The impact of Israeli Geopolitical Risks on the Lebanese Financial Market: A Destabilizer Multiplier

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Abstract

This paper is the first econometric study that investigates empirically the impact of Israeli Geopolitical Risks on the Lebanese financial market.
We run Vector Autoregression model, Granger causality tests, generalized impulse response functions and Variance Decomposition Analysis, to assess the impacts of Israeli Geopolitical Risks (GPRs) on the Lebanese financial stability, on the Foreign reserves' depletion and the economic activity.
To measure the Lebanese financial stability, we consider the Lebanese Financial Stress Index (FSI) that was initially calculated by Ishrakieh *et al.* (2019, 2020). The Geopolitical Risks Index (GPRI) are measured by taking the continuous variable calculated on a monthly basis to best suit time series analyses, calculated by Dario Caldara & Matteo Iacoviello in 2018.

This paper illustrates many novelties such as incorporating the Financial Stress Index for the first time in an empirical, econometric study. Also, the adequate level of International Reserves (IRs) is taken by calculating the ratio of International reserves to Foreign currency deposits as a more appropriate measurement for a dollarized country. Similarly, to measure the economic activity and the business cycle on a monthly basis, we consider the employment in private sector as a better proxy than traditional variables considered in previous studies.

Results show that if any financial crisis occurs in Lebanon, an economic recession is more likely to follow within six months. Also, we find that International Reserves (IRs) shocks may cause a financial crisis thus economic recession. Finally, we conclude that Israeli GPRs are destabilizer multiplier: they trigger financial instability and economic recession in Lebanon. They cause IRs shocks, threaten the Lebanese financial market and provoke economic recession. To sustain financial market stability, policy makers should not only accumulate sufficient level of IRs relatively to foreign deposit, but also, they have to avoid Israeli-Hezbollah tensions.

Keywords: Financial Crises, Geopolitical Risks, Economic Activity, Lebanon, Israel, VAR, Granger Causality.

JEL: G01, F50, F51, C32,

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Introduction

Lebanon has historically attracted loads of studies in political science. However, econometric studies that aim to assess Middle East geopolitical risks' impact and more particularly, the Lebanese economy vulnerability remain extremely rare. Most of Lebanese geopolitical conflicts studies are published by United Nations and the World Bank where they list in percentage the cost of geopolitical conflicts on Education, Welfare, Agriculture and Employment. Such reports lack econometric analysis.
It goes back to 1999 where Philip Schrodt tried to create a political early warning indicator to assess tensions between Israel and the Middle East, or more precisely between Israel and Lebanon (South Lebanon and/or Hezbollah). Albeit interesting political outcomes, economic outcomes were limited and subject to high discrepancy due to lack of data. Since then, economic studies exploring the linkage between geopolitical instability and the Lebanese financial market remain limited.

This paper is the first econometric study that investigates the economic impact of Israeli Geopolitical Risks (GPRs) such as wars, political tensions or economic/politic sanctions on Lebanon, a country known by its "*multidimensional conflicts"*[1] feature because:

Economically, Lebanese authorities and policy makers must deal with vulnerable indicators' levels that have overshoot the tolerate level prescribed by the International Monetary Fund (see IMF Strategy, Policy, and Review Department 2017) such as Debt and external debt level, public deficit, trade deficit, accumulation of IRs, remittances etc.

Politically, Lebanon is characterized by being more complex than other Arab countries. Most of the countries are divided by two main different political thoughts or group ethnics-*duopoly*-. Whereas in Lebanon, the country is known by diversity of parties-incompatible most of time-, making them smaller, more vulnerable and subject to political instability.

Geographically, Lebanon and Israel[2] have common frontiers and have always been the *best of enemies*: They shared several wars and conflicts memories, tensions with Hezbollah, thus, represent threats for each other.

Not surprisingly that empirical econometric studies highlighting the linkage between geopolitical instability and the financial market of Lebanon are nonexistent. An economic-financial index in Lebanon or alternative index, able to measure stressful periods overtime and able to be incorporated in empirical studies was still absent until 2019. After explaining the methodology of constructing the financial stress index for Lebanon (FSI) that was first accomplished by Ishrakieh-Mansour *et al.* (2020), we update it to November 2018, and we proceed by the first empirical and econometric application of the FSI.
The Geopolitical Risks Index (GPRI) is calculated by Caldara & Iacoviello (2018). Unlike previous discrete GPRI listed in literature, this GPRI is a continuous variable calculated on a monthly basis thus more consistent with time series analyses.

Using graph analysis, then econometric tests, we measure the impacts of Israeli GPRs on the Lebanese financial stability, the International reserves depletion and the economic activity.
The remainder of the paper is organized as following:
Section I, entitled "literature review" gives an overview of previous studies that emphasize the linkages between political - geopolitical stability with economic or financial performances.
Section II breaks down data taken or used in calculating the updated version of FSI. In this section also, we interpret graphically the FSI and evoke eventual relations between the FSI, the economic activity and geopolitical risks to be verified empirically in next section.

[1] Expression used by Jeremy M. Sharp, Analyst in Middle East Policy
[2] Occupied Territories

Section III, entitled "Methodology and econometric framework", exposes econometric models, covering prerequisite time series tests, Vector Autoregression model (VAR), Granger causality test, generalized impulse response functions and Variance Decomposition Analysis.
Section IV calibrates the model and interprets results found.
The conclusion summarizes findings, that the banking system is fragile and subject to volatility despite the crucial economic role it plays throughout years. IRs do effectively play a crucial role in stabilizing the Lebanese financial market. Since the Israeli GPRs seem to granger cause stress period in Lebanon and enhance economic recession by triggering IRs fluctuations, we conclude that Israeli GPRs are a destabilizer *multiplier.*

I. Literature Review

In the late 90s and early 2000s, the world has witnessed a series of emerging markets' financial crises, from Mexico (in 1994), to Turkey (in 2001), passing by Argentina, Brazil, Russia, Korea, Thailand, Indonesia and Philippines. Financial crises have become so familiar that economists attributed names and expressions such as fear of floating by Calvo and Reinhart (2002), psychological impact and fear of losing International Reserves by Aizenman *et al.* (2012), twin crises by Kaminsky and Reinhart (1999), mania by Kindleberger (1996), Russian virus and Asian flu by Kristin Forbes (2000) and tequila effect by Uribe (1996).

Also, in the 1990s, a dozen of non-emerging countries also suffered profoundly from financial crises, after genocides and politicides movements.
Accordingly, politics-geopolitics stability and economics-financial stability seem to play similar role in triggering financial crises. Indeed, many economists such as Kaminsky (1999), Aghion *et al.* (2018), Rogoff (1999), Sach *et al.* (1996), Schrodt (1999), Eishengreen *et al.* (1995), Mansour-Ichrakieh and Zeaiter (2019) among others have been aware of Geopolitical Risks (GPR) impact on the financial market. They have included GPRs econometrically in their studies, aiming to provide guidance for national and international policymakers in predicting or mitigating future financial crises.

Besides, GPRs impacts differ depending on the stability state or regime of the economy. For instance, a fall of a one single missile (during period of peace) will cause an exaggerated response of the overall economic agents, while during a war, one additional rocket or missile will pass by unseen. Consequently, **predicting GPR**, especially in **stable-low stress period** could be a guide indicator for policy makers and for the private sector too (Durante and Zhuravskaya, 2018). It helps local and foreign investment and stock market decisions (Thomann, 2013; Caldara & Iacoviello, 2018).

a. Political Stability and Economic Performance

The linkage between political stability and economic performance has been widely studied in several economic fields such as financial and energy economics, development economics and income inequality (Barro, 1996; Alesina *et al.,*1996; Acemoglu *et al.,* 2008; Brunetti, 1997; Przeworski and Limongi, 2004; Tavares and Wacziarg, 2001; Asher and Novosad, 2017; Brady *et al*., 2016; Aladlani, 2019). Most of empirical studies admit that these two are always interrelated; in other terms, there is no economic growth without being preceded or followed by political stability (Alesina *et al.*, 1996; Feng, 1997; Jong-a-Pin, 2009).
Some economists argue that economic performance promotes political stability (Barro, 1999; Duch and Stevenson, 2008; Kayser and Peress, 2012; Sumanjeet , 2015; Haggard and Kaufman, 2008, 2018; Geddes, 1999; Treisman, 2014, 2018). Other economists think differently, they found that political stability is more likely responsible for enhancing economic growth through investments, credits, consumption and others (Aizenman and Marion, 1993; Acemoglu *et al.,* 2005, 2014; Bernanke, 1983; Canes-Wrone and Park, 2014; Aisen and Veiga, 2013; Cohen *et al*., 2011). For instance, Clague *et al.* (1997), and Grier and Munger (2006) have shown that even if the current policy regime is undesirable but stable in time (so-called duration), positive economic outcomes are expected. Briefly, politics and economics constitute a couple: they benefit and suffer together from instability consequences.

Later on, studies were more oriented toward the impact of political institutions on economic growth, the relationship between income and policy regime, the role of governance, corruption and constitution in promoting stability and development. According to Andersen and Aslaksen (2008), Azerki and Bruchner (2011), Apergis and Payne (2014), Bodea and ELbadawi (2016) and Ali *et al.* (2016), the impact of institution can be so harmful that it might convert natural resources' abundance from a blessing to a curse. Political stability in economic studies refers to one or a couple of the following indicators: *–a-* Voice and Accountability, *-b-* Political Stability and Absence of Violence/Terrorism, *-c-* Government Effectiveness,

*-d-*Regulatory Quality, *-e-*Rule of Law, *-f-* Control of Corruption, *-g-* institution and bureaucratic, *-h-* policy regime and others.
Although politics and economics are interconnected, no one has the exclusive power in affecting the other, but it represents one significant factor among others.

b. Geopolitical risks, financial market and economic performance.

