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A Composite Index for Tracking Financial Markets in Israel[1]

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Abstract

The state of financial markets is reflected in the developments of many financial and economic series, and tracking these series on an ongoing basis is an inseparable part of any analysis of overall financial stability. However, the large number of series makes both ongoing tracking as well as assessing the situation of financial markets following events with crisis elements difficult. To simplify such tracking, we adjusted the solution used by the Fed to the Israeli market: We took a number of financial and economic series and consolidated them into one series, referred to as "the Index". This Index receives values between 0 and 1, where values of or near 0 indicate calm and values of or near 1 indicate a financial crisis. Other than the simplification achieved by tracking a single series, the Index also allows an analysis of events with crisis elements and the comparison of the extent of the damage to the financial markets caused by various events. A uniform and objective interpretation of the impact of various events on the financial markets can make the policy-setting process simpler. From a historical perspective, taking in the past decade, we see that the Index "captured" events that influenced financial stability and presented a different view of the severity of events that were considered at the time to be threats to financial stability. In addition, the Index indicates that over the years, the economy developed a resilience to security and political events.

מדד משולב למעקב אחר השווקים הפיננסיים בישראל

יוסי סעדון ומיטל גראם

תקציר

מצב השווקים הפיננסיים משתקף בהתפתחותן של סדרות פיננסיות וכלכליות רבות, ומעקב שוטף אחר סדרות אלה הוא חלק בלתי נפרד מניתוח היציבות הפיננסית בכללותה. ואולם ריבוי הסדרות מקשה הן על המעקב השוטף והן על אבחון מצבם של השווקים הפיננסיים בעקבות אירועים בעלי אופי משברי. במטרה לפשט את המעקב התאמנו למשק הישראלי את הפתרון המשמש את ה-Fed: נטלנו מספר סדרות פיננסיות וכלכליות, ואיגדנו אותן לכדי סדרה אחת, להלן "המדד". מדד זה מקבל ערכים בין 0 ל-1, כאשר הערך 0 וסביבתו מצביעים על רגיעה, ואילו הערך 1 וסביבתו מאותתים על משבר פיננסי. מלבד הפישוט האמור של המעקב אחר סדרה בודדת, המדד מאפשר לנתח אירועים בעלי אופי משברי ולהשוות את מידת הנזק שאירועים שונים גורמים לשווקים הפיננסיים. פרשנות אחידה ואובייקטיבית להשפעת האירועים השונים על השווקים הפיננסיים יש בה כדי לפשט את תהליך קביעת המדיניות. בהסתכלות היסטורית, המשתרעת על פני העשור האחרון, נראה כי המדד "תפס" אירועים בעלי השפעה על היציבות הפיננסית וכן הציג בפרופורציות אחרות אירועים שנתפסו בזמנם כמאיימים על היציבות הפיננסית. בנוסף, המדד מצביע על כך שבמרוצת השנים המשק פיתח עמידות לאירועים ביטחוניים ופוליטיים.

1. Introduction

The day to day tracking of the situation in the financial system, as a means of monitoring financial stability, is based on tracking many economic series—from the financial markets and from the economy in general. Many of these series respond differently, on a day to day basis, to different types of events. This phenomenon makes tracking difficult. Another difficulty derives from the fact that crisis events are reflected in a succession of exceptional points, but exceptional series values do not necessarily indicate a crisis. The natural "noise" that exists in these series, and the almost exclusive reliance on them, create a need for a simple system of tools to filter out the "noise", to be constructed on the basis of financial crises that occurred in the past. Such a system will assist financial and monetary policymakers in focusing their responses on real events and not on "noise".

Nelson and Perli (2005) developed a method for the ongoing analysis of the financial system. This method underwent various adjustments by Carlson, Lewis and Nelson (2012), and the revised method is being used by the Fed as a tool for monitoring the system—that is, as a financial stress index. The method's developers based it on 12 series that were selected from the financial markets. They divided these series into four groups by the information that they present, and estimated how the series reacted to two events that they defined as financial crises—the LTCM (Long Term Capital Management) crisis, and the September 11, 2001 attack on the World Trade Center (the Twin Towers). At the end of the process, they obtained a series with values between 0 and 1. These values present the probability that the economy is undergoing, in the present, a financial crisis as powerful as the two stated events. Tracking this series is simple, and it provides a clear picture of the situation of the financial markets at any moment, as opposed to tracking many series, the behaviors of which, in instances of financial instability, have not been assessed.

In this study, we apply the Nelson and Perli (2005) financial stress index from the US to the financial markets in Israel between 1997 and 2012. The implementation process—which yielded a single series of values between 0 and 1—was made up of four stages: (1) Selection and processing of the series: We selected eleven series from the financial markets in Israel, in accordance with the information they present, the share of the market they represent in the financial markets, and their relevance for the economy as a whole. (2) Selection of a crisis event in the Israeli economy: We selected the collapse of the LTCM hedge fund and the 2002 crisis.[1] [2] These events constitute the reference point for calibrating the index, i.e., for setting the weight given to each of the processed series. (3) Building a binomial model: The dependent variable in this model receives the value of 1 at a crisis period and 0 the rest of the time. The processed series from the first stage are the independent variables in this series. We selected a binomial model from among models that are differentiated by the frequency of the sample, by events in the sample and by the series explaining them. (4) Estimation of the model: Given the values of the series, we can use the

[1] The crisis that began with the sharp reduction of the Bank of Israel interest rate from 5.8 percent to 3.8 percent in December 2001.

[2] In the body of the work, we will explain why we selected specifically these events from among the three crises that affected the Israeli economy, i.e., the fall of the LTCM hedge fund, the 2002 crisis and the subprime crisis of 2008-09.

model's equation to calculate an index that expresses the likelihood that the economy is in a financial crisis as strong as the crises used to calibrate the model.

The index which is obtained can serve two purposes—ongoing tracking of markets, and retroactive assessment of events. Financial and monetary policymakers can use the index itself, one of the purposes of which is to cancel out the "noises" in the various financial series, for ongoing tracking and for setting policy. If necessary, it is also possible to assess on an ongoing basis the developments of the sub-indices that make up the index and thus to learn what markets responded with greater stress than others. Assessing the sub-indices allows for an in-depth analysis of events that caused financial instability. For example, during the Second Lebanon War, it was primarily the stock market that was negatively impacted, and for part of the period (the day after the event started), uncertainty about the exchange rate increased, though without significant volatility in the exchange rate itself. Such a detailed analysis will enable policymakers to respond in a precise manner to each event.

The index can also serve in assessing events in retrospect, since it can be used as a tool to compare and analyze events. Two events similar in their character—such as the resignation of finance minister Benjamin Netanyahu in 2005 and the resignation of finance minister Dan Meridor in 1997—could lead to different values in the index. These values express the markets' reactions to both events, and comparing them can indicate, *inter alia*, about a change in the financial markets' robustness or stability.

Just like the Composite State of the Economy Index, which provides an assessment of real economic developments, has become an established feature in the regular economic analysis at the Bank of Israel, we are now attempting to construct a composite index for the financial situation that will constitute a basis for analyzing risks in the economy, as has recently been done in many countries.

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Few works have assessed the behavior of the financial markets in Israel following events exogenous to the financial system. We will report on three of them: Blass, Peled, and Yafeh (2002) assessed the influence of various types of events on the stock and bond markets, focusing on the effect of these events on the cost of capital. Zussman, Zussman and Nielsen (2006) examined the effects of the Israel-Palestinian conflict on the stock market. And finally, Shoham, Rosenboim, Maulu and Saadon (2011) examined the effects that terrorist attacks in Israel had on the stock market, and compared domestic market returns in response to security events in the central region to its return in response to events in the periphery.

In contrast to these works and others, in this paper, we constructed two indices. The first is based on a crisis event, and is intended to characterize how strong the effects of various events are on the financial markets in general by using values from 0 to 1. The second index is a "synthetic" index that is not committed to a specific event. It is comprised of sub-indices whose values can be compared in a reviewed period. The Index on which we have focused in this paper is the first index.

This paper is structured as follows: The second section reviews the theoretical background of the issue and the relevant literature. Section 3 presents how the index

is constructed. Section 4 presents the model and the results of the estimation. Section 5 presents the uses of the index, and the final section summarizes and presents conclusions.

2. The theoretical framework

Financial stress is defined as an "interruption" to the normal functioning of financial markets.[3] Alternatively, it is defined as a force exerted on economic agents through an increase in uncertainty and through a change in expectations of losses in financial markets and institutions.[4] An index of financial stress is commonly referred to in global literature as FSI (Financial Stress Index). This is a continuous variable with a broad range of values, where high values tend to indicate periods of financial stress. The stress increases with expectations of financial loss as a result of risk (a wide distribution of the expected loss) or as a result of an increase in uncertainty. It should be noted that there is a difference in the literature between the financial stress index and a Financial Conditions Index (FCI). The FSI provides an answer to the question of whether the financial markets are functioning or behaving in their typical manner, while the FCI serves to assess the macroeconomic ramifications of developments in the financial sector.[5]

Illing and Liu (2006) developed one of the first and most influential stress indices for the financial system in Canada. The advantage in this study from our point of view is that it also deals with a small and open economy, in contrast to studies that deal with the United States, where the exchange rate is not a main player. In this study, the index is a continuous, daily, variable with a range of values, where its extreme values are considered financial crises. An internal survey by the Bank of Canada helped in selecting the variables. The index comprises the stock market, the bond market, the foreign exchange market, and the banking sector. The index was constructed through a weighted value for the stated market indices.

The researchers relate to the crisis measurements that appear in the literature, and they show that these measurements do not precisely reflect the Canadian experience, while the measurements that they develop in the study present it well, and are therefore more compatible with a developed financial system. The researchers further note that a precise specification of stress must be developed before trying to predict a financial crisis. They claim that the literature on the matter of financial crises hardly discusses an actual measurement of the level of contemporaneous (prolonged) severity of crises. It is correct to measure crises via simple binary variables. Moreover, crises are commonly viewed as banking and/or currency phenomena and not as multisystem phenomena.

Hakkio and Keeton (2009) constructed a new index called the Kansas City FSI (KCFSI). They used eleven standardized variables from February 1990 to March 2009. The index was built such that the average value of the variables would be zero. The financial variables selected by the Federal Reserve Bank of Kansas City are divided into two categories—yield spreads and asset price behavior—and they must fulfill three criteria: (1) They are available on at least a monthly basis as of 1990; (2)

[3] According to Hakkio and Keeton (2009).
[4] Illing and Liu (2006).
[5] See, for example, English, Tsatsaronis and Zoli (2005).

they are either market prices or yields; (3) they represent at least one of five characteristics of financial stress: (a) an increase in uncertainty concerning the basic value of the assets; (b) an increase in uncertainty concerning the behavior of other investors; (c) information asymmetry between lenders and borrowers and between the sellers and purchasers of financial assets; (d) flight to quality; (e) flight to liquidity.

