1 - 2018:Q4
Bahrein	2008 :Q1 - 2018:Q4
Saudi_arab	2008 :Q3 - 2018:Q4
Tunisia	2008 :Q3 - 2018:Q4
Morroco	2007 :Q3 - 2018:Q4
Algeria	2013 :Q1 - 2018:Q4
Egypt	2008 :Q1 - 2018:Q4
Lebanon	2008 :Q3 - 2018:Q4
Iraq	2010 :Q1 - 2018:Q4

A1.2 Determinants of CDS, Fixed effect

```
. encode ctr, generate(ctr1)
. xtset ctr1 T
       panel variable:  ctr1 (unbalanced)
        time variable:  T, 1 to 52
                delta:  1 unit
```

```
. xtreg CDS CPI pub_deb cr_acc_bl exp unemp gdp_gw res_imp reer
opnes brent vix
>  usa_bnd AMF_pgm, fe
```

```
Fixed-effects (within) regression               Number of obs      =       324
Group variable: ctr1                            Number of groups   =        11

R-sq:  within  = 0.4291                         Obs per group: min =         1
       between = 0.0558                                        avg =      24.9
       overall = 0.1303                                        max =        36
                                                F(14,297)          =     15.94
corr(u_i, Xb)  = -0.4660                        Prob > F           =    0.0000

------------------------------------------------------------------------------
         CDS |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         CPI |   -.0128932    .1703202    -0.08   0.940    -.3480807    .3222942
     pub_deb |   .3016915   .0707193     4.27   0.000     .162517     .440866
```

```
  cr_acc_bl |    .738411   .2405898     3.07   0.002     .2649341
1.211888
       exp |  .9223715    .294764     3.13   0.002     .3422808   1.502462
     unemp |  -.7618453   .1531673    -4.97   0.000    -1.063276   -
.4604146
    gdp_gw |  -.7522354    .264403    -2.85   0.005    -1.272576   -
.2318947
   res_imp |  -.5910676    .093185    -6.34   0.000    -.7744542   -
.407681
      reer | -1.381373   .4530482    -3.05   0.003   -2.272965   -.489782
     opnes |  -.5013338   .1924356    -2.61   0.010    -.880044    -
.1226237
     brent |  -.3088882   .1081205    -2.86   0.005    -.5216676   -
.0961089
       vix |  .0098823   .0743774     0.13   0.894   -.1364912    .1562558
   usa_bnd |  -.5590935   .1194756    -4.68   0.000    -.7942196   -
.3239675
   AMF_pgm |  - .0448949   .0367165     2.04   0.042     .0026373
.1471525
     _cons |  2.688116   .5523109     4.87   0.000    1.601177   3.775055
-------------+----------------------------------------------------------------
    sigma_u |  .44037186
    sigma_e |  .15971582
        rho |  .88375161   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(12, 297) =    25.06                 Prob > F = 0.0000


. estimates store fixed.
```

A1.3 Determinants of CDS, Random effect

```
. xtreg CDS CPI pub_deb cr_acc_bl exp unemp gdp_gw res_imp reer
opnes brent vix
>  usa_bnd AMF_pgm, re
```

```
Random-effects GLS regression                   Number of obs     =       324
Group variable: ctr1                            Number of groups  =        11

R-sq:  within  = 0.2978                         Obs per group: min =         1
       between = 0.7548                                        avg =      24.9
       overall = 0.7353                                        max =        36

                                                Wald chi2(14)     =    858.34
corr(u_i, X)   = 0 (assumed)                    Prob > chi2       =    0.0000

------------------------------------------------------------------------------
         CDS |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         CPI |    .547067   .2022778     2.70   0.007     .1506098    .9435242
      pub_deb |    .2397503   .0542512      4.42   0.000      .1334199
.3460808
    cr_acc_bl |     1.41284   .1678225      8.42   0.000      1.083914
1.741766
         exp |   .2088402   .1858983     1.12   0.261    -.1555138    .5731941
```

```
      unemp |  -.0036772   .0517457    -0.07   0.943    -.1050969
.0977426
     gdp_gw |  -1.649289   .2802082    -5.89   0.000    -2.198487   -
1.100091
    res_imp |  -.4288755   .0562349    -7.63   0.000    -.5390939   -
.3186571
       reer |  -3.836028   .3008923   -12.75   0.000    -4.425767   -
3.24629
      opnes |  -.5169302   .0618686    -8.36   0.000    -.6381905   -
.39567
      brent |  -.426811   .1345021    -3.17   0.002    -.6904303  -.1631917
        vix |   .0120876   .0980092     0.12   0.902    -.1800069   .2041822
    usa_bnd |  -.5642563    .153563    -3.67   0.000    -.8652343   -
.2632783
    AMF_pgm |   .2586351     .04146     6.24   0.000     .177375
.3398952
      _cons |  2.319318   .5732141     4.05   0.000    1.195839   3.442797
-------------+----------------------------------------------------------------
    sigma_u |          0
    sigma_e |  .15971582
        rho |          0   (fraction of variance due to u_i)
```

Appendix A2

A2.1 Impact of institutional variables

```
. xtreg CDS l_gv_corrup CPI pub_deb cr_acc_bl exp unemp gdp_gw
res_imp reer opn
> es brent vix usa_bnd AMF_pgm, fe
```

```
Fixed-effects (within) regression               Number of obs      =       324
Group variable: ctr1                            Number of groups   =        11
R-sq:  within  = 0.4601                         Obs per group: min =         1
       between = 0.1738                                        avg =      24.9
       overall = 0.2271                                        max =        36
                                                F(15,296)          =     16.81
corr(u_i, Xb)  = -0.4839                        Prob > F           =    0.0000

------------------------------------------------------------------------------
         CDS |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
 l_gv_corrup |   -.639545    .155182    -4.12   0.000    -.9449448   -.3341452
         CPI |   .0691568   .1671042     0.41   0.679    -.259706    .3980196
     pub_deb |   .3059447   .0688975     4.44   0.000     .1703537    .4415358
   cr_acc_bl |   .6860909   .2347092     2.92   0.004     .2241807    1.148001
         exp |   .8661166   .2874625     3.01   0.003     .3003873    1.431846
```

unemp | -.9165204 .1538527 -5.96 0.000 -1.219304 -.6137368

gdp_gw | -.7560857 .2575644 -2.94 0.004 -1.262975 -.2491962

res_imp | -.6151586 .0909623 -6.76 0.000 -.7941733 -.4361438

reer | -2.079981 .4727628 -4.40 0.000 -3.010383 -1.149578

opnes | -.5625835 .1880454 -2.99 0.003 -.9326589 -.1925081

brent | -.3138377 .1053302 -2.98 0.003 -.5211287 -.1065468

vix | -.0165918 .0727374 -0.23 0.820 -.1597398 .1265562

usa_bnd | -.5570308 .1163858 -4.79 0.000 -.7860793 -.3279823

AMF_pgm | -.0397629 .0367685 1.08 0.280 -.0325979 .1121237

_cons | 3.883142 .611186 6.35 0.000 2.680321 5.085963 ----------

+---------- sigma_u | .41272507

sigma_e | .15558386

rho | .87557673 (fraction of variance due to u_i)

F test that all u_i=0: F(12, 296) = 21.22 Prob > F = 0.0000

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