Economic positive outcomes of financial stability have been empirically is verified by Diaz-Alejandro (1985), Rajan and Zingales (1996), Sahay *et al.* (2015), Aizenman, *et al*. (2015), Durusu-Ciftci and Yetkiner (2017). They find that financial market stability promotes economic growth through facilitating credit conditions, encouraging investments and purchases, as well as insuring better expectation in the Long term. Through the literature, the Financial stress index is the most common variable used empirically to represent the financial sector in studying the causality with economic growth (Calvo and Talvi, 2008; Rogoff and Reinhart, 2009; Hakkio and Keaton, 2009; Aklan, *et al.,* 2015; Claessens, *et al.,* 2008).
Beck, *et al.* (2007) and Burgess and Pande (2005) show that financial development can even contribute in reducing poverty, since changes in investments and economic activities resulting from financial stability are more proportional. On the other side, Kaminsky and Reinhart (2002), Mendoza and Terrones (2008), Calvo and Talvi (2005), Reinhart and Rogoff (2010) find that a financial crisis is inevitable after a recession.

Nowadays, with the economic globalization and the financial openness, countries have become more connected and dependent, not only economically but also geopolitically. As proved by Mansour-Ichrakieh and Zeaiter (2019), a political instability in one influenceable country such as Russia or Saudi Arabia can either result in threats for neighbors or on the contrary, can be perceived as an opportunity for "rival" neighbors who take advantage of geopolitical instability. Whether GPRs externality is "threat" or "opportunity", it becomes a relevant indicator to be included when studying financial crisis and economic growth.
Geopolitical risks refer to a measurement of risks associated with war, terrorist acts and tensions between states that can affect the normal and the peaceful course of international relations.
Geopolitics are seen to be a more completed, realistic, updated and extended version of political stability. It is somehow a way to continue including politics' consequences without being limited by country's official borders. For example, when USA strengthens or abolishes sanctions toward Iran, all the region (Iran, and/or its allied countries and/or adversaries Gulf countries) will either take advantages or incur inconvenience.

GPRs analyses in political science went back to the 70s with Choucri and Robinson (1978) and Singer and Wallace (1979). They tried to elaborate geopolitical Early Warning Indicators (EWI) such as "arms races" that are predecessor to war. Philip Schrodt (1999) has mentioned in his study that prior geopolitical EWI elaborated by Laurance (1990), Schrodt (1995), Bueno de Mesquita *et al*. (1985,1996), Cimbala (1984), Hudson (1991), Hughes (1984) and Ward (1985)[3] failed because of data limitation and statistical discrepancy.

With the upsurge terrorists' attacks, regional wars and new form of collective violence, the interest on GPRs increased significantly, and "*will undoubtedly change and multiply due to increased interaction*[4]". (Barro, 2006; Gourrio, 2012; Schrodt and Gerner, 2004; Hendrix, 2019; Plakandaras and Wong, 2019; Lee, J. E. 2019; Bouras, *et al.,* 2019; Mansour-Ichrakieh and Zeaiter, 2019; Apergis *et al.,* 2018; Cheng and Chiu, 2018; Kirikkaleli, D, 2016).

[3] Inn Schrodt (1997)
[4] Lacoste Yves. 2003. *De la géopolitique aux paysages: Dictionnaire de la géographie*. Paris: Armand Colin

c. Measuring Geopolitical Risk and Economic/financial stability

GPR components variables are all related to social-human behaviors. Calculating GPR remains a challenging task. (Bloomberg, *et al*., 2004; Tavares, 2004; Glick and Taylor, 2008, 2010). This index is based on a "tally of newspaper articles covering geopolitical tensions and examining its evolution and effects since 1985". Having tested the newly constructed GPR index, Caldara and Iacoviello (2018) find that it reveals "spikes around the Gulf War, after 9/11 attacks, during the 2003 Iraq invasion, during the 2014 Russia-Ukraine crisis, and after the Paris terrorist attacks". Indeed, Das, *et al.* (2019) have adopted Caldara and Iacoviello (2018) index and found this index to more specialized since it captures specific events and is expected to have explicit impact on the financial variables.

As for the financial crisis, it usually refers to -1- equity market (drop or fluctuation of stock prices); -2- the currency crises, also called a balance of payments crisis (the exchange rate misalignment), -3- the Banking crisis (the flight to capital and Bank runs) or -4- the debt crisis the (sovereign default in paying back debts or debt services). Since markets and sectors are closely interconnected, each sector's problem often spreads to other sectors[5] and so worsen consequences.

The deleterious losses of financial crises have enhanced economic and econometric studies to focus primarily on breaking down financial crises and on identifying Early Warning Indicators (EWI) also known as vulnerable indicators for each sector or market.

Instead of considering one EWI such as debt level or foreign debt level or foreign reserves accumulated etc.., Bank of Canada (Illing and Liu, 2003, 2006) has introduced an index called Financial Stress Index (FSI), that includes several EWI. The FSI measures the vulnerability of the overall financial sector and improves the prediction and the identification of financial stress episodes. Later on, the FSI has been developed and elaborated for many countries such as Denmark (Hansen, 2006), Canada (Misina and Tkacz, 2008), Honk Kong (Yiu *et al.*, 2010) , Sweden (Sandahl *et al*., 2011), Greece (Louzis and Vouldis, 2013), and France (Aboura and Roye, 2017) among others.

In USA, Hakkio and Keeton, (2009), Kliesen and Smith, (2010), and Oet *et al*. (2011) have respectively constructed an FSI for the Federal Reserve Bank (FRB) of Kansas City, the FRB of St Louis and the FRB of Cleveland.

Most of the constructed FSIs of emerging countries are based on the IMF Methodology, by Cardarelli *et al*. (2009), such as for Egypt, Turkey, Bulgaria, Czech Republic, Hungary, Poland, and Russia (El-Shal, 2012; Cevik *et al*., 2016; Dahalan *et al*., 2016; Tng *et al.,*2015).

A Financial Stress Index has finally landed in Lebanon. Ishrakieh *et al.* (2019, 2020), have constructed the first financial stress index for Lebanon following broadly the IMF's emerging market FSI methodology, but customized with additional vulnerable indicators to fit better a developing and dollarized country like Lebanon. No empirical studies have been elaborated with the Lebanese FSI yet. This paper will develop for the first-time an empirical study of the FSI, aiming to detect and to assess variables that trigger the financial instability of Lebanon.

[5] For example, concerns about a country's fiscal deficit might lead to a run on the exchange rate, or undermine confidence in banks holding government debt, thereby triggering a banking crisis.

II. Data and Graph Analysis

All data are on a monthly basis from January 1998 to November 2018 and are taken from the Central Bank of Lebanon (BDL), the Datastream and the Federal Reserves Fred-St Louis. In running econometric models, variables are calculated in percentage growth rate, from February 1998 to November 2018. The descriptive statistics and variable correlations are respectively reported in table 1 and table 2.

a. The Lebanese Financial Stress Index: FSI

The Lebanese Financial Stress Index' aim is to express in values the increase of uncertainty, panic, change of expectations about future financial losses in the financial market, which is composed of the banking sector, the stock market and the exchange & debt markets.

The FSI constructed by Ishrakieh *et al.* (2019, 2020) is being updated to November 2018[6] with minor modifications. It includes main EWIs of each of the Banking sector, the Stock or Equity market and the Foreign Exchange & Debt markets[7]. Its construction is consistent with the methodology of Cardarelli *et al.* (2009) and Balakrishnan *et al.* (2009, 2011) but it is extent, developed and tailored, by including the dollarization rate to better represent a developing dollarized country.

b. Business Cycle

In Lebanon, a GDP[8] proxy so called Coincident Indicator (CI) is calculated on a monthly basis by BDL. It includes electricity production, petroleum derivatives imports, cement deliveries, money stocks, cleared checks, imports, exports and passenger flows. Using the fluctuation of CI that reflects the overall economic activity, Jad (2017) defines business cycle (recession and expansion) following Bry & Boschan's (1971) methodology. Recession periods are reported graphically in figure 2 (Shaded areas)

c. Economic activity ECO

In running empirical models, economists such as Kaminsky and Reinhart (2002), Mendoza and Terrones (2008), Diaz-Alejandro (1984), Calvo and Talvi (2008), Rogoff and Reinhart (2010), Demetriades *et al.* (2017) among others have taken the Industrial Production Index (IPI) as a proxy of GDP. Since neither GDP, nor IPI nor capital stock data exist on a monthly basis in Lebanon, and since employment and IPI are considered in the literature among the best proxy for economic business cycles, we take employment level in the private sector as proxy of economic activity. It is calculated on a monthly basis and seasonally adjusted by the Federal Reserves-Saint Louis. The correlation between employment in the private sector (yearly) and the GDP constant values (yearly basis) has reached 88% and is reported in Table 3.

d. Geopolitical Risks Index -GPRI

The GPRI data are taken from Caldara and Iacoviello (2018) who have constructed, on a monthly basis, a continuous variable (rather than discrete), appropriate for time series empirical studies that best reflects geopolitical risks, military-related tensions, nuclear tensions, war threats, terrorist threats, and the beginning of a war. The GPRI is constructed for several countries, mainly those who have international political and geopolitical influences.