The index was built through a Principal Component Analysis of the eleven financial variables, after standardization. A positive value of the index indicates that financial stress is higher than the long-term average, and the opposite is indicated by a negative value. The researchers identify three "crisis" periods: (1) 1990–91; (2) several periods between 1998 and 2002; (3) August 2007 until the beginning of 2009. The researchers outline various ways to identify financial stress: an increase of one or two standard deviations from the average, a comparison of the various values to various reference points, discussion of percentiles, etc. The researchers emphasize that their paper does not try to define a critical index level above which there is a significant concern of financial stress. The article claims that policymakers can assess the seriousness of the financial stress by comparing the current value of the index to its value in a tangible situation of financial stress in the past.

Haakio and Keeton's index (2009) also provides valuable information concerning future economic growth. In addition to the KCFSI, these researchers created the CFNAI index (Chicago Fed's National Activity Index). This index takes a large number of monthly indicators of employment, production and expenditure, and combines them into an overall index of economic activity. The researchers reported three findings. First, there is a negative correlation between this index and the KCFSI—that is, an increase in financial stress can lead to a decrease in economic activity. (From 1990 to August 2008, the correlation between the two was -0.52, and from August 2008 onward, the negative correlation grew to -0.72.) Second, the financial stress index can predict economic activity, but not the other way around. (The researchers examined this through regressions of the indices on lags in the second variable.) And finally, there is a correlation between the stress index and the index that is based on tightening credit terms, meaning the percentage of banks that claimed they have tightened credit terms during the past three months. From 1990, the correlation between the two is 0.80. We note that while the index can predict a tightening of credit terms, the tightening of credit terms cannot predict financial stress.

Another financial stress index—developed by the IMF in 2008—attracted our attention.[6] All of the variables are on a monthly basis, and the data starts from 1980. Compared with the two previous indices, the IMF index uses fewer variables (seven), in order to be compatible with 17 different countries. In addition, the IMF index does not use the Principal Component method to calculate the coefficients of the variables in the index, but rather uses equal weights (the average of the variables). Financial stress situations are defined as one standard deviation above the trend (HP filter). If crisis episodes are just two quarters apart from each other, they are defined as one episode. The IMF differentiates between a banking crisis, a securities market crisis, and a foreign exchange market crisis. They look at the index value in the quarter before the beginning of the episode, subtract it from the maximum value of the index

[6] IMF World Economic Outlook, Oct. 2008.

during the crisis period, and examine what components were the sources of the increase (banking, securities or foreign exchange).

Yiu, Ho and Jin (2010) developed a financial stress index for Hong Kong. They used variables that appeared at a monthly frequency during the period between 1997 and 2009, and built four sub-indices: the capital market, the domestic bond market, the foreign exchange market, and the banking sector. The index values ranged from 0 to 100. The overall index was constructed as the average of the sub-indices.[7]

In this study, we used an approach that differed from those presented above, which is also used by the Fed. This approach is based on the work of Nelson and Perli (2005), and on the continuation of their work, by Carlson, Lewis and Nelson (2012). These researchers relied on the method outlined in Early Warning System models, which provides a continuous evaluation of financial stability as expressed in the financial markets. Nelson and Perli presented indices for the evaluation of the situation of the overall financial markets, the mortgage market and financial institutions, and the evaluation of the probability that important companies would declare bankruptcy. In this work, we will focus on the first of these indices, the index for ongoing evaluation of the state of overall financial markets.

In contrast with researchers who developed EWS models, Nelson and Perli did not presume to predict crises before they occurred, since the dependent variable was inserted simultaneously with the independent variables.[8] During crisis periods, the indices they developed will indicate a lack of quiet, or stress. The method allows the evaluation of the measure of stress in the financial markets based on one simple observation, and makes objective comparisons between various stress periods possible. This index serves as an important sensor for the financial markets, thus improving the ability to conduct monetary policy. The data upon which the index is based are taken mostly from the financial markets, which give the index important advantages, since it allows an ongoing evaluation that is based on data that most of the time is available on a daily, or even more frequent, basis.

Nelson and Perli used two financial crises that took place in the past as their basis for calibrating the index: the LTCM crisis that broke out in August–September 1998, and the crisis that broke out in September 2001 following the terrorist attack on the Twin Towers. The advantage of this method is that there is a standard for each of the index values. In contrast, Carlson, Lewis and Nelson (2012) did not select crisis events based on their own judgment, but rather on the basis of the judgment of regulatory bodies. They selected crisis periods based on the answer to the question of whether the policymakers responsible for the supervision of financial institutions intervened in financial markets, out of concern over the systemic risks posed by difficulties at US

[7] In this context, we also note Van Den End (2006), who built a financial stability index for the Dutch financial system. Other stress indices that were developed in recent years include, inter alia, Brave and Butters (2011), Kliesen and Smith (2010), Kritzman, Li, Page and Rigobon (2010), Oet, Eiben and Bianco (2011), and Bank of America Merrill Lynch (2010).

[8] In the EWS models, the dependent variable is based on future scenarios. In other words, the dependent variable would only receive a value of 1 if a crisis takes place in the future, in the period to which the forecast relates. In the Nelson and Perli model, the dependent variable receives a value of 1 only if a crisis is currently taking place.

financial institutions or "impaired functioning" in a US financial market.[9] In other words, the index indicates the level of similarity between the conditions prevalent in financial markets and the conditions that were prevalent during periods when policymakers were sufficiently concerned to get involved.[10]

Nelson and Perli divided the twelve variables used in the regression equations into four main groups: liquidity indices, risk indices, volatility indices, and expectations of real activity. Each variable can be reflected by a number of time series. The series chosen are obtained in the US on a daily or even more frequent basis, but the sample in the work is based on weekly data from the period between June 1994 and June 2002. One of the changes made by Carlson, Lewis and Nelson (2012) is the use of daily data instead of weekly data, which we also do in our work.

Nelson and Perli grouped the twelve series into three series through statistical processing. The first series is the average of all of these series after being standardized in accordance with their average and standard deviation. This series is labeled λ.[11] The second series is the series of changes in the previous series (the rate of change in the average of the series in the past eight weeks). This series is labeled δ. In contrast to these, Carlson, Lewis and Nelson did not use the series of changes, but rather the series of volatility—the sum of the squares of the daily changes in the average series for the last 50 days. The third series presents the level of the correlation in the variance of the series. At the foundation of this series is the estimation that during stress or crisis periods, the financial variables will tend to change in the same direction. Therefore, the correlation in the level of change of all 12 of the series is important in evaluating the situation of the financial markets. In order to construct this series, Nelson and Perli calculated the comovement of all 12 series, which is based on a moving 26-week window of time. This series is labeled ρ.

These three series were inserted into a binomial model that is based on a Logit distribution as follows:

$$p_t = L(\beta_0 + \beta_1 \cdot \lambda_t + \beta_2 \cdot \delta_t + \beta_3 \cdot \rho_t)$$

(2.1)
$$p(y_t = 1) = \frac{e^{(\beta_0+\beta_1\cdot\lambda_t+\beta_2\cdot\delta_t+\beta_3\cdot\rho_t)}}{1+e^{(\beta_0+\beta_1\cdot\lambda_t+\beta_2\cdot\delta_t+\beta_3\cdot\rho_t)}} = \frac{1}{1+e^{-(\beta_0+\beta_1\cdot\lambda_t+\beta_2\cdot\delta_t+\beta_3\cdot\rho_t)}}$$

Where *y* receives the value 1 during periods defined as a crisis and the value of 0 during periods not defined as such. The estimated probability is the financial stress

[9] We found an example of another method for selecting crisis events in the study by Grimaldi (2010). She used the frequency of selected words such as "slowdown", "lack of certainty", "risk", "difficulty", "stress", and so forth in the *European Central Bank Monthly Bulletin* as a guide for characterizing the difference between a crisis period and a normal period.

[10] According to the researchers' definition, a crisis period is spread over eight weeks—four before the involvement and four after.

[11] In order to measure the level of stress in the components of the financial system, we can use the Level series alone. Such use was made by the central bank of Switzerland. See, for instance, *Financial Stability Report*, Swiss National Bank (2006), p. 44. The index based on the Level series as it is does not contain information on its development during crisis periods, and it therefore does not eliminate noise.

index. It should be noted that using this method, three sub-indices—levels, changes/volatility, and comovement—are studied, and we ask which of them is more relevant as a signal of stress. This is in contrast to the method used by other researchers, which asks which of the various asset prices provides a better signal of stress.

In their work, the researchers show how the index is successful at capturing events that caused stress in the financial markets, outside the sample period, such as the beginning of the process of raising interest rates carried out by the Fed in the summer of 2004 and the uncertainty that was prevalent at the time. During the sample period as well, we can see how the index signals events that were accompanied by stress in the financial markets but were not inserted as crises into the model.

3. Construction of the index

3a. Selecting the series

When applying the stress index to the Israeli economy, it is important to select series that will best present the current situation of the financial markets in Israel. The series that appear in the American index are not necessarily compatible with the Israeli economy, and vice-versa. Moreover, the series in the American index do not exist in the Israeli economy for various reasons. In contrast with the US economy, the Israeli economy has experienced periods of hyper-inflation, which were accompanied by deep financial and economic crises. As a result, a tradition developed in Israel of concern over the reappearance of inflation. Furthermore, the Israeli economy is small and open. It relies on the global economy, particularly on the US economy, and is therefore influenced by external business cycles and shocks. Therefore, a stress index for the Israeli economy that does not include information on inflation or the foreign exchange market is incomplete.

The frequency of the data also has an important function in selecting the series for the Israeli economy. We selected only series with a daily frequency, for three reasons. First, most of the exceptional information is obtained by surprise. Therefore, if we conduct measurements at weekly or monthly frequencies, we may lose important information. In such cases, it is impossible to assess market behavior immediately upon the appearance of information and thereafter, even though such an assessment is very important in analyzing the shock. Second, a measurement based on low frequency may smooth over shocks, since in this case, the index is calculated based on averages within the period, while high frequency estimates may provide current information that will allow a better analysis of the market response, and assist policymakers in reaching decisions in real time rather than with a delay. Third, daily frequency is the highest possible frequency within the existing limitations of data availability. In a case where any daily information was lacking, we used the average of the values closest to it in order to maintain the daily consecutive nature of the information.

Finally, in addition to the considerations regarding inflation, the foreign exchange market and frequency, the selection of the series must take into account their

interconnectedness.[12] The financial system is characterized by mutual dependence between the financial markets, the financial institutions, and corporations. Therefore, if current and available data from the various institutions are missing, we can compensate for this through series from the financial markets. We note that despite this mutual impact, certain series may respond in exceptional ways to certain events (even as a result of measurement errors), but using the average level of all the series enables us to smooth over events that do not have economy-wide crisis characteristics, thereby reducing the concern of false alarms.

To construct the index, we also have selected variables that can be classified into the following four categories: liquidity, volatility, risk, and economic activity.

Liquidity indices

When shocks are radiating through the financial system, the level of liquidity is very important in moderating them. Experience has shown that financial shocks are accompanied by liquidity crises. The level of liquidity can indicate the ability of the financial markets to absorb high transaction volumes without suffering shocks, meaning without sharp changes in financial asset prices. A sharp increase in the liquidity premium, which indicates a sharp decline in the level of liquidity, can indicate a shock in the financial markets. The Fed measures the level of liquidity in the bond market through bid/ask spreads, meaning through the difference between the sale price (bid) and the purchase price (ask), and also through the spread between bonds with the same duration but with different liquidity levels. In Israel, it is not possible to calculate liquidity levels in these two ways due to the absence of data. As an alternative, we can use liquidity indices such as "Amihud"[13] or the Hui-Heubel (HH) Ratio.[14]

Nelson and Perli discussed the liquidity premiums of bonds with two and ten years to maturity, and relied on them in order to present the liquidity situation in the market. In Israel, there is no justification for the use of just two series, because there is a lack of continuity in the various bonds series. Therefore, in contrast to the American approach, which is based only on liquidity in the bond market, we chose to include the liquidity situation in two important markets in the Israeli economy—the government bond market and the foreign exchange market—in the index.

To calculate foreign exchange market liquidity, we used the bid/ask spreads on the shekel-dollar exchange rate.[15] To measure government bond market liquidity, we used the HH index, which is affected by the level of volatility and the speed of the cycle. This index is obtained by dividing (1) the normalized standard deviation of the implied yield on the bond in the last five days by (2) the average speed of the cycle during those days. The government bond market in Israel is comprised of various types of bonds ("Shahar", "Galil", "Gilon", "Gilboa", *makam*, and so forth). In selecting the series that present the liquidity in the stress index, we gave preference to *makam*, "Shahar" and "Galil" securities, because they were and continue to be

[12] The series that comprise the index, and their weights, were selected, inter alia, after discussions in the Financial Stability Unit and inter-departmental discussions, as well as after assessing their adjustment to events with crisis characteristics.
[13] See Amihud (2002).
[14] See Hui and Heubel (1984).
[15] An explanation on how the series is built appears in Appendix 8B.

dominant in the bond market, and because in relative terms, their level of tradability has not changed in the past decade. (The tradability level of most bonds has changed in the past decade due to changes in public preferences, in the inflation environment, and in issuance limitations, as well as due to the natural growth of GDP.) It is worth noting that "Galil" is a CPI-indexed bond and may therefore serve as a financial shelter during times of uncertainty. Liquidity for each of these securities is measured with HH, and the three series were then grouped into one series by calculating the weighted average of the market value of all three.

In this category, two series were selected:

1. Liquidity in the bond market.
2. Liquidity in the foreign exchange market.

Volatility indices

The implied standard deviations in prices of options prices on financial assets reflect the volatility in interest rates and in asset prices, and enable us to obtain a good measurement of the uncertainty felt by investors and to calculate the probability function of the underlying assets.

In selecting the series to measure market volatility, we preferred using implied volatility over past actual volatility, because one of the notable characteristics of a financial shock is a sharp and sudden change in various series. Such a change may appear immediately in the implied volatility in options on various assets, while it will only appear in the actual standard deviation after some time (in line with the number of observations upon which the calculation is based). In cases where the stress index is calculated on a monthly basis, we can obviously use the actual deviation as an approximation, which is calculated on the basis of roughly 20 days.

The foreign exchange market, equity market and bond market are the main financial markets in the Israeli economy. Options from which we can derive the implied volatility are issued on the first two markets. The calculation of the implied volatility in the foreign exchange (shekel-dollar) market, and in the equity market by call options per month is based on the approach and calculations of Hecht and Pampushko (2005). Concerning the third—the bond market—since there are no long-term options or futures contracts on this market in Israel, we estimated its volatility through the actual standard deviation of the change in the bond indices (*Makam*, "Shahar", and "Galil") during the past five business days.[16]

Four series were selected in this category[17]:

3. The actual standard deviation (in the last five days) in the implied yields of long-term bonds (duration of more than two years).

[16] For each day, the change in the index was calculated in relation the previous day. For all changes obtained from all three of the indices (*Makam,* "Shahar" and "Galil"), a moving standard deviation was calculated for five days, and finally, the average of all the standard deviations was calculated.

[17] Nelson and Perli (2005) used five variables in this category: the standard deviation of the interest rates for three months for a year forward, the implied volatility in long-term US bonds, the implied volatility in options on the euro-dollar exchange rate for half a year (180 days); the implied volatility in US ten-year bonds; and the implied volatility in the S&P 100 stock index.

4. The actual standard deviation (in the last five days) in the implied yields of short-term bonds (duration of two years or less).
5. The implied volatility of the shekel-dollar exchange rate.
6. The implied volatility of the Tel Aviv 25 (MAOF) Index.

Risk indices

The risk premiums obtained as the differential between yields to maturity on corporate bonds and those of parallel government bonds with the same duration indicate the risk inherent in the companies issuing these bonds and investors' readiness to take risks. Therefore, we can derive the real risks and investor optimism or pessimism from these premiums. A sharp increase in premiums, aside from the market shock that is inherent in it, could point to a new risk pricing level in the market, which may be derived from, among other things, increased uncertainty or a deterioration of the financial conditions in the markets or the companies.

There are fewer corporate bonds traded in Israel, and they have a lower level of tradability, than government bonds. Moreover, it is hard to obtain yield to maturity data on corporate bonds for years prior to 2005. Despite this, we built[18] a series of yield spreads between fixed-rate CPI-indexed bonds with a duration of 4–7 years. We note that there are two problems with this spread. First, prior to 2005, there were few corporate bonds (about 20). Second, there is data on these bonds only from August 1998 onward. In order to overcome the second problem, we were forced to find another series that could better explain the "corporate bond spread" variable since 1995. After several attempts, we selected a series in which the gap between the government and corporate bond indices was calculated, since it succeeded in explaining about 55 percent of the shorter series. Through the coefficients of the regression that was run, we back concatenated the series of spreads. In this category, we selected one series[19]:

7. Bond spreads on CPI-indexed, fixed rate corporates with a duration of 4-7 years.

Economic forecast indices

Asset prices vary in accordance with how investors relate to risk, which in turn is influenced by their expectations, the amount of information they possess, and the level of uncertainty regarding macroeconomic conditions in general, and regarding the situation of the companies in particular. Investors' forecasts of real activity have tremendous importance in evaluating the current and future market situations. The profit multiples that the analysts forecast (for companies included in the S&P 500 index) provide a large amount of information on future real activity, which affects the financial markets. Additional information on macroeconomic conditions can be obtained from the central bank's interest rate. We can also obtain this information from the short-term bond yield, since this behaves similarly to the central bank

[18] We thank Vladimir Lifshitz and Hanan Zalkinder for their help in gathering the data.

[19] Nelson and Perli (2005) used three variables in this category: the spread between yields on bonds ranked BBB and the yield on US Treasury bonds; the spread between the yields on bonds ranked AA and the yields on US Treasury bonds; and the spread between the yields on high-risk corporate bonds and the yields on US Treasury bonds.

interest rate and responds faster than it. The Fed chose to use the following two series: 1. The yield on two-year US notes; 2. The excess yield of stocks over bonds.[20]
When assessing the situation of the Israeli economy, focus must be placed on, *inter alia*, inflation and GDP. Israel's economy, which underwent a process of disinflation following the period of hyperinflation, was left with a fear of inflation. The many indexing mechanisms that were developed, the fear of uncertainty regarding inflation, and monetary policy that is also based on inflation expectations, have all strengthened the need to use indicators of the inflation situation when developing a macroeconomic evaluation of the economy.

In Israel there exists, almost exclusively, the possibility of conducting ongoing measurements of inflation expectations for various ranges. Since monetary policy in Israel relies on inflation expectations for a year ahead, we have chosen to insert inflation projections for a year ahead as derived from the capital market and obtained as the difference between the implied yields on unindexed government bonds and those of indexed bonds with a duration of one year. We used the absolute value of the difference after standardization since we wanted the index to relate to a sharp drop in inflation expectations as a negative event, precisely the way that it relates to a sharp increase in expectations. This is because a sharp drop in inflation expectations indicates expectations of moderation in economic activity. Note that Nelson and Perli did not use indicators of the inflation situation.

In the Israeli economy, there is a transmission between the exchange rate and inflation. The perception of the dollar as a strong and stable currency compared to the shekel, and the transmission that exists between it and inflation, have turned the dollar into a safe haven during times of uncertainty. Therefore, depreciation of the shekel against the dollar may capture stress existing among the public.

The stock market reflects investors' forward-looking forecasts. In order to present this market, we selected the Tel Aviv 100 index, which includes the 100 shares with the highest market value in the stock market. In order for an increase (decrease) in the index to represent an increase (decrease) in financial stress, we reversed the values of the standardized series, meaning that a negative value became positive, while a positive value became negative.

We can also obtain important information on real activity from the central bank's interest rate. However, this interest rate varies, in general, at fixed times, and does not respond rapidly to events. In contrast, the implied yield on bonds varies each day in accordance with current information, and it should provide information regarding investors' projections. Since inflation expectations have already been included as a separate variable, using unindexed bond yields should put in the same information a second time. Therefore, similar to the American approach, we inserted the implied yield on CPI-indexed two-year "Galil" bonds.

Four series were selected in this category:
8. Absolute value inflation expectations.
9. The shekel-dollar exchange rate.

[20] The calculation: Earning-price ratio of the S&P 500 minus the real level of the ten-year Treasury rate.

10. The Tel Aviv 100 index (reverse sign).
11. The implied yield on CPI-indexed bonds with a duration of two years.

These, then, are the eleven series that make up the composite index for tracking the financial markets in Israel, and all are expected to respond in a similar manner to information indicating a deterioration of the economy. The level, duration and strength of the response vary from series to series and according to the type of information obtained.

Table 1 presents the weight given to each of the markets (the bond market, the foreign exchange market, and the stock/derivative market) in the composite index constructed in this paper[21], in the index created in the study by Nelson and Perli, and in the index created by the IMF, and organizes the weights by index categories: liquidity indices, volatility indices, risk indices and activity projection indices. We can see that Nelson and Perli included indicators from the bond market (about two-thirds) and from the stock/derivative market (about one-third). In contrast, we added the foreign exchange market, which lowered the relative weights attributed to the bond and stock/derivative markets. The table also shows that share of the risk indices in our composite index is very small compared to the other two indices.[22] The picture is reversed when assessing the weights of the economic forecast indices. The weights given to the various markets in our work are not disconnected from their share in the public's asset portfolio.

Table 1: Summary table of the series comprising the index—comparison between the index we constructed and the indices built by Nelson and Perli and by the IMF

	Category												Total		
	Liquidity			Volatility			Risk			Activity					
Series source	IMF	N&P	Israel	IMF	N&P	Israel	IMF	N&P	Israel	IMF	N&P	Israel	IMF	N&P	Israel
Bond market	14%	17%	9%			18%	28%	42%	9%		8%	18%	42%	67%	54%
Foreign exchange market			9%	14%								9%	14%		18%
Stock/derivatives market, others				14%	25%	18%	14%			14%	8%	9%	42%	33%	27%
Total	14%	17%	18%	28%	25%	36%	42%	42%	9%	14%	17%	36%	100%	100%	100%

3b. Transforming from eleven series to three
After selecting the eleven series, we grouped them into just three. Each of the three series obtained was intended to capture one principal component of all of the original series. Each of the eleven original series was characterized by a different distribution. Therefore, **in the first stage**, we standardized all of the series and obtained a new series for each of them with an expected value of 0 and a variance of 1.