[6] FSI monthly data are available upon request to layal.ichrakieh@lau.edu.lb or drlayalmansour@gmail.com
[7] For more details, see Ishrakieh L.M, *et al.*(2020)
[8] In Lebanon, the GDP is subject to high discrepancy, and it is not calculated on a monthly basis.

e. International reserves: The adequate level in a dollarized country.

The International Reserves (IRs), also known as Foreign Reserves (FXR), have rapidly increased since early 90s, about six-fold in the past decade. the race of hoarding IRs has raised the question of whether this accumulation is excessive "*too much of good things*[9]" or whether it results from "*psychological impact*" in seeking to hedge against any recurrence (Aizenman *et al.,* 2010). Later on, mathematics and macro-econometric studies that incorporate costs and opportunity costs of IRs were elaborated to define the adequate level of IRs. According to the IMF, the adequate level of IRs (if required level is not respected) became an early warning indicator or a vulnerable indicator.
Outcomes of IMF studies by Osrey and Sheehy (2011) and economists such as Jeanne and Rancière (2009), Jeanne (2007), Durdu *et al.* (2009), Obstfeld *et al.* (2008; 2009), that have best contributed in assessing empirically the adequate level of hoarding IRs against *sudden stop* are the following:

- IRs/GDP The IRs to Gross Domestic Product (GDP) ratio is considered a general measurement with a little theoretical or empirical backing, usually used as a scaling factor for cross-country analysis.

- IRs/M2: The IRs to broad money (typically M2) ratio is usually informative for countries with large banking sector and very open capital accounts. IRs/M2 can be useful to capture capital flight risks since many recent capital account crises have been accompanied by outflows of residents' deposits. (The upper end of a prudent range for reserve holdings is typically set at 20 percent).

- IRs/IM: The IRs to Import ratio also called the import cover ratio might be an informative measurement of adequacy for countries with less open capital accounts. The ratio focuses on the duration of import that IRs can cover in case a shock occurs (typically 3 months of Import).

- IRs/STED: The IRs to short-term external debt ratio known as Guidotti-Greenspan Rule[10] remains the "rule of thumb" to guide reserve adequacy since 2009. IRs level should cover hundred percent of short-term external debt. This ratio became an indicator of crisis risk that is the most widely used standard of adequacy in countries indebted in foreign currencies.

Unlike emerging countries whose IRs accumulated result mainly from trade balance surplus Foreign Direct Investment (FDI) or Tourism, Lebanon holds IRs by getting indebted in foreign currencies from private banks and from foreign institutions and organizations. Indeed, throughout decades, Lebanon suffers from a severe trade balance deficit where imports exceed exports by five to ten times (annex 1).
In addition, Lebanon is highly dollarized, and its dollarization rate that exceeds 72%, goes toward "*absorbing*" relatively more foreign currencies IRs. Indeed in 2017, the IMF country report for Lebanon, entitled financial system stability assessment has stated that "*A common shock to bank liquidity, leading to a demand for foreign currency, could result in a drop in international reserves (1 percent of deposits are equivalent to 3.7 percent of reserves)*".

Consequently, in a dollarized country, a "more" adequate level of hoarding IRs is calculated by taking the ratio of IRs to Foreign Currencies Deposit (IRFX). According to Gonçalves (2007)-IMF, Garcia and Soto (2004), Durdu *et al.*(2009), Calvo *et al.*(2008) who studied adequate level of IRs in dollarized countries, found that money demand in foreign currencies is highly correlated with sudden stop and systemic crises and thus taking the vulnerable indicator IRFX would be more informative. We report in Annex 2 ratios of IRs/M2, IRs/IM, IRs/FX and IRs/STED.

[9] In fact, IRs are considered as auto-insurance against future crises (Calvo and Reinhart, 2000 and Calvo, 2006), guarantees better exchange rate stability and promotes mercantilist export promotion as well as economic growth (Aizenman *et a*l., 2004;2007; 2008; and 2010) and Vidon (2007).
[10] According to Greenspan and Guidotti (1999), a country needs to maintain hard currency reserves equal to at least 100% of their short-term foreign debt (maturing in the next 12 months) in order to avoid credit default.

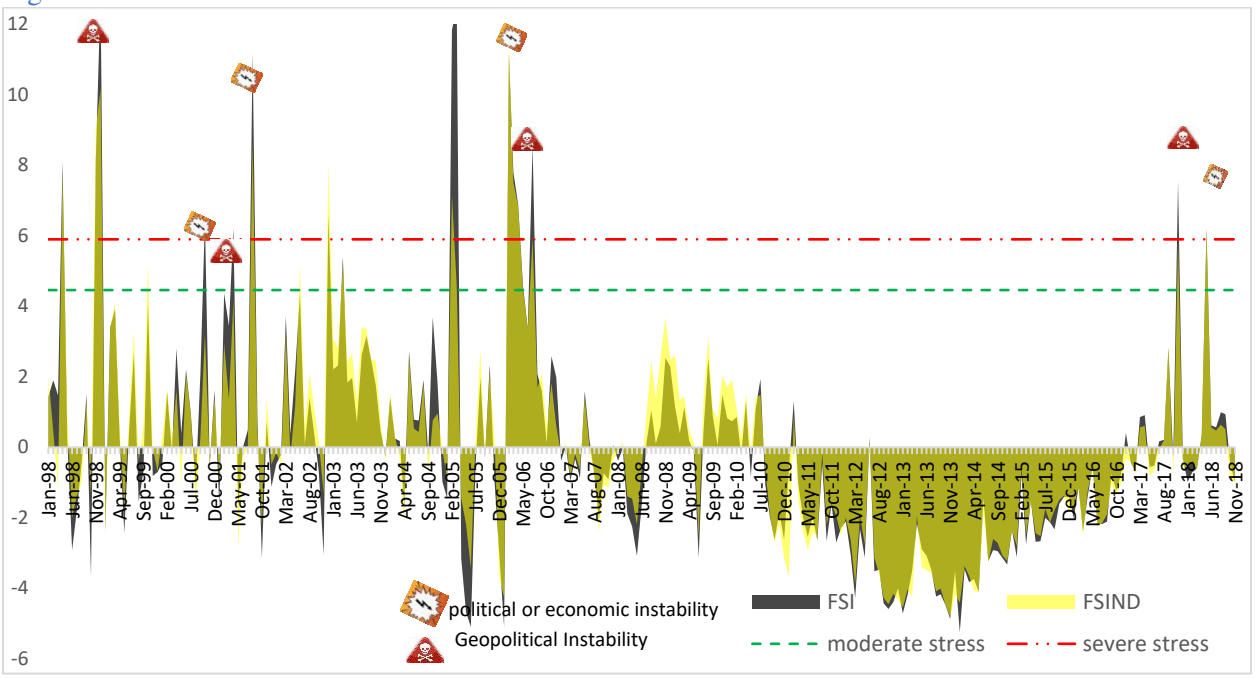
If we focus only on IRs/STED ratio, we conclude that Lebanon is much far from being risky, since its IR covers STED by about 10 times (8 to 16 times). But if we apply the IRs/FX that is most appropriate to a dollarized country, we conclude that the BDL holds IRs less than 50 percent only FX deposit and the ratio has been decreasing along the last 5 years. Consequently, unlike the previous conclusion, Lebanese money market seems to be risky, since IRs accumulated can cover barely 30 percent of total deposit.
Also, IRs/IM[11] (3 months) and IRs/M2 fail to be adequate since ratios are less than 100%

It should be noted that when measuring the adequate level of IRs, gold is excluded because gold is not exchanged in the open market and does not reflect monetary authority's reaction toward stress periods.

f. Graph Analysis and interpretation

Interpreting graphically the FSI of a country remains a traditional task before proceeding by econometric verification and analysis. First, we analyze spikes (Figure 1) and then we verify graphically the causality between stress periods and economic activity (Figure 2).

Figure 1: The Financial Stress index with dollarization rate and without dollarization rate.



Source: Author's Calculation and Elaboration

Figure *1* shows the fluctuation of informative vulnerable indicators of main financial sectors. We draw the FSI and the FSI that does not include the dollarization rate (FSIND). High fluctuations are reported in positive values, they indicate stress periods or a financial crisis, while low fluctuations reported in negative values indicate low stress periods. Moderate stress and severe stress are respectively represented by 1.5 and 2 FSI standard deviation. We deduce:

1. Prior to 2007, or more precisely, prior to the Israeli attack (war) in July-August 2006, the dollarization rate seems to play a leading indicator in detecting financial crises or stability periods. Indeed, FSI spikes exceed FSIND spikes which means that economic agents express their expectations in terms of financial stability by converting (or not) their local currency to foreign currencies (more trustful currency).
2. The FSIND can barely detect severe stress periods while FSI seem to be more accurate in reporting the gravity of financial episodes.

[11] Note that to calculate IRs/Import; we collected data on a monthly basis

3. After 2007 and until November 2017, Lebanon has witnessed less stressful periods since fluctuations were below the moderate stress level. We notice that during low stress period, the dollarization rate seems to be usefulness which confirms our deduction of being an informative coincident (or leading) indicator.

4. At the end of 2017, and beginning of 2018, the Lebanese financial market seems to lack instability since the FSI beats the moderate stress level. Here again we notice that the dollarization rate gives better information about the riskiness of the episode, consistent with previous remarks.