Standardization can be fixed or moving. In fixed standardization, the series were standardized on the basis of the expected value and the standard deviation for the entire sample period (July 1996–October 2012). The sample period has two important characteristics: First, it has a not inconsiderable number of shocks, and second, there was an improvement in the functioning of the financial markets with a decline in the volatility of asset prices in recent years. These two characteristics point to the

[21] The eleven series selected were given identical weight, as stated.
[22] This is because this type of index was lacking in Israel for years.

assumption hinted at in the previous estimations, that the expected value and the standard deviation of the eleven series remained constant.

In a moving standardization, in contrast, the series are standardized on the basis of the expected value and standard deviation during the past year. This supports the assumption that the standardized series are characterized by a distribution with an expected value of 0 and a variance of 1. This statistical operation has economic significance. We will illustrate this with an example: Let us observe a daily increase of 1 percent in the dollar exchange rate where the center of the inflation target is 9 percent and inflation expectations are similar. Such an increase would be accepted with much more tolerance than a similar increase of the dollar after a disinflationary process. This means an attitude to a change of 1 percent in all eleven series separately during periods of disinflation which is similar to that toward the same rate of change during periods after the inflation target had been reached, may lead to an index that is too "calm" during periods where the markets are in an improved situation, after achieving the inflation target. Moreover, we noted that fixed standardization causes the stress index to be high during the period we have defined as crisis, and lower during other periods. As a result, the index captures fewer exceptional events. For these reasons, we decided to standardize the series with a moving standardization.

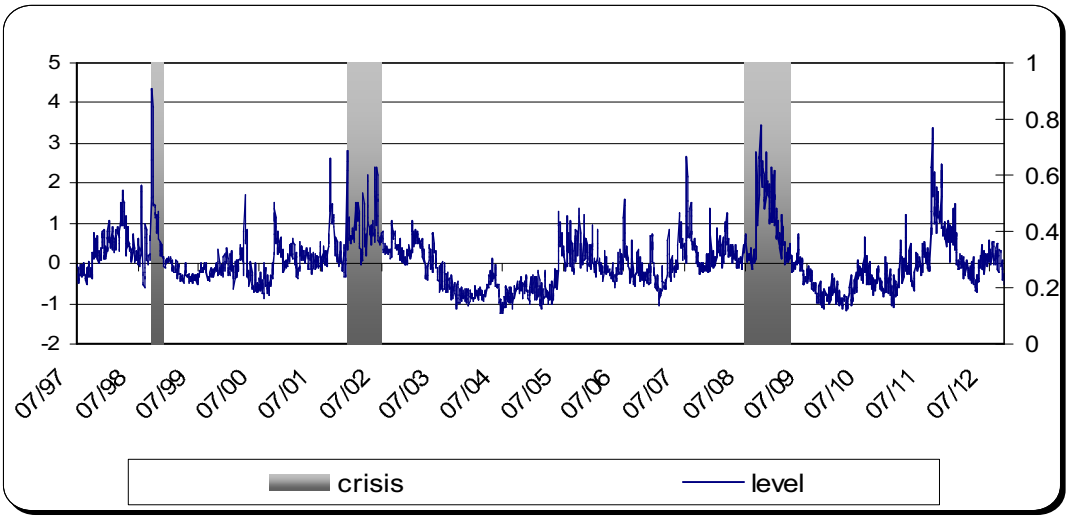
However, this approach is also not free of problems, several of which are: (1) The mean (and the standard deviation) calculated based on the past year should fall markedly a year after a market shock, even in the absence of an additional exceptional event. As a result, the series would respond today (with a sharp increase or a sharp decline) to a shock that took place a year ago; (2) The index is intended to highlight exceptional events, enabling policymakers to focus on them. An index that is too volatile misses this purpose; (3) If the index is based on a uniform standardization that includes crisis periods, then it has clear significance—it expresses the relationship between the current event and events based on which the model was calibrated. An index based on a moving standardization does not keep this significance.

In the second stage the simple arithmetic mean of all the standardized series was calculated, and finally one series was obtained. This series is called the Level series[23], and is labeled λ. The use of the simple mean attributed equal weight to all of the series that were selected. Since these series are a representative sample of the current information from the various sources, the simple arithmetic mean should capture the information from the entire market well. If we give greater weight to a certain series in calculating the average, it could increase the sensitivity of the series of averages to information that this series presents, while the aim is to smooth over responses to exceptional information in an individual series. Moreover, the use of various methods to build a representative series for all eleven series—from the weighted average by market value (see Oet, Eiben and Bianco (2011)) through the Principal Component (see Brave and Butters (2011))—did not generate better results than the use of the simple arithmetic mean, because there is a correlation between most of the series taken from the financial markets during the periods when exceptional information was obtained.

[23] It is possible to use only this series as a noncalibrated stress test. See the review of the literature above.

The Level series throughout the entire reviewed period—July 1997 to October 2012—appears in Figure 1.[24] We have labeled three crisis periods in it: 1998, 2002, and the last financial crisis (2008–09), which we will expand upon in the next section.

Figure 1: The Level Series
(July 1997-October 2012)



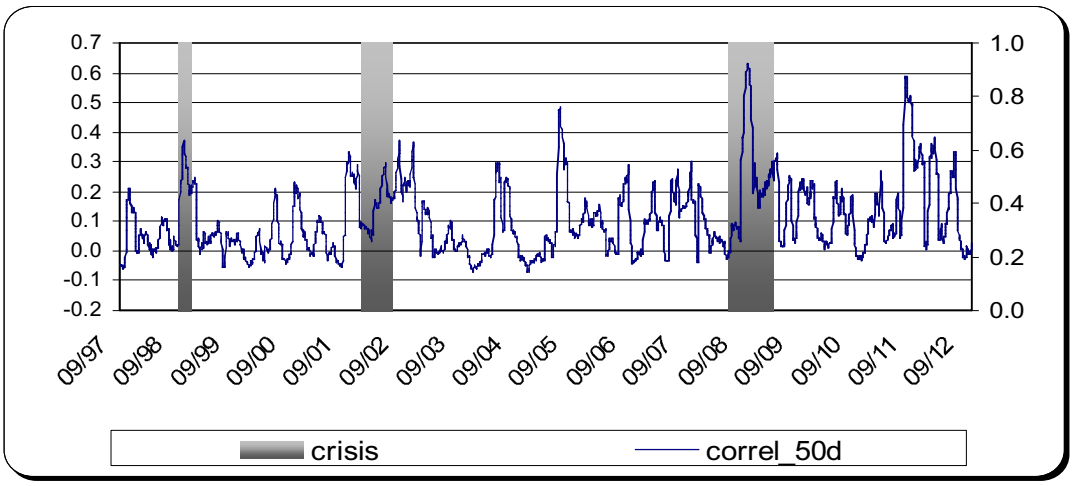
In the third stage, we calculated the average of the cross correlation coefficients for all eleven series over the previous fifty days. In practice, we also examined other lags, but we preferred not to enter variables that are based on shorter periods, since they are very volatile, contain a lot of noise, and were found to match events with crisis elements less. We thus obtained the second series, called the "Common Correlation series" (Correl_50d). This series is labeled ρ, and it appears in Figure 2. During periods of stress, asset prices tend to change together, meaning the correlation between them approaches 1. Thus, the higher a particular sub-index is, the better the ability of a single common factor to explain the changes in the series that comprise it.

In contrast with the markets' behavior during calm periods, their behavior during periods of stress, as reflected in the original series, indicates a very clear deterioration: While changes in the original series also take place during periods of calm as a result of new information obtained on an ongoing basis, this response is stronger during periods of stress. Therefore, the correlation series captures an important component in calculating the stress of the financial markets. With that, this series also takes on high values when there is a sharp and correlated decline in the values of the eleven series as a result of a rapid calming of the markets[25] (mainly following sudden events that generated a shock and caused uncertainty that later dissipated rapidly after market participants understood the meaning of the events). The use of this series in the index is based on the assumption that any rapid and correlated change in the financial markets, even if it is in a positive direction, is considered negative behavior in that it shows a lack of financial stability.

[24] Charts for all eleven series can be seen in Appendix 8a.
[25] A gradual calming of the markets, similar to a gradual build-up of stress, would not lead to sharp increases in the series, since in such cases, the information unique to each of the various series is reflected more than unimportant information that they have in common.

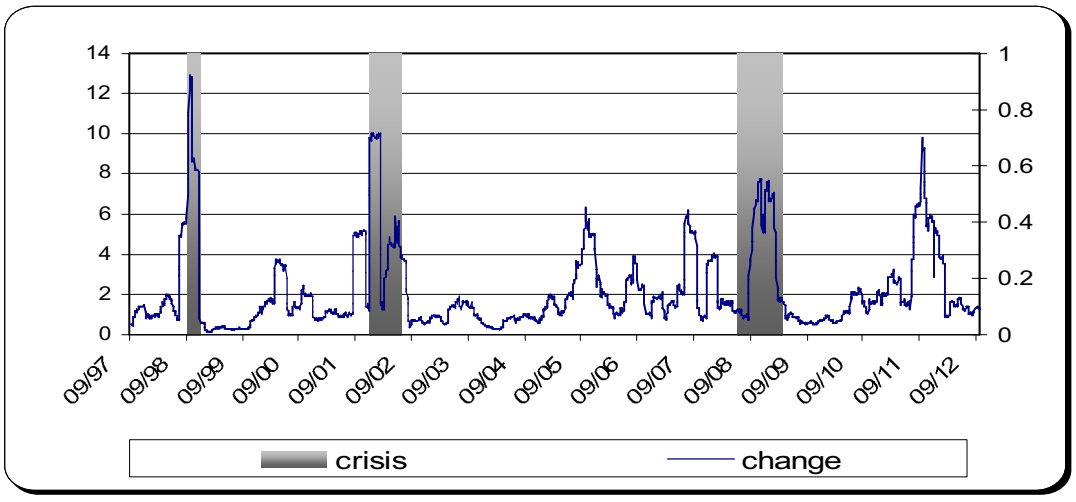
Figure 2 indicates that the Common Correlation series does not properly "capture" the 2002 crisis, but it does take on high values during the 1998 crisis and during the recent subprime crisis.

Figure 2: The Common Correlation Series
(September 1997–October 2012)



In the fourth stage, we calculated a "volatility" sub-index as calculated in the study by Carlson, Lewis and Nelson (2012): the sum of the squares of the daily changes in the Level series over the previous 50 days. This index is intended to estimate the level of volatility in the eleven series, and the series is labeled δ. In using this series, we see that in an event with crisis characteristics, the volatility of the series will be higher. At the same time, we note that the volatility index is also expected to respond to moves from periods of greater stress to periods of less stress. Figure 3 shows that during crisis periods, the volatility index does increase. The graph also shows that there was actually a significant jump in this sub-index during a time that was not defined as a crisis period–October 2011.

Figure 3: The Volatility Series
(September 1997 – October 2012)



3c. Selecting events in order to calibrate the model

In order to calibrate the series coefficients, it is necessary to define the periods characterized by crises. The identification of crisis periods is fundamentally problematic and can be defined in various ways. Among the conditions for the existence of a crisis are: (1) a change in the size of the economic series within a relatively short time, and (2) an unconventional response by policymakers. In the past fifteen years, we can identify three events with crisis characteristics, and they can serve as a basis for a more precise definition of crisis periods.

The first event began at the end of August 1998, after the Russian government declared a default on its debts. The value of the Russian currency and of Russian bonds fell sharply, leading to a chain of sharp changes in currency exchange rates worldwide, including the currencies of the strongest and most stable markets. This led investors to re-evaluate how worthwhile it was to hold currencies and bonds from those countries, the credit granted to them, and the shares of companies in all emerging markets.

With the sharp decline in bond prices and equity indices in those markets, international funds, led by the giant American LTCM hedge fund, collapsed. As a result, the banks began demanding larger security margins on all risk funds, and this demand was reflected in an increase in liquidity needs. The increase in liquidity requirements by banks throughout the world only increased the pace of sell orders placed by foreign investors in emerging markets. Since Israel was considered among these markets, these sales increased the demand for foreign currency in Israel and led to a very sharp depreciation of the shekel: 13 percent within 13 trading days at the beginning of October. For its part, the depreciation caused tremendous concern among Israeli business groups that had taken credit in foreign currency, households with expenses linked to foreign currency, and policymakers.

The second crisis event began on December 23, 2001, after the Bank of Israel announced a sharp reduction of the interest rate, from 5.8 percent to 3.8 percent. A parallel decision was made to reduce public spending. As a result, and against the background of a worsening of the security situation, there was tremendous volatility in the markets. The situation became worse when it became clear that the government would not reduce public expenditure. During the first half of 2002, the shekel depreciated sharply, bond prices fell, and there was a serious concern over Israel's ability to raise capital. In contrast with the 1998 crisis, this event continued for a long time, and negatively impacted a different market at each stage. The precise dates of the beginning and end of the event in the markets are not particularly clear, against the background of the large number of terrorist attacks during that period.

The third crisis event was the sub-prime mortgage crisis. This crisis erupted in the United States in July-August 2007, and beginning in September 2008 it grew into a global crisis. The crisis began with a sharp increase in the share of borrowers who could not meet their mortgage payments. For its part, this increase led to an increase in the interest rate at which other companies were prepared to lend to mortgage lenders. In addition, the real estate market in the United States had been suffering from a slowdown since 2005, which led to borrowers who were unable to meet their payments also not being able to sell their properties in order to repay the loans. Many

properties were foreclosed on by lenders, but the lenders were also unable to sell them for the same reason. This worsening of the conditions of mortgage lenders created a "credit crunch", and from the beginning of 2007, there was a marked increase in the rate of bankruptcies among companies providing loans. The bankruptcies led to a decline in the shares of companies connected to real estate, as well as to a wave of sharp declines in bonds that had been securitized and were purchased by banks and financial institutions around the world. Stock markets throughout the world began falling, and the United States was forced to reduce interest rates.

The worsening of the crisis began on September 14, 2008 with the collapse of the Lehman Brothers investment bank. As event followed event, global credit markets froze, shares of large banks collapsed, the crisis moved into the real economy and companies began laying off workers. The global economy entered a complete freeze and a high level of uncertainty. Finance ministers and central banks throughout the world began consultations, at the end of which various assistance packages were formulated, mainly for the banking sector, in the hope of leading to a thaw in the provision of credit. The State of Israel was not significantly harmed by the crisis. The shekel depreciated through most of the period, there was a decline in inflation expectations, share prices fell on the Tel Aviv 100, corporate bond spreads widened, and a number of firms were forced to enter debt restructuring proceedings. There were also short episodes of increases in the implied volatility of the shekel-dollar exchange rate and the Tel Aviv 25 index.

In order to more precisely define the crisis periods, we used the grouped series presented above. We can identify that the 1998 crisis began at the beginning of October (with a sharp increase in the Level series and the Volatility series) and ended at the beginning of December of the same year. The 2002 crisis is harder to define. The event began at the end of December 2001, about three months after the World Trade Center attack, with the announcement of the sharp reduction in the interest rate. As a result of the announcement, yields to maturity on various bonds declined. The foreign currency market also responded with severe volatility. After a short time, the Bank of Israel was forced to intervene through continuous interest rate increases, and the foreign currency and bond markets continued to react with serious volatility.

It seems that the 2002 event continued until June. While the Level series did increase markedly at the end of December 2001, and remained at high levels until the end of June 2002, there were many increases and decreases during that period. In contrast, the Volatility series began to increase at the beginning of December 2001, and reached its apex at the end of January 2002. Another increase in this sub-index can be seen at the end of April 2002, and a return to the levels seen before the crisis period only occurred in mid-July 2002. The Common Correlation series, which shows the correlation between the series over the previous fifty days, increased on precisely the date that the Bank of Israel announced a reduction in the interest rate (December 23, 2001) for a few days, and immediately began declining. It declined until March, then began to rise, and remained at high levels until June 2002. In the final analysis, we decided to bound the 2002 crisis as the period between the end of December 2001 and the end of June 2002.

With regard to the sub-prime crisis, Dovman (2010) defined it within the period from the third quarter of 2008 to the second quarter of 2009. We decided to define it within

the period from the third quarter of 2008 to the first quarter of 2009, because of the rapid recovery in the markets during the second quarter of 2009, which was reflected in the Level series. The Common Correlation series began to rise only in the fourth quarter of 2008, as a result of the uniform response of the series during this quarter. There was a significant increase in the Volatility series at the beginning of October 2008.

Other events generated shocks in the financial markets in Israel, including the outbreak of the Second Intifada (October 2000), the terrorist attack on the World Trade Center (September 2001)—the effects of which can be seen in the Level series, in the Common Correlation series, and the Volatility series—and the Second Lebanon War (2006). Despite the serious shock to the financial markets during these events, we have not defined them as crises in the estimations made in this paper.

At this point already, it is important to note the **model's weakness**. The model's coefficients are calibrated based on the definitions and assumptions we have used during our work, and these have problems. We note two of the more important and decisive ones: (a) In this model, we have defined the term "crisis" in a binary fashion, so we can only choose among two possibilities: the financial system is in crisis, or the financial system is not in crisis. However, in practice, it is more a matter of grades, and the amount of stress in the various events can provide additional information.[26] This raises many questions, such as whether we can actually define the events of 2002 as a crisis. Perhaps the markets' behavior following the outbreak of the Second Intifada (October 2000) can also be defined this way? Can we ignore lower-level shocks? At what level of shock do we define the shock as a crisis? (b) The second problem concerns the determination of the duration of the crisis. This problem derives from the difficulty in finding exogenous events with a clear direction of effect that would indicate the beginning or end of a crisis. The difference between the series values in periods that have been defined as crisis periods and their values during periods with crisis characteristics that have not been defined as a crisis—for instance, the outbreak of the Second Intifada in October 2000 and the World Trade Center attack in September 2001—has an influence on the values of the coefficients in the estimation, and therefore on the stress that the index will present during periods of light shocks. As a result, during a crisis, we may miss crisis episodes that are close together, which provide information on the behavior of asset prices.

In an attempt to deal with the problems presented herein, we have selected models that are separated from each other in their sampling frequency, in defining 2002 as a crisis, and in the composition of the series, and we finally selected the best model.

4. The estimation and the results

In order to calibrate the index, we had to decide whether it was possible to define the three events described above as significant crises that would be compared with future crises. First, we decided that our sample would be divided into two: in the sample and out of the sample. The sample period was set from September 1997 to December 2006, while the period outside the sample was set from the beginning of 2007 until October 2012, and will serve as a control. We made this division because we wanted

[26] See Oet, Eiben and Bianco (2011).

at least one of the three crises to be outside the sample—in this case, the most recent financial crisis in 2008 and 2009.

We now ask the question whether we should also define the 1998 crisis and the 2002 crisis as classic crises. If we include 2002 in the sample and define some of it as a crisis, despite the unclear correlation of the series with the crisis, it will increase the sensitivity of the index to shocks in the market. If we remove 2002 from the sample and leave only the 1998 event, which was characterized by a clear correlation of the series with the crisis, it will cause the index obtained on the basis of this estimation to be less sensitive to shocks in the financial market. There are advantages and disadvantages to this. Among the advantages is the fact that this index will smooth slight shocks and will help those using it to focus on events with far greater economic significance. However, this advantage is also a disadvantage: ignoring shocks may induce a dangerous complacency by those using the index.

When determining the periods to be defined as crisis/shock, a series was built that takes on the value of 0 during periods of calm and values of 1 during periods of crisis/shock. This variable will be the dependent variable. The independent variables are the three series obtained after reducing the eleven series: the Level series, the Common Correlation series (correl_50d), and the Volatility series (change). The method of estimation is binomial, based on a Logit distribution.[27] After the equation has been estimated and the coefficients have been obtained for each of these series, we can calculate the probability that a financial crisis is taking place in the financial markets. This value will be the market stress index.

In the first stage, the dependent variable takes on a value of 1 both in the crisis event that we defined in 1998 and in the crisis event that we defined in 2002. Equation 3.1 presents the estimation results. We note first that the variables came out statistically significant: 1. The intercept is negative—a negative intercept reduces the influence of the three variables on the estimated probability, thereby smoothing it and setting the level of its sensitivity to the various events; 2. As expected, the Level series coefficient is positive—meaning an increase in level raises the likelihood that there is a financial shock in the market; 3. The Common Correlation series coefficient is also positive—meaning an increase in the average of correlation coefficients between the eleven series over the previous fifty days also increases the probability that the market is going through a financial crisis; 4. The Volatility Series coefficient is also positive, meaning that, as expected, during crisis periods, the volatility of the series increases. The value of the McFadden statistic, which has a meaning similar to R^2, is high at 0.65, meaning that the hypothesis that the use of this equation is not justified is rejected with a high probability. We also note that the high number of observations—2,274 (days)—gives the significance of the results added validity.

(3.1)
$$p(y_t = 1) = \frac{1}{1 + e^{-(\underset{0.00}{-6.84} + \underset{0.00}{2.57}\cdot\lambda_t + \underset{0.00}{4.23}\cdot\rho + \underset{0.00}{0.69}\cdot\delta)}}$$

Sample: 9/97 – 12/06, Total observations – 2,274, McFadden = 0.65

[27] The use of the Logit distribution as opposed to Probit enables us to randomly remove observations from the sample (in order to increase the difference of the dependent variable) without harming the quality of the results.

Due to the difficulty in defining the period in which the 2002 crisis took place, we made a further estimation based on Equation 3.1, in which we do not define the crisis event that took place in 2002 as a crisis:

(3.2) $$p(y_t = 1) = \frac{1}{1 + e^{-(\underset{0.00}{-38.7} + \underset{0.00}{4.19} \cdot \lambda_t + \underset{0.00}{57.7} \cdot \rho + \underset{0.00}{2.76} \cdot \delta)}}$$

Sample: 9/97 – 12/06, Total observations – 2,274, McFadden = 0.90

The results are presented in Equation 3.2, and show that the intercept and the coefficients of the three variables remain significant at a level of 1 percent, their signs do not change and their values increase. In addition, the explained percentage of variance grows significantly, from about 65 percent to 90 percent. In other words, the simple average of the series, the average of their correlation coefficients in the last fifty days and their volatility explain about 90 percent of the probability that the market is being hit by a financial shock.