5. The fundamental financial market of the Lebanese economy might have changed after 2007.
   - Either economic agents have less access to *automatic* conversion from local currency to foreign currency through internal- *Central Bank*- capital control and restrictions (which is not the case).
   - Thanks to higher financial inclusion, and financial openness, households and investors with high uncertainty might have preferred to *flee* their deposits to a *safer* place "flight to safety" rather than converting deposit portion thus resulting in more vulnerable banking system (see Gorton, 2009).
   - Deposits are relatively less liquid which is mainly due to the secondary market in government debt and the BDL certificates of deposit that are illiquid.

6. Examining the graph, we remark that among a dozen of spikes illustrating financial stress periods, most triggered by political-geopolitical instability. For instance, April 1998, October 98, October 2000.

7. April 2001 and July 2006 spikes correspond to Israeli attack and Israeli-Hezbollah pressures. February 2005, February 2011 and November 2017 severe stress corresponds respectively to domestic political events such as -*i*-the assassination of a prime minister who symbolized peace and reconstruction to most of Lebanese and foreign investors, -*ii*-an unexpected resignation of the current Lebanese government and -*iii*- an ambiguous incident where the current prime minister was blocked in KSA and has officially announced his resignation.

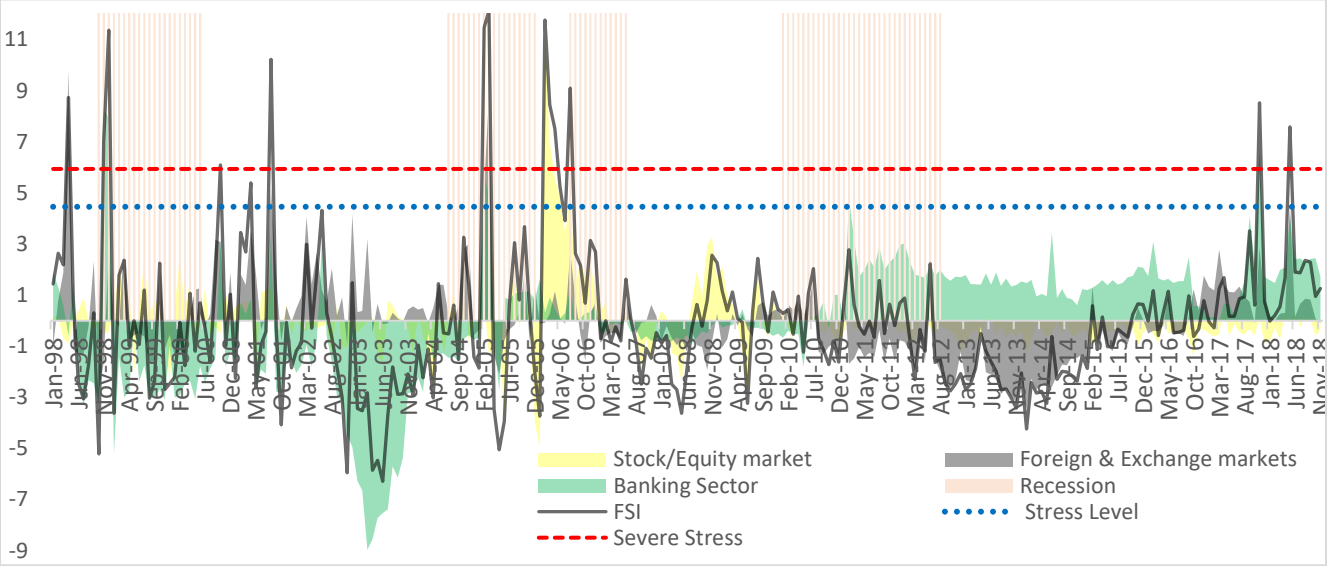
8. The FSI detects economics uncertainties such as Fitch's and Moody's credit in October 2000 and August 2001, May 2012 and August 2017.

9. It also reveals stress periods that were somehow hidden by media and/or policy makers. For instance, only investors involved in the stock market knew that a financial crisis has started in May 2006, few months before the 2006-Israeli-Hezbollah-War. During that period, investors (mainly from Gulf countries) have disinvested in the Lebanese stock market thus caused an implicit financial crisis.
   Indeed, according to the Lebanese penal code 340/1943, art. 319 reformed by the law 239/1993, any spread of information related to the financial market stability that triggers panic and uncertainty of economic agents, is forbidden. Lebanese households become victim of information asymmetry and *unfamiliar* in economics.

Another graph analysis remains important and common in the literature which consist to detect visually eventual relation/causality between ta financial stress index and the recession business cycle (Cardarelli *et al.,*2009; Balakrishnan *et al*., 2009, 2011; Davig and Hakkio, 2010; Hubrich and Tetlow, 2015; Cevik *et al.,* 2012, 2013a, 2016a). Although several techniques exist to calculate the business cycle as discribed in Škare and Stjepanović (2016)[12], most of authors cited above have defined recession and expansions periods according to Harding and Pagan (2002) business cycle method. As mentioned earlier, in Lebanon, the business cycle is defined by Jad (2016, 2017), consistent with Bry and Boschan's (1971a, 1971b) definition and methodology and it is represented below in figure 2.
We also report FSI's sectors and examine graphically their fluctuations.

[12] Škare and Stjepanović produce a table showing technical economic definition of measuring business cycle according to Burns and Wesley (1946), NBER (2010), Zarnowitz (1992), King, Plosser and Stock (1991), Singleton (1988), King and Rebelo (1998), Baxter and King (1999).

Figure 2: The Banking sector, the Stock market, the exchange & foreign markets, the FSI and recession.



Source: Author's Calculation and Elaboration

By decomposing the Lebanese Financial stress index and showing separately each sector, we notice:

1. Most of recession periods overlap positive FSI values. However, we cannot deduce graphically whether the value of the coincident indicator or business cycle is robust enough to predict or forecast the state of the other variable FSI. Further empirical analyses are needed.

2. Prior to 2006 the Foreign & Exchange Markets (FXEM) are frequently positive. Positive values indicate that the FXEM is vulnerable and a trigger of eventual crisis. During that period, the banking sector that is often negative indicate how trustful, safe and stable is the banking sector in the Lebanese financial market.

3. Lately, since 2011, the banking sector has surprisingly shifted upward and has taken positive values, representing thus a more vulnerable sector, while the FXEM is perceived to become more secure.

   The Lebanese banking sector has been a stable and profitable sector during late 90s and early 2000s. It was one of the most competitive sector thanks to its innovation in products and services, and by being technologically up-to-date and operating in alignment with international standards (IMF, 2017). Although relatively solid, Lebanese banks remain highly exposed to severe crisis for the following reasons:
   - ***Illiquidity:*** The secondary market in government debt and the BDL certificates of deposit are illiquid,
   - ***Monopoly:*** Corporate bonds are nonexistent, thus banks become the main financial lending institution.
   - ***Dependency:*** Banks that hold more than 50 percent of total government loan, similarly to poor African countries (IMF, 2017) may provoke a crowding out effect on the economy by decreasing overall bank loans (Christensen, 2005).

The current Lebanese banking crisis of 2019-2020 is not a few months old; it dates many years ago. In November 2017- January 2018, the banking sector has effectively and economically crashed although not announced officially. This highlights on how accurate is the FSI in predicting future financial crisis.

III. Methodology & Econometric Framework

Although *Figure 2* shows that most of recession periods overlapped with FSI high spikes it does not give valuable information whether the value of one variable is robust enough to predict or to forecast the state of the other variable. The Granger causality analysis under VAR Models elaborates the relation between the Economic Activity (ECO) and the FSI to deduce whether a stressful period can predict a future recession and vice versa. We also develop the generalized impulse response functions and the Variance Decomposition Analysis.
Before proceeding with any times series analysis, stationarity of variables is necessary.
Since all variables of time-series are included in growth patterns, covariance stationarity can be observed graphically in *Annex 3.* We run the Unit Root Test- (ADF) and Philips Perron test to verify stationarity of variables. Results are reported in *table 4a.* Also, we run the cointegration test to estimate the long run parameters or equilibrium in the system with unit root variables. *Table 4b* shows that we reject Null Hypothesis (p-value < 0.05) and cointegration.

a. Simple and Multivariate Granger Causality Tests under VAR Model

The VAR model is conceived to capture dynamic interactions among the variables undertaken. With VAR Model, we can check the cause and effect relationships among the variables under the Block Exogeneity Wald framework. For instance, if past values of one variable like ECO, helps in predicting future values of another variable such as FSI, then it is said that ECO granger causes FSI or FSI is getting affected by ECO[13].

The simple Granger causality test considers only two variables such as FSI and ECO[14]. For instance, to test the granger causality between FSI and ECO, we expressed the model in the following way.

$$FSI_t = a_1 + \sum_{i=1}^{m} \alpha_i ECO_{t-i} + \sum_{j=1}^{n} \beta_i FSI_{t-j} + \varepsilon_t \quad (1)$$

$$ECO_t = a_2 + \sum_{i=1}^{p} \theta_i FSI_{t-i} + \sum_{j=1}^{q} \phi_i ECO_{t-j} + \mathfrak{z}_t \quad (2)$$

Where ECO_t and FSI_t are the growth rate of the ECO and the FSI in time *t*. ECO_{t-i} and FSI_{t-i} are the growth rate of ECO and the FSI in time *t-i*. ε and $\mathfrak{z}$ denotes for the error term.
Granger Causality is often tested in a context of model, since omitted variables bias might cause problems. Hence, we run a VAR Model-multivariate granger causality test to verify the causality between the economic activity and LFI by including ECO, FSI and IRFX.