The estimation under discussion is based only on the 1998 crisis, which was short but severe, so that the probability estimated in other events (which have not been defined as crises) is lower. This can be shown by the higher value obtained by the McFadden coefficient, which shows the compatibility of the estimated probability with the period defined as a crisis. This result shows that there was room for the hesitation that was described above regarding the definition of the 2002 event, although it does not show the preference of a comparison that does not include 2002 as the basis for calculating the estimated probability (the index). The measure of sensitivity required of the estimated probability must be the important factor in deciding whether to include 2002 as a crisis in the sample.

4a. The calibrated index

An assessment of the selected series, while using the results of the estimation for calibration, allows an evaluation at any time of the probability that the market is in the midst of a crisis: The values of the estimated probability indicate the amount of stress in the markets. During periods of calm, the estimated probability will obtain values close to zero, while values close to 1 will indicate a crisis.[28] We can therefore use the estimated probability as an index of the level of stress in the financial markets. The sample period, as stated, is from September 1997 to December 2006. Outside the sample period, the index has been calculated on the basis of coefficients obtained in the estimation.

The index is based on all eleven of the original series, which were reduced to three, and is obtained as the estimated probability according to the model being estimated. Figures 4 and 5 portray the behavior of the index during the past fifteen years, and the periods defined as crises. Figure 4 shows the calibrated index in which only the 1998 crisis is defined as a crisis, while Figure 5 shows the calibrated index on the basis of the 1998 crisis and on the basis of the 2002 crisis. We can see that, other than the

[28] The estimated probability/stress index provides values in relation to crises that were defined (1998, 2002), making the index relative to these crises.

periods defined as crises, there were other periods in which the index obtained high values. This can be explained through events that took place during those periods.

Figure 4: The Calibrated Model—2002 is Not Defined as a Crisis
(September 1997–October 2012)

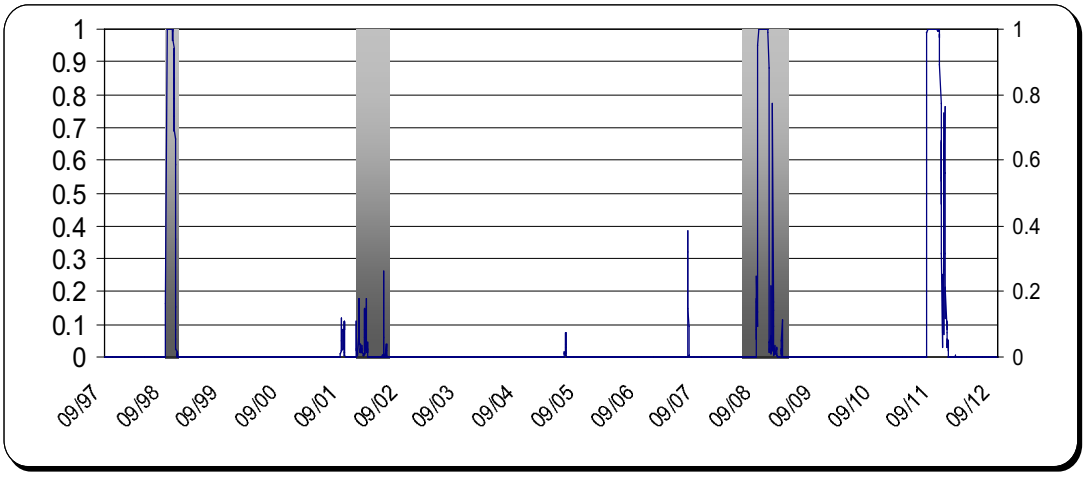
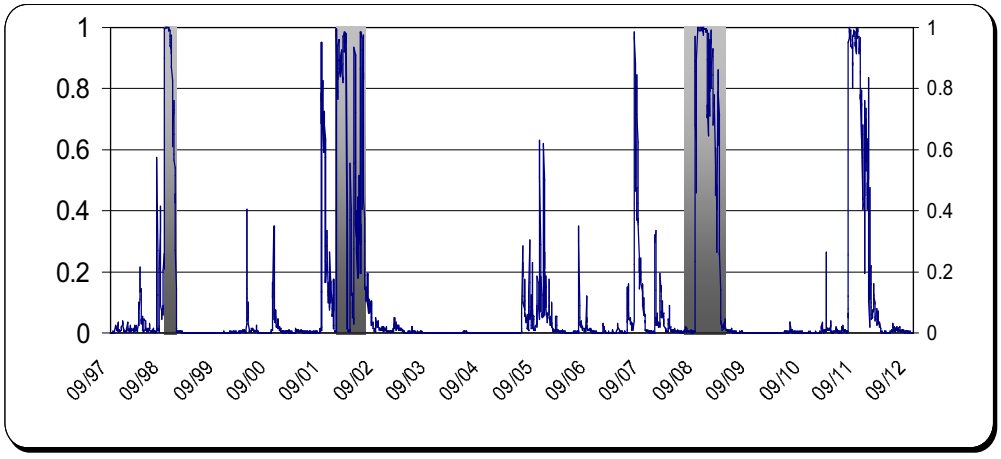


Figure 5: The Calibrated Model—2002 is Also Defined as a Crisis
(September 1997–October 2012)



The high value obtained by the McFadden coefficient in the model that did not include the 2002 period as a crisis (Equation 3.2) is reflected very prominently in Figure 4. As noted above, when the model is based only on a single crisis that was particularly short and severe (the 1998 crisis), the probability of financial stress in other events (for the most part) was close to zero. We can see that there was an increase in the estimated probability during the 2002 crisis period, during the most recent financial crisis in August–September 2007, and in August–December 2011. In contrast, Figure 5 shows many more events in which there was an increase in the probability[29], which can help us with ongoing tracking of the amount of stress in the financial markets.

[29] Upon which we will expand below.

The period of relative calm that prevailed for most of the reviewed period requires relatively low values for the index in most of the period. Formally, an index whose average values during the reviewed period is high does not reconcile with this known fact, and the same is true of a standard deviation that is too high. We must also expect that the skewness value[30], which measures the level of asymmetry in the distribution, would have a high positive value, since this shows that there are more index values that are close to zero than values that are extreme, meaning index values that indicate a shock in the financial markets. We will track the fulfillment or non-fulfillment of these requirements through Table 2. First, we can see that the index that does not include 2002 as a crisis has a mean, median and standard deviation that are smaller than the index that does include this crisis event. In addition, it is characterized by much more asymmetry with a strong pull rightwards. This means, as is also shown by the index charts, a calmer stress index that may even be too calm.

Table 2: Summary of statistical data of the two calibrated indices

	With 2002	Without 2002
Mean	9.9%	4.0%
Median	0.4%	0.0%
Maximum	100.0%	100.0%
Minimum	0.0%	0.0%
Standard Deviation	24.7%	18.6%
Skewness	2.75	4.76
Kurtosis	9.22	24.10
Observations	3,692	3,692

4b. The "synthetic" index

As we noted at the beginning of this paper, we constructed a synthetic index that is virtually uncommitted to a specific event. It is constructed of partial indices, and its values can be compared for the reviewed period. Further to the estimations outlined above, we propose here an estimation that uses original series standardized as they are. For each of the series that are incorporated into the Level series (eleven series), for the series of correlation coefficients of the series during the last fifty days, and for the Volatility series—a total of thirteen series—we calculated a partial stress index as follows: $\frac{1}{1+e^{\alpha_0+\alpha_1 \cdot x}}$, where the intercept and the coefficient (α_0 and α_1) were those that were compatible with the situation in which the mean and the standard deviation of x are identical to the mean and the standard deviation of the selected calibrated stress index.

[30] The skewness value measures the level of asymmetry in the distribution—positive values indicated positive asymmetry, and vice versa.

Mathematically:

$$I.\ E\left(\frac{1}{1+e^{\alpha_0+\alpha_1\cdot x}}\right)=\int_{-\infty}^{\infty}\frac{x}{1+e^{\alpha_0+\alpha_1\cdot x}}dx=E(crisis\_f)$$

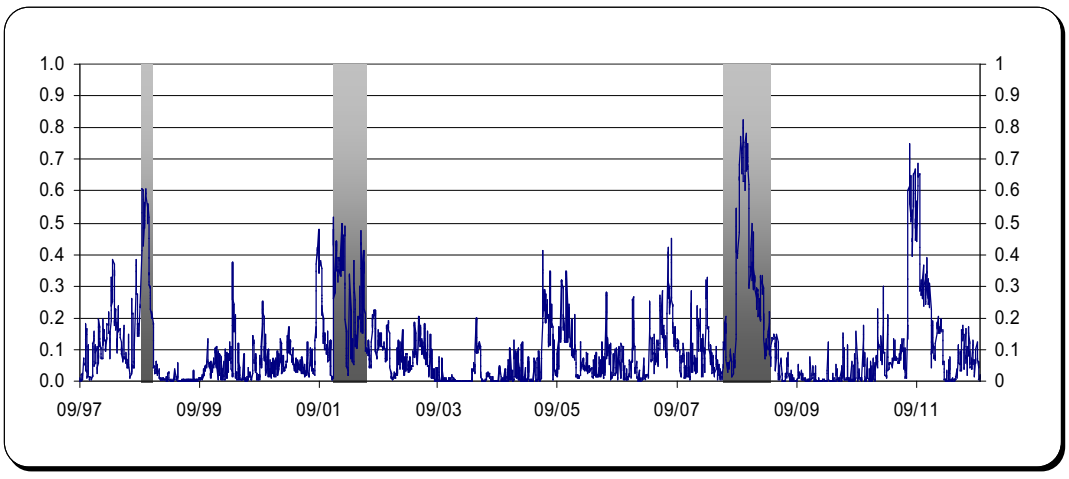
$$I.\ V\left(\frac{1}{1+e^{\alpha_0+\alpha_1\cdot x}}\right)=\int_{-\infty}^{\infty}\frac{x^2}{1+e^{\alpha_0+\alpha_1\cdot x}}dx-\left(E\left(\frac{1}{1+e^{\alpha_0+\alpha_1\cdot x}}\right)\right)^2=V(crisis\_f)$$

Crisis_f = the calibrated model.

In the end, we reached an approximate solution that is based on the actual distribution of x.

At this point, we calculated the weighted average of all of the partial indices, assigning a weight of 70 percent to the average of the eleven series, 15 percent to the Volatility series and 15 percent to the Common Correlation series. The result is a synthetic stress index that obtains a maximum value of 0.823 (during the crisis of 2008). The index is outlined in Figure 6 below. We can see that the synthetic index is particularly volatile, and during the defined crisis periods, there was a high probability of financial shock. The figure also shows that the strength of the last financial crisis (2008–09) and of the crisis in the summer of 2011 were even greater than the strength of the 1998 crisis.

Figure 6: The Synthetic Index
(September 1997–October 2012)



5. Uses of the Index

5a. Analysis of the movement of the indices in response to a sample of events that affected the financial markets

Another criterion in examining the quality of indices is to compare their responses to an event that caused financial instability and their movement in the period preceding the event. The expectation from the index is that sharp movement in it reflects a

financial market event that occurred during an event with an observable impact—economic, social, security-related, political, climatic, or global—on the economy.