Since graphically we saw a certain relation between Israeli-Hezbollah tensions and FSI, we verify the causality between Israeli GPRs and Lebanese financial stability by running VAR Model-multivariate granger causality with GPRs, the IRFX and FSI. Under the VAR model, each variable is a linear function of its own or other variable's lagged values. The model becomes:

$$X_t = \sum_{j=1}^{p} A_j X_{t-j} + u_1 \quad (3)$$

Where X_t is an $m \times 1$ vector of the endogenous variables and u_t is an m×1vector of error terms in equation (3). Based on the both OLS coefficient and significance, three cases are to be considered:

[13] The study employs Diebold and Yilmaz procedures to come out with a spillover index with the aim to calculate the total contribution of the shocks on an asset market arising from the contribution of all other markets. The index is calculated on the basis of N-variable Vector Autoregression model

[14] Recall that employment in the private sector was taken as proxy of economic activity.

- Unidirectional Granger Causality from FSI to ECO or from ECO to FSI, which means that one variable increases the prediction on the second variable but not vice versa
- Bidirectional causality where ECO predicts FSI and FSI predicts ECO too.
- Independence between ECO and FSI where no granger causality exists in any direction.

The Lag Order Selection Criteria of the sequential modified (LR) test statistic (each test at 5% level), the Final prediction error (FPE), Schwarz information criterion (SC), Hannan-Quinn information criterion (HQ) and the Akaike information criterion (AIC) are reported in tables 5a and 6a. Since the literature of finding the best length criteria is vast and specific to each model such as shown in Omer & McMillin (2001), Ng and Perron (2001), Gutierrez *et al.* (2009), Hecq *et al.* (2019), we select the traditional AIC length criteria. Also, we test the residual serial correlation to make sure to accept at 5% the Null Hypothesis which is absence of autocorrelation in lag given by AIC. Residual serial correlation tables are reported in table 5b and 6b.

b. Generalized Impulse Response Functions and Factor Decomposition of Variables

We run a generalized impulse response function (G) for a shock to the entire system u_t^0 like proposed by Pesaran and Shin. It is represented by the equation (4) below. X_{t+N}

$$G_s = E\left(\frac{X_{t+N}}{u_t} = u_t^0, \Omega_{t-1}^0\right) - E\left(\frac{S_{t+N}}{\Omega_{t-1}^0}\right) \qquad (4)$$

Where the history of the process up to period t − 1 is regarded as information set Ω_{t-1}^0. Assume $u_t \sim N(0, \Sigma)$ $E\left(\frac{u_t}{u_{jt}} = \delta_j\right) = (\sigma_{1j}, \sigma_{2j}, \sigma_{3j}, \ldots\ldots, \sigma_{mj})' \ \sigma_{jj}^{-1} \ \delta_j$, where $\delta_j = (\sigma_{jj})^{-1/2}$ denotes a one standard error shock.
Annex 4 shows the G function that captures response of one variable towards one standard deviation shock to another variable's error term[15] .

IV. Results and Interpretation

After verifying correlation, stationarity and cointegration test of variables and residual serial correlations in tables 2, 3a, 3b, 4a, 4b, 5a, 5b, 6a and 6b, we conduct a Granger Causality Tests under VAR Model with appropriate lag, Impulse Response functions and factor decomposition of variables.

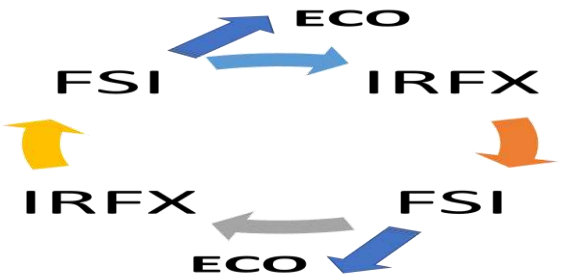
a. Financial Market and Economic Activity

We verify the causality between the FSI, ECO and IRFX to check whether a financial stress amplifies changes in investments and the economic activities and predicts future recession (Calrson *et al.,* 2008). Since hoarding international reserves is vital for the central bank to maintain currency stability and/or economic stability, we include IRFX.
Results in table 5c show find that there is a unidirectional causality from FSI and ECO significant at 5%; which means that a financial stress in Lebanon is strong enough to predict a future recession within six months. While the opposite case is not true since *p-value* is greater than 0.05. A financial crisis causes panic and uncertainty, increases information asymmetry spread and contributes to irrational behaviors of investors thus leads to economic contraction. Our result is consistent with most of studies testing the causality between economic activity and financial stress such as Kaminsky and Reinhart (2002), Mendoza and Terrones (2008), Calvo and Talvi (2008), Rogoff and Reinhart (2010), Illing & Liu (2003), Elekdağ *et al.* (2012), Cevik *et al*. (2013) and Gunes & Camlica (2016b) among others.

[15] Another subset of VAR model is VDA that simply accounts for percentage of variations caused by another variable in an endogenous system. In other words, VDA states that when a shock is given to one variable, then that accounts for how much forecast error variation in another variable.

Also, we find a bidirectional causality between the International Reserves shocks and the financial stress in Lebanon with a *p-value* less than 5%, which means that one variable is a good predictor for the other one, and that one chock causes deleterious economic effects by triggering the other chock . *Figure 3* shows that IRFX is a core of the Lebanese financial market stability as mentioned earlier, that a dollarized country with a fixed exchange rate regime is strongly dependent on the level of IR. IRFX causes financial crisis, and financial crisis causes both, more IRFX fluctuation and economic recession.

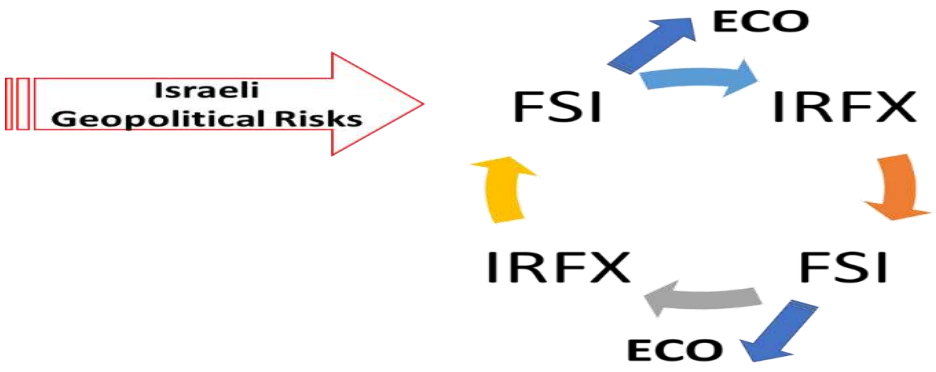
Figure 3: The relation between foreign reserves, economic activity and financial stability



b. Israeli Geopolitical Risks and Financial crises.

We conduct a Granger Causality Test under VAR Model by including the impact of Israeli Geopolitical Risks on the Financial market stability. IRFX is considered in the model as a main indicator of financial stability for a dollarized country. Results in table 6c show that Israeli GPRs are a good predictor of a future crisis in Lebanon within six months since there is a unidirectional causality and significant at 5% (p-value is 0.033) from Israeli GPRs and FSI. Again, the table 6c shows the bidirectional causality between FSI and IRFX and both significant with a *p-value* less than 5%, which means that the Israeli GPRs do not only cause a financial market crisis in Lebanon, but it amplified negative impacts through International Reserves level(figure 4).

Figure 4: The relation between Israeli GRPs; foreign reserves, economic activity and financial stability



Israeli Geopolitical Risks plays the role of a multiplier destabilizer in the Lebanese financial market. It triggers the FSI, and FSI causes IRFX and ECO causes in return FSI and so on...like shown.

c. Impulse Response functions and variance decomposition of variables.

In order to verify, out of sample, the results of the Granger Causality test, we simulate the impulse response functions (IRFs) in Annex 4 and describe the evolution of variables of interest along the next ten months after a shock of one standard deviation. We report in table 7.he variance decompositions of variables, that measures the contribution of each type of shock to the forecast error variance. Obviously, in Annex 4 the response of FSI to Israeli GPRs varies ± [-5, +5] and the response of FSI to IRFX varies ± [-9, +9]. Also, table 7. results show how big the impacts of IRFX and Israeli GPRs on FSI.

d. Important Remarks

We tested the GPRs impacts of KSA, Russian and Turkish on the Lebanese financial market, using same methodology. We found that none of them are powerful enough to predict future Lebanese financial stress in few months. A comparative analysis of Middle East Geopolitical risks countries with Granger Causality tests and Threshold VAR will elaborated upon further in the next study.