We chose to analyze the indices by examining various exogenous events that potentially affected financial markets. It should be stressed that we selected events that we believed to have an impact on the economy, and consequently on the various indices; no unequivocal causality should be inferred between them. The index needs to capture the greatest number of events as possible, at an acceptable level, and be free of false alarms as far as possible. Table 3 presents 14 of the most prominent events depicted in Figures 4 (the calibrated index—2002 is not defined as a crisis), 5 (the calibrated index—2002 is defined as a crisis), and 6 (the synthetic index), most of which occurred without warning.

The calibrated indices differ in their sensitivity, but are based on the same series. The difference highlights the difficulty in choosing the preferred index in terms of the required degree of sensitivity of the index. The index that excludes the year 2002 as a crisis is less sensitive and tends to smooth out shocks. At these times, its values approached zero, while the corresponding index, which included 2002 as a crisis, obtained high values. Nonetheless, Table 3 indicates that during a shock to the markets the less-sensitive calibrated index indicated a more significant decline compared to the average in the period (in this case, the month) preceding the shock, compared both to the calibrated index that includes 2002 as a crisis, and to the synthetic index.

Table 3: Sample of events and values of various indices

Event date and index	Event	Reactions of indices to the event: Max value obtained by the index, presumably in response to the event; the first figure in parentheses is the index mean in the month preceding the event; the second figure in parentheses is the ratio between index to index mean in the month preceding the event.		
		The calibrated index – 3.2 (based on 1998 crisis only)	The calibrated index – 3.1 (based on 1998 and 2002 crises)	The synthetic index
17/04/2000 (1)	Burst of the Dot-com bubble: share prices drop on Wall Street (by close to 6%) and NASDAQ (close to 10%). Technology shares drop by an average of 17%. Shares on TASE drop by an average of 8%.	0.00% (.%) 0	40.37% (.45%) (89.6)	37.31% (4.98%) (7.5)
17/10/2000 (2)	October 2000 riots	0.00% (.%) 0	34.75% (1.75%) (19.9)	25.34% (4.92%) (5.1)
11/09/2001 (3)	Terrorism attack against Twin Towers by al-Qaeda	0.06% (.%) 0	94.84% (1.03%) (92.2)	34.48% (8.02%) (4.3)
23/12/2001 (4)	BOI sharply cuts interest rate from 5.8% to 3.8%.	10.90% (0.10%) (108.7)	99.62% (8.42%) (11.8)	48.10% (7.39%) (6.5)
28/04/2002 (5)	NIS 250 million embezzlement discovered at Trade Bank Ltd. Four dead and 7 wounded in a terrorist attack at the settlement of Adora.	0.10% (0.00%) (3278.6)	93.51% (16.81%) (5.6)	38.09% (14.75%) (2.6)
23/06/2002 (6)	Five killed in a terror attack in Itamar.	3.83% (1.62%) (2.4)	97.63% (50.80%) (1.9)	41.14% (26.02%) (1.6)
21/06/2005 (7)	Marked global strengthening of the dollar begins. Oil prices rise. TASE declines as a result of, among other things, concerns of size of government and the manner of execution of the disengagement plan.	0.02% (0.00%) 0	28.44% (0.54%) (52.6)	41.00% (4.23%) (9.7)
16/07/2006 (8)	Second Lebanon War begins	0.00% (0.00%) (12004.)	35.20% (0.86%) (41.1)	27.82% (5.78%) (4.8)
23/06/2007 (9)	Bear Stearns injects $3.2 billion into two of its hedge funds to prevent their collapse.	0.00% (0.00%) (50.)	15.76% (4.01%) (3.9)	28.37% (15.13%) (1.9)
29/07/2007 (10)	Panic on Ehad Haam: Dollar appreciates sharply against shekel; sharp drops on the Tel Aviv Stock Exchange, fears of collapse of the US market.	38.31% (0.00%) (25287843.7)	98.64% (3.64%) (27.1)	42.22% (12.51%) (3.4)
29/10/2008 (11)	**Crisis peaks:** Fed cuts interest to 1%, dollar plunges against shekel. US automobile sector requests federal aid. US real estate prices continue to drop. US consumer confidence drops to record low.	100.00% (93.50%) (1.1)	99.90% (95.49%) (1.)	82.35% (66.76%) (1.2)
01/02/2011 (12)	Riots erupt in Egypt	0.00% (0.00%) (158.2)	3.54% (0.31%) (11.4)	22.75% (5.47%) (4.2)
07/03/2011 (13)	Moody's downgrades Greece's credit rating by three notches.	0.00% (0.00%) (7387.2)	26.64% (0.94%) (28.2)	29.88% (9.61%) (3.1)
10/08/2011 (14)	US credit rating downgraded. Fed announces that interest rate will remain low for two years until mid-2013.	100.00% (12.20%) (8.2)	99.88% (16.13%) (6.2)	70.63% (15.39%) (4.6)
	Total for all ratios	(25310842)	(393)	(60)

All the analyses performed above indicate that the criteria were better satisfied by calibrated index 3.1 (based on 1998 and 2002 crises) than by calibrated index 3.2. This conclusion is reinforced when we take into account the fact that we wish to use

the calibrated index as a measure to detect not only extreme events but a diverse range of financial market events, as well as on the fact that calibrated index 3.1 is based on two types of crisis systems.

Now we conduct this exercise in reverse. We select the top decile of the values generated by the selected calibrated index and use the occurrence of actual events in our attempt to explain these extreme values. Table 4 presents such an attempt for the values of calibrated index 3.1 in the period defined as out of the sample (January 2007–October 2010.[31] In this exercise, no attempt was made to associate an event to each irregular index value, as not all the irregular index values were caused by sudden events. In some cases, events began to emerge several days before the day on which the index rose sharply, and therefore it is the "economic climate" that should be analyzed. For this reason, we present a table arranged by periods. As shown in Table 4, where the index value remained high for a specific period, we did not match index values to event dates. Table 4 illustrates that with the exception of the sub-prime crisis, recent events that began in the summer of 2011—the social protest, the European debt crisis, and the downgrading of the US credit rating—caused a significant jump in the stress index in the period defined as outside the sample.

Table 4: The top decile of values obtained from the calibrated index (3.1) since January 2007

Date	Events that potentially affect the index	Index value
29/7/2007—22/08/2007	The emerging credit crisis triggered declines in stock exchanges around the world. US authorities launch a new program to supervise subprime lenders. Bear Stearns liquidates two hedge funds that invested in MBS (mortgage-backed securities). The Fed reduces interest margins on window loans to 50 basis points.	39%–98%
17/9/2008—02/03/2009	Fannie Mae and Freddie Mac are placed in government conservatorship . Lehman Brothers files for Chapter 11 bankruptcy protection. Interest rates worldwide are reduced in coordination. Bank of America purchases Merrill Lynch. AIG debt rating is cut. Bailout program for AIG. US Treasury launches Money Market Guarantee program. Euro block leaders agree on aid program for banks. Cast Lead military campaign begins.	38%–99%
7/8/2011—26/12/2011	European debt crisis expands. Social protest continues. US credit rating downgraded. US Fed announces that interest rates will remain low for two years, until mid-2013. Italian government approves a €45 million austerity program. Credit ratings of Belgium, Hungary, and Portugal downgraded. Spain encounters difficulty in raising bond debt. Economic reform agreement for the Euro bloc.	40–99%

5b. Using the index to compare the effects of various events on the markets

It is difficult to measure an economy's financial robustness and resilience on a scale between 0 and 100 percent. The financial strength of a market can be inferred from an analysis of financial infrastructure, the financial balance sheet, significant scenarios, etc. However, the impact of various events on the markets may vary, depending on factors that are difficult to measure—that is, background factors that change over time, such as the political situation, the security situation, forecasts, uncertainty, relevant scenarios and their probability of occurrence, the learning curves of market

[31] The events were taken from quarterly development reviews and press clippings by Yifat.

participants, the extent to which asset prices are not justified by economic fundamentals, the time elapsed since the beginning of the current business cycle. Analyses of events that have similar significance may provide some indication of the changes in the financial system's environment: not only the underlying environment, which can be structurally measured and assessed, but primarily the environment that is not given to measurement, the environment that is affected by the set of background factors listed above.

If we study the events that affected the markets, and use the index to measure their impact, we can reach some conclusions about the changing background conditions. An analysis of the stress index's response to two events of a similar nature may provide at least a partial picture of the background to the two events. We illustrate this point with an example—the resignation of Minister of Finance Benjamin Netanyahu on August 8, 2005 and the deterioration in the health of Prime Minister Ariel Sharon on January 5, 2006, which ultimately put an end to his role. In the resignation event, the selected calibrated index obtained the value 30%, whereas the synthetic index obtained the value 35%. Note that these values are in the ninth decile of the calibrated index and in the top decile of the synthetic index. The "Sharon event," which was of a more extreme nature, in fact obtained lower values (10% and 21%, respectively), both in the ninth deciles of these indices. An attempt to explain the difference between these values, obtained in response to two comparable events, may generate several important insights on financial resilience (even though it is possible to attribute the different responses to features inherent in the events themselves, which moderated the responses).

Another example: Against the backdrop of the economic pessimism of the first half of 2002, noneconomic events (terror attacks, IDF actions, etc.) were reflected in the index rising to high values, within the top deciles of both the calibrated index and the synthetic index. In contrast, events of a similar nature in other periods (in the year 2003, for example) generated index values of close to zero. It is similarly possible to analyze events of a disparate nature, and study the indices' response to internal and external security incidents, political events, economic events, and others.

5c. Analysis based on partial indices

In this section, we propose an analytical method based on the original series that comprise the index. We constructed 11 partial indices (corresponding to the number of the original series), each partial index based on a specific series. These series all have a distribution with an expected value of 0 and variance of 1. Into the partial indices, we substituted the values obtained in the series on which they were based, testing these series instead of the Level series, using the coefficients we obtained from the general estimation. In this manner, we obtained 11 stress indices, each of which represents the index that would have been generated had the index been based solely on a specific series (Equation 5.1).

(5.1)
$$p_i(y_t = 1) = \frac{1}{1 + e^{-(\beta_0 + \beta_1 \cdot (0 + \ldots + \lambda^i_t + \ldots + 0) + \beta_2 \cdot \delta_t + \beta_3 \cdot \rho_t)}} = \frac{1}{1 + e^{-(\beta_0 + \beta_1 \lambda^i_t + \beta_2 \cdot \delta_t + \beta_3 \cdot \rho_t)}}$$

Using this method, we can analyze shocks by closely examining their development from the moment the unusual data emerges, and by tracking the time that elapses until an effect appears in each series (the category or market that the series represents), its trajectory of "contagion" (which market was first to become affected, which one followed, etc.), the intensity of its impact, and other effects.

Below we offer a simple analysis of seven events (Tables 5-11): the 1998 crisis, the September 11th terror attack on the World Trade Center, the 2002 crisis, the Second Lebanon War, the subprime crisis, the onset of public unrest in Egypt, and the events of August-October 2011 (downgrading of US credit rating, the social protest in Israel, and the expansion of the European debt crisis). The second column on the left depicts the index value based on Equation 3.1. The values that the index would have obtained from being based exclusively on a single series appear in the remaining columns to the right. We divided the values obtained for the partial indices into four categories—less than 10 percent, 10–40 percent, 40–70 percent, and between 70 percent and 100 percent. The categories are represented on a light-to-dark color scale.