V. Conclusion

We investigate empirically the impact of the Israeli Geopolitical Risks on the Lebanese financial market.
To assess the Lebanese financial stability, we consider the Lebanese Financial Stress Index (FSI) that was initially calculated by Ishrakieh-Mansour *et al*. (2019, 2020). The Geopolitical Risks Index (GPRI) is measured by taking the continuous variable calculated on a monthly basis to best suit time series analyses, calculated by Caldara and Iacoviello (2018).
We run econometric models, covering prerequisite time series tests, Vector Autoregression model (VAR), Granger causality tests, generalized impulse response functions and Variance Decomposition Analysis, to assess the impacts of Israeli Geopolitical Risks (GPRs) on the Lebanese financial stability, on the international reserves and on the economic activity.
All data are taken from Central Bank of Lebanon, the Datastream and the Federal Reserves Fred-St Louis, on a monthly basis from January 1998 to November 2018.
The adequate level of International reserves (IR) is taken by calculating the IR to Foreign currency deposits ratio (IRFX) as a more appropriate measurement for a dollarized country.
To measure the economic activity and the business cycle on a monthly basis, we consider the employment in private sector as a better proxy than traditional variables considered in previous studies.
Graph analysis reveals that -*i*- the banking system is fragile and subject to volatility despite the crucial economic role it plays throughout the years, -*ii*- the Lebanese financial stability seems sensitive to political and geopolitical tensions, and -*iii*- that a certain relation might exists between the economic recession and financial stability.
Empirical results show that a financial stress in Lebanon is strong enough to predict a future recession within six months: it causes panic and uncertainty, increases information asymmetry spread and contributes to irrational behaviors of investors that leads to economic contraction.
Also, we find a bidirectional causality between the International Reserves shocks and the financial stress in Lebanon which means that one variable is a good predictor for the other one. Indeed, IRFX is a core of the Lebanese financial market stability since a dollarized country with a fixed exchange rate regime is strongly dependent on the level of IRs to foreign deposit hoarded by the central bank.
Finally, results show that Israeli GPRs are good predictor of a future crisis in Lebanon within six months consequently, which means that the Israeli GPRs are destabilizer multiplier since they threaten financial market stability, trigger IRs shocks and thus destabilize the whole Lebanese financial market again and cause economic recession. If Lebanese policy makers prioritize financial stability, they should consider hoarding sufficient level of IRs relatively to Foreign deposit, but also avoid Israeli/Hezbollah tensions.

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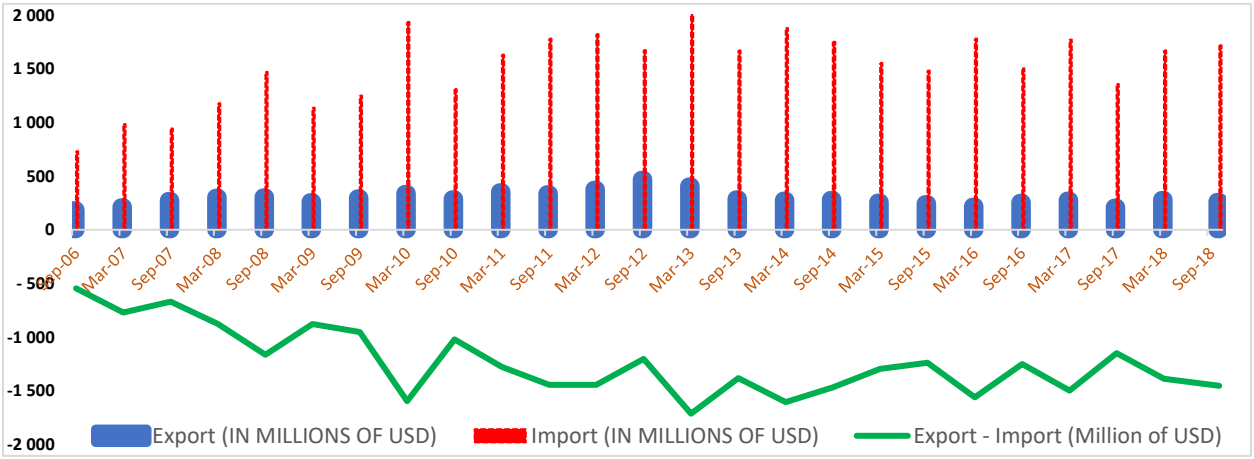
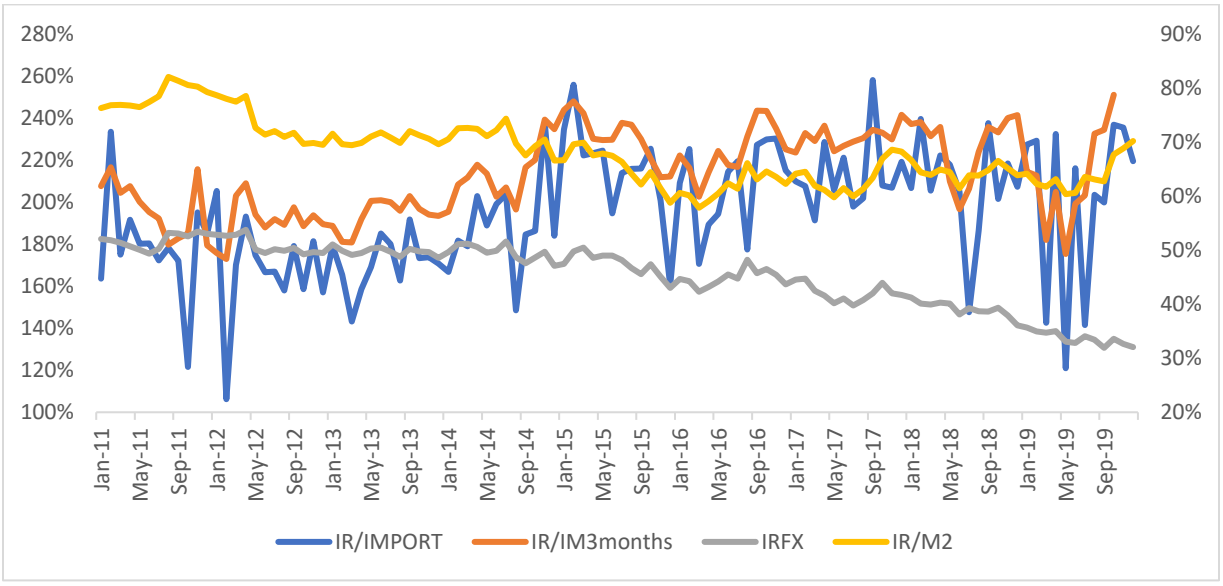
Annex

Annex 1 - Imports and Exports of Lebanon over years



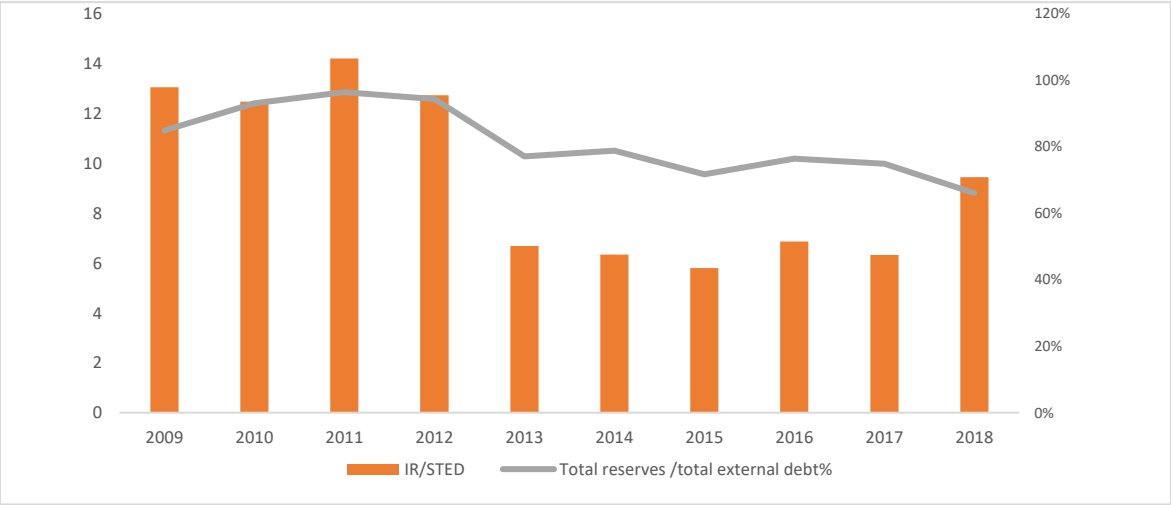
Source: *Author's calculation*

Annex 2 a- the ratio IRs/IMPORT, IRs/IM and IRs/M2



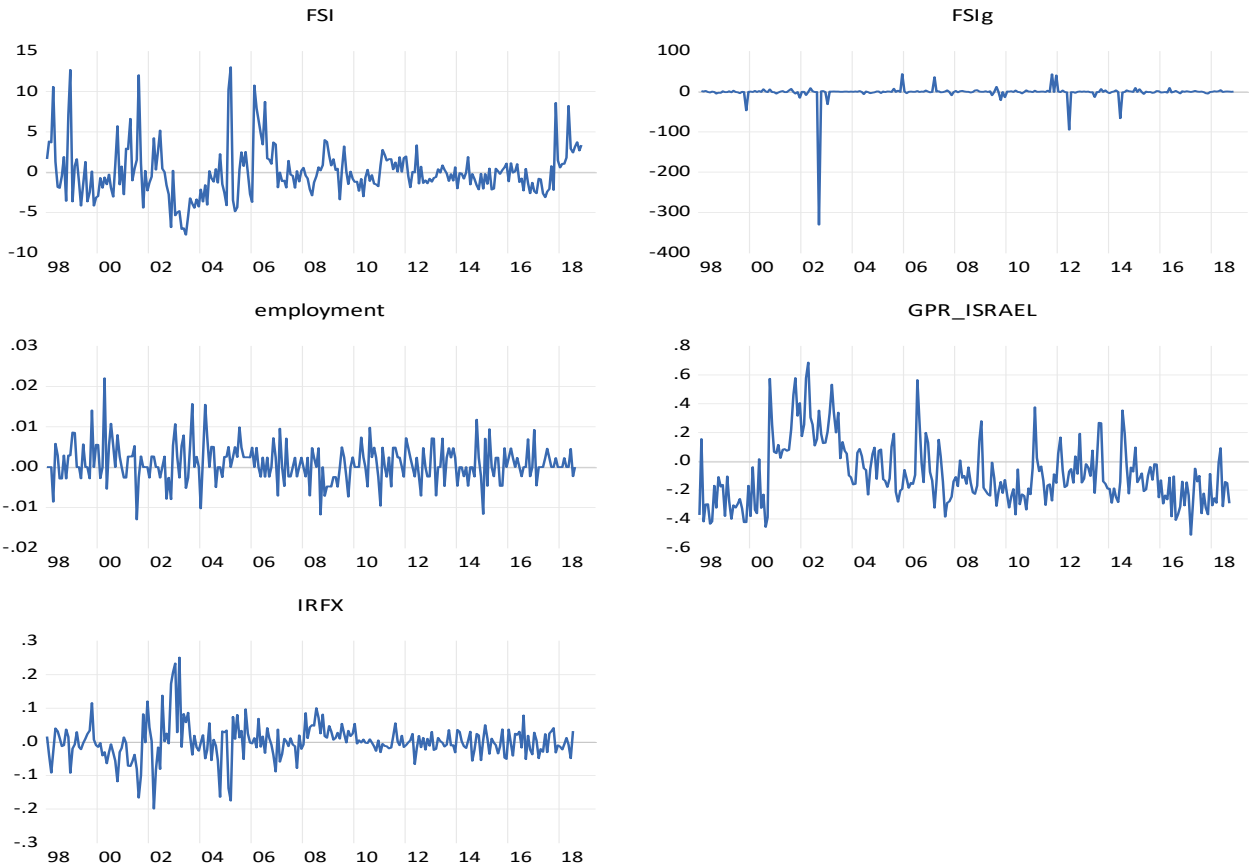
Source: *Author's calculation*

Annex 2 b- Foreign reserves to total external debt or to STED Ratio.

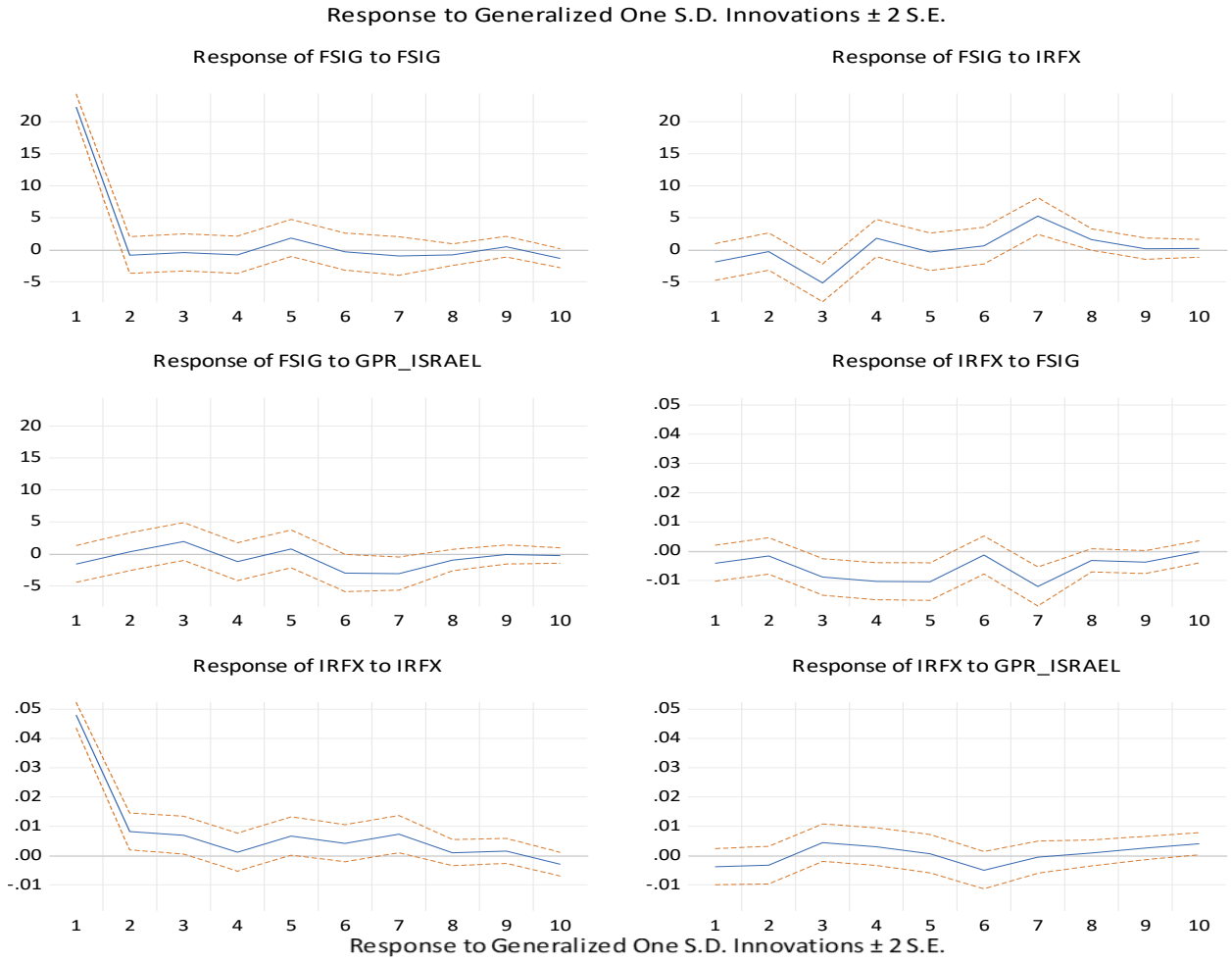


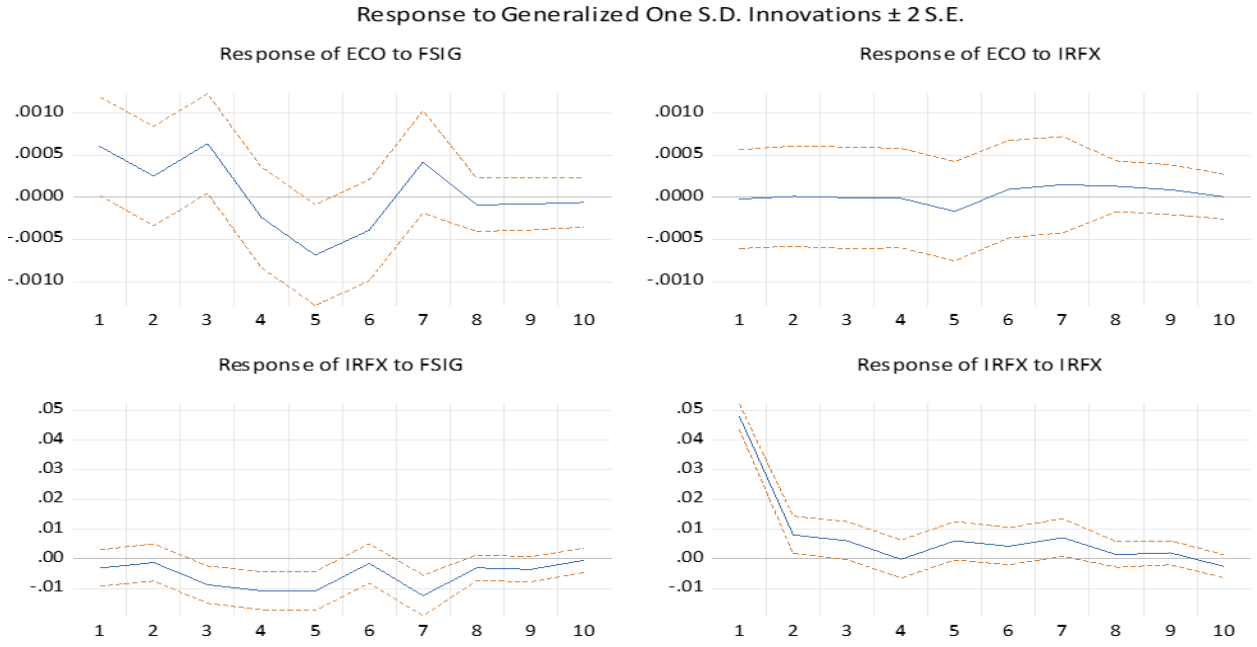
Source: *Author's calculation*

Annex 3 – Variables growth rate patterns (time series)



Annex 4- Response to one standard Deviation Impulse Shock





ANNEX – TABLES

Table 1: Descriptive statistics

	FSI_Sum	FSI	IRFX	ECO	GPR_ISRAEL
Mean	-0.0003	-2.0916	0.0005	0.0010	-0.0862
Median	-0.218	-0.4172	-0.0026	0.0000	-0.1334
Maximum	13.04	43.5708	0.2506	0.0220	0.6871
Minimum	-7.76	-330.5790	-0.1992	-0.0130	-0.5109
Std. Dev.	3.176	23.1960	0.0537	0.0047	0.2192
Skewness	1.2	-11.7018	0.5312	0.4076	0.9242
Kurtosis	6.47	163.6876	7.9981	4.9996	3.8494
Jarque-Bera	196.63	274669.2000	268.7097	48.1840	42.9328
Probability	0.000	0.0000	0.0000	0.0000	0.0000
Sum	-0.009	-522.8958	0.1158	0.2413	-21.4727
Sum Sq. Dev.	2522.390	133975.30	0.7102	0.0055	11.9117
Observations	251	250	247	248	249

Table 2: Variable autocorrelations

Correlation	FSI	ECO	IRFX	GPR ISRAEL	GPR RUSSIA	GPR KSA	GPR TURKEY
FSI	**100%**						
ECO	11%	**100%**					
IRFX	-6%	-1%	**100%**				
GPR ISRAEL	-12%	-4%	0%	**100%**			
GPR RUSSIA	-12%	-1%	8%	18%	**100%**		
GPR KSA	-14%	0%	3%	52%	37%	**100%**	
GPR TURKEY	-8%	-3%	10%	10%	54%	51%	**100%**

Table 3a- Correlation of GDP, Capital Stock and Employment in Private Sector (Annual Data)

	Capital Stock Mill USD	Employment in Private Sector in Thousands of Persons	GDP Mill USD
Capital Stock Mill USD_	1	0.764	**0.965**
Employement in Private Sector	0.764	1	**0.8871**
GDP Mill USD	**0.965**	**0.8871**	1

Table 3b-Annual Data of Employment (in thousands of persons), Capital stock in Bill of USD and Constant GDP in Mill USD

Years	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
GDP in MILL USD	2866	2972	3289	3453	3549	3671	3803	3892	3935	4155	4310	4424	4612	4662	4836	4964
Employment in Private Sector	37.9	37.5	39.0	39.8	41.5	42.2	42.3	41.5	40.7	41.6	41.7	41.9	43.0	42.9	42.8	43.4
Capital Stock in Bill USD	246.41	249.16	252.62	257.81	263.04	268.31	276.78	289.07	307.54	325.17	340.13	355.47	373.71	389.19	403.02	418.49

Source: Fred Saint Louis-Fed Reserves

Table 4a: Augmented Dicky Fuller Test: Stationarity test

Stationarity Test	ECO		FSI		GPR-Israel		IRFX	
	t-stat	Prob	t-stat	Prob	t-stat	Prob	t-stat	Prob
ADF intercept	-16.11	0.00	-10.07	0.00	-3.22	0.019	-7.85	0.00
ADF intercept & Trend	-16.21	0.00	-10.06	0.00	-7.853	0.000	-8.83	0.00
ADF none	-15.47	0.00	-10.09	0.00	-2.915	0.003	-7.868	0.00
Phillips-Perron Intercept	-16.11	0.00	-15.77	0.00	-7.463	0.00	-12.36	0.00
Phillips-Perron Trend & Intercept	-16.22	0.00	-15.72	0.00	-7.68	0.00	-12.34	0.00
Phillips-Perron none	-15.64	0.00	-15.68	0.00	-6.702	0.00	-12.38	0.00

Author's calcuolations
Null Hypothesis for ADF and PP tests is that the variable has a unit root.

Table 4b: Cointegration Test

No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.275271	147.8443	47.85613	0.0000
At most 1 *	0.146241	69.93070	29.79707	0.0000
At most 2 *	0.091357	31.66899	15.49471	0.0001
At most 3 *	0.034453	8.484650	3.841466	0.0036

242 after adjustments with series ECO FSI GPR_ISRAEL IRFX

Trend assumption: Linear deterministic trend
Trace test indicates 4 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table 5a: Lag Length Criteria: ECO and FSI and IRFX

Included observations: 242						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	213.64892	NA	3.52e-05	-1.740900	-1.697649*	-1.723477*
1	225.32516	22.966	3.44e-05	-1.763018	-1.590013	-1.693325
2	240.08622	28.668	3.28e-05	-1.810630	-1.507871	-1.688668
3	247.33996	13.907	3.33e-05	-1.796198	-1.363685	-1.621966
4	257.50066	19.229	3.30e-05	-1.805791	-1.243524	-1.579289
5	260.81258	6.1858	3.46e-05	-1.758782	-1.066761	-1.480011
6	280.45265	**36.1961***	**3.17e-05***	**-1.846716***	-1.024942	-1.515676
7	283.42564	5.4054	3.33e-05	-1.796906	-0.845378	-1.413596
8	291.04154	13.658	3.37e-05	-1.785467	-0.704185	-1.349888

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error AIC: Akaike information criterion
SC: Schwarz information criterion HQ: Hannan-Quinn information criterion

Table 5b: VAR Residual Serial Correlation

Null Hypoethesis: No Seriaal Correlation		**Null Hypoethesis: No Seriaal Correlation**	
Lag= 6	**Prob.**	**Lag 1 to 6**	**Prob.**
1	0.7796	1	0.7796
2	0.409	2	0.4905
3	0.0266	3	0.2749
4	0.1636	4	0.4007
5	0.3013	5	0.5384
6	0.0902	6	0.1227

Table 5c: Multivariate Granger Causality Test between ECO and FSI and IRFX

LAG = 6	Obs	F-Statistic	Prob.
ECO does not Granger Cause FSI	244	0.35534	0.9063
FSI does not Granger Cause ECO		**2.94128**	**0.0087**
IRFX does not Granger Cause FSI	**244**	**4.74548**	**0.0001**
FSI does not Granger Cause IRFX		**5.83881**	**1.E-05**
IRFX does not Granger Cause ECO	245	0.32282	0.9246
ECO does not Granger Cause IRFX		1.59546	0.1493

Table 6a- Lag Length Criteria: GPR, IRFX and FSI

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-710.0483	NA	0.076416	5.942069	5.985577	5.959600
1	-636.9823	143.6963	0.044805	5.408186	5.582218*	5.478308*
2	-622.9986	27.15177	0.042984	5.366655	5.671211	5.489369
3	-611.7514	21.55711	0.042191	5.347928	5.783008	5.523234
4	-603.1203	16.32726	0.042328	5.351002	5.916606	5.578899
5	-589.9807	24.52717	0.040904	5.316506	6.012634	5.596995
6	-569.8770	**37.02433***	**0.037304***	**5.223975***	6.050627	5.557055
7	-566.4381	6.247275	0.039095	5.270318	6.227494	5.655990
8	-563.8781	4.586675	0.041280	5.323984	6.411684	5.762248

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error AIC: Akaike information criterion
SC: Schwarz information criterion HQ: Hannan-Quinn information criterion

Table 6b: VAR Residual Serial Correlation

Null Hypoethesis: No Seriaal Correlation		**Null Hypoethesis: No Seriaal Correlation**	
Lag= 6	**Prob.**	**Lag 1 to 6**	**Prob.**
1	0.7181	1	0.7181
2	0.8009	2	0.8642
3	0.29	3	0.6126
4	0.1144	4	0.4942
5	0.5662	5	0.5235
6	0.0672	6	0.3059

Table 6c: Multivariate Granger Causality between GPR, IRFX and FSI

LAG = 6	Obs	F-Statistic	Prob.
FSI does not Granger Cause GPR_ISRAEL	242	1.15410	0.3320
GPR_ISRAEL does not Granger Cause FSI		**2.33434**	**0.0330**
IRFX does not Granger Cause GPR_ISRAEL	243	0.88749	0.5047
GPR_ISRAEL does not Granger Cause IRFX		1.24842	0.2825
IRFX does not Granger Cause FSI	**244**	**4.74548**	**0.0001**
FSI does not Granger Cause IRFX		**5.83881**	**1.E-05**

Table 7 : Variance decomposition of Variable

Variance Decomposition of GPR Israel

Period	S.E.	FSI	IRFX	GPR_ISRAEL
1	0.160643	**0.501171**	0.750192	98.74864
2	0.178737	**0.416205**	2.368289	97.21551
3	0.182835	**0.434971**	2.870133	96.6949
4	0.184873	**0.504588**	2.811687	96.68372
5	0.186289	**0.581562**	3.179684	96.23875
6	0.190909	**1.978981**	3.620117	94.4009
7	0.199421	**3.706192**	4.064682	92.22913
8	0.202839	**3.700688**	4.185023	92.11429
9	0.20442	**3.644654**	4.198992	92.15635
10	0.205903	**3.620366**	4.325088	92.05455

Variance decomposition of IRFX

Period	S.E.	FSI	IRFX	GPR_ISRAEL
1	0.047967	**0.746589**	99.25341	0
2	0.04875	**0.837322**	98.83702	0.325657
3	0.050116	**3.916534**	95.04302	1.040443
4	0.051218	**7.809661**	90.99737	1.19297
5	0.052589	**11.34926**	87.51507	1.135677
6	0.052982	**11.24238**	86.80591	1.951708
7	0.054713	**15.43474**	82.70675	1.858508
8	0.054812	**15.71137**	82.42199	1.866636
9	0.055007	**16.07429**	81.88722	2.038492
10	0.055218	**15.95261**	81.56368	2.483709

Variance decomposition of FSI

Period	S.E.	FSI	IRFX	GPR_ISRAEL
1	22.32709	100	0	0
2	22.34776	99.96039	**0.027552**	0.012057
3	23.00484	94.36711	**5.218918**	0.41397
4	23.11104	93.61989	**5.734839**	0.645268
5	23.2008	93.51492	**5.697284**	0.787795
6	23.40177	91.93409	**5.665468**	2.400438
7	24.14523	86.52776	**9.940945**	3.531296
8	24.22236	86.08242	**10.27469**	3.642888
9	24.22754	86.082	**10.27631**	3.641693
10	24.26768	86.10525	**10.24386**	3.650889