Tables 5-11 indicate which markets were affected, and to what extent, in each of the events studied. Such an analysis of partial indices may offer important insights on the factors that influenced, or were influenced by, various events, and insights on the intensity of their impact. In the future, readers will be able to use the index and its components to perform more in-depth analyses and examine the effects of events that interest them. We can see that different variables were affected in each event. Taking the height of the subprime crisis (October-December 2008), for example, we see that, similarly to the 1998 crisis, the impact of this crisis is sharply evident in all markets: the government and corporate bond markets, the foreign exchange market, and the equities market. In contrast, a security-related event such as the Second Lebanon War mainly affected uncertainty in the stock market and the foreign exchange market, whereas unrest in Egypt had little impact on the domestic market in Israel altogether.[32] The September 11th attack had a powerful impact on the US economy, and, to some extent, radiated financial stress to most markets.

[32] At the beginning of the unrest in Egypt inflationary expectations increased against the backdrop of the rising value of the dollar, which occurred in response to a Bank of Israel announcement of reserve requirements for foreign currency derivatives.

Table 5: The 1998 Crisis

DATE	Index_EQ_(3.1)	Foreign exchange market liquidity	Shekel-dollar exchange rate	Tel Aviv 100 index	Inflation expectations	Bond market liquidity	Two-year bond yields	Bond spreads	Standard deviation of long term bonds	Standard deviation of short term bonds	Standard deviation of shekel-dollar exchange rate	Standard deviation of Tel Aviv 25 index
24/9/98	5.9%	6.5%	96.9%	22.5%	8.2%	3.9%	5.8%	0.0%	6.9%	0.7%	21.4%	26.6%
27/9/98	20.7%	4.4%	97.1%	46.1%	9.0%	44.5%	8.5%	0.0%	25.5%	94.3%	28.2%	35.0%
28/9/98	26.1%	3.6%	97.0%	38.2%	11.5%	24.8%	9.6%	0.0%	33.1%	99.9%	28.2%	40.6%
1/10/98	21.0%	4.3%	98.4%	69.8%	10.6%	18.5%	9.4%	0.0%	10.3%	93.2%	32.7%	45.9%
6/10/98	90.2%	73.2%	100.0%	93.1%	59.9%	42.3%	6.9%	0.8%	43.3%	100.0%	100.0%	71.1%
7/10/98	99.6%	100.0%	100.0%	98.0%	84.7%	72.0%	7.4%	2.0%	98.8%	100.0%	100.0%	86.8%
8/10/98	100.0%	100.0%	100.0%	99.9%	100.0%	34.0%	6.5%	26.8%	100.0%	100.0%	100.0%	99.0%
13/10/98	100.0%	100.0%	100.0%	99.8%	100.0%	60.3%	16.4%	16.8%	100.0%	100.0%	100.0%	99.4%
14/10/98	100.0%	100.0%	100.0%	99.9%	100.0%	74.2%	29.7%	34.4%	100.0%	100.0%	100.0%	99.8%
15/10/98	100.0%	100.0%	100.0%	99.9%	100.0%	66.2%	73.9%	26.8%	100.0%	100.0%	100.0%	99.9%
18/10/98	99.9%	100.0%	100.0%	99.9%	97.8%	86.4%	69.3%	28.9%	99.9%	100.0%	100.0%	99.9%
19/10/98	99.9%	100.0%	100.0%	99.9%	99.4%	98.1%	72.2%	47.2%	99.8%	100.0%	100.0%	99.9%
20/10/98	99.9%	99.9%	100.0%	99.8%	99.9%	98.6%	61.2%	45.5%	99.6%	99.8%	100.0%	99.9%
21/10/98	99.9%	100.0%	100.0%	99.8%	100.0%	98.0%	37.2%	16.0%	99.8%	99.8%	100.0%	100.0%
22/10/98	99.9%	100.0%	100.0%	99.8%	100.0%	53.8%	30.8%	6.4%	100.0%	100.0%	100.0%	100.0%
25/10/98	99.9%	100.0%	100.0%	99.6%	100.0%	70.6%	49.8%	8.4%	99.9%	100.0%	100.0%	100.0%
26/10/98	99.9%	100.0%	100.0%	99.6%	99.8%	92.4%	74.0%	7.2%	99.9%	99.8%	100.0%	100.0%
27/10/98	99.9%	100.0%	100.0%	99.4%	99.8%	92.4%	81.0%	8.6%	100.0%	99.6%	100.0%	100.0%
28/10/98	99.8%	100.0%	100.0%	99.4%	99.8%	93.6%	84.0%	9.0%	100.0%	99.7%	100.0%	100.0%
29/10/98	99.1%	100.0%	100.0%	97.5%	99.5%	60.8%	45.7%	4.1%	99.2%	97.0%	100.0%	100.0%
1/11/98	99.3%	100.0%	100.0%	97.4%	100.0%	35.1%	37.9%	3.4%	85.9%	98.1%	100.0%	100.0%
2/11/98	99.1%	100.0%	100.0%	97.6%	99.9%	26.7%	34.8%	4.1%	84.3%	98.9%	100.0%	100.0%
3/11/98	99.1%	100.0%	100.0%	97.2%	99.9%	21.8%	29.8%	20.8%	92.2%	98.7%	100.0%	100.0%
4/11/98	97.6%	100.0%	100.0%	91.0%	99.8%	22.5%	11.7%	5.7%	79.4%	95.4%	100.0%	100.0%
5/11/98	96.9%	99.7%	100.0%	91.1%	99.8%	35.0%	12.4%	3.7%	71.0%	94.3%	100.0%	100.0%
8/11/98	95.8%	97.0%	100.0%	96.2%	99.8%	45.1%	12.0%	3.6%	45.0%	92.4%	99.9%	100.0%
9/11/98	95.0%	87.8%	100.0%	96.4%	99.9%	35.3%	9.6%	4.1%	36.8%	93.1%	99.9%	100.0%
10/11/98	94.1%	83.2%	100.0%	97.4%	99.9%	34.4%	11.7%	2.7%	30.5%	94.0%	99.9%	100.0%
11/11/98	93.0%	91.1%	99.9%	96.0%	99.8%	28.7%	12.5%	1.5%	32.9%	90.6%	99.9%	99.9%
12/11/98	91.7%	93.6%	99.9%	96.9%	99.7%	12.9%	15.0%	3.0%	51.6%	78.6%	99.7%	99.9%
15/11/98	96.8%	91.8%	99.9%	96.9%	99.3%	93.5%	55.9%	0.3%	99.9%	96.4%	99.5%	99.9%
16/11/98	97.7%	97.0%	99.7%	94.2%	88.4%	98.8%	75.5%	0.8%	100.0%	98.7%	99.2%	99.9%
17/11/98	96.9%	95.0%	99.7%	87.5%	90.4%	99.2%	84.1%	0.1%	100.0%	98.5%	97.8%	99.8%
18/11/98	95.7%	89.0%	99.5%	84.9%	62.2%	97.8%	91.1%	0.4%	100.0%	97.2%	98.3%	99.7%
19/11/98	87.0%	85.3%	99.5%	71.1%	59.6%	40.3%	91.1%	0.6%	99.4%	80.7%	97.8%	99.6%
22/11/98	82.7%	80.9%	99.5%	69.9%	69.4%	55.7%	90.1%	0.4%	90.4%	65.5%	98.1%	99.4%
23/11/98	79.2%	69.0%	99.6%	64.3%	79.6%	28.5%	89.1%	0.9%	59.2%	65.3%	98.4%	99.3%
24/11/98	69.6%	66.5%	99.5%	59.1%	78.3%	8.5%	89.6%	0.8%	21.1%	48.0%	96.3%	99.1%
25/11/98	64.0%	64.2%	99.3%	55.9%	75.6%	4.8%	89.3%	0.9%	9.5%	31.4%	96.9%	98.9%
28/11/98	61.9%	63.3%	99.3%	38.4%	61.0%	7.4%	90.1%	1.1%	9.1%	39.9%	95.9%	98.5%
29/11/98	60.9%	65.1%	99.2%	39.2%	72.8%	8.7%	88.4%	0.2%	9.6%	42.2%	98.1%	98.2%
30/11/98	66.8%	74.8%	99.4%	47.0%	72.2%	46.1%	86.0%	0.8%	10.9%	29.8%	95.2%	97.9%
1/12/98	72.9%	69.7%	99.3%	66.1%	48.4%	94.2%	81.4%	0.8%	23.7%	49.0%	93.4%	97.6%
2/12/98	78.1%	55.3%	99.2%	59.8%	74.0%	96.5%	79.2%	1.1%	30.7%	71.2%	92.5%	97.2%
3/12/98	71.9%	52.0%	99.1%	57.0%	72.1%	82.1%	74.0%	0.8%	32.0%	73.3%	94.4%	96.8%

Table 6: The Attack on the World Trade Center

DATE	Index_EQ_(3.1)	Foreign exchange market liquidity	Shekel-dollar exchange rate	Tel Aviv 100 index	Inflation expectations	Bond market liquidity	Two-year bond yields	Bond spreads	Standard deviation of long term bonds	Standard deviation of short term bonds	Standard deviation of shekel-dollar exchange rate	Standard deviation of Tel Aviv 25 index
10/9/01	1.8%	6.8%	86.4%	6.1%	92.1%	0.0%	0.0%	7.3%	6.3%	1.6%	0.3%	0.0%
11/9/01	13.7%	9.7%	97.2%	14.9%	99.5%	0.0%	0.0%	17.7%	92.0%	16.3%	17.5%	0.4%
12/9/01	94.8%	100.0%	98.9%	57.9%	87.6%	0.3%	0.0%	62.7%	99.8%	66.7%	46.6%	25.5%
13/9/01	68.6%	98.0%	99.6%	79.2%	99.8%	2.1%	0.1%	72.6%	97.3%	80.7%	37.1%	3.3%
16/9/01	78.3%	86.9%	99.6%	90.5%	99.7%	3.2%	0.2%	84.0%	82.3%	70.2%	98.1%	63.2%
20/9/01	76.0%	98.1%	99.6%	93.2%	99.9%	5.0%	0.2%	78.5%	72.9%	85.3%	32.2%	42.5%
23/9/01	82.4%	98.0%	99.6%	97.2%	100.0%	10.0%	0.2%	88.9%	84.5%	83.5%	40.2%	46.6%
24/9/01	67.7%	86.7%	99.8%	94.5%	99.9%	0.5%	0.3%	92.2%	58.4%	10.9%	44.5%	64.1%
25/9/01	58.9%	45.5%	99.7%	95.3%	97.0%	0.8%	0.4%	83.7%	67.7%	43.9%	81.3%	17.8%
30/9/01	62.0%	45.1%	99.7%	94.7%	96.9%	0.9%	0.4%	74.1%	97.9%	51.3%	46.6%	30.3%
3/10/01	72.5%	43.9%	99.8%	95.8%	92.6%	25.7%	0.2%	82.4%	99.9%	24.4%	40.0%	38.3%
4/10/01	68.1%	44.7%	99.6%	95.2%	91.1%	65.2%	0.3%	81.0%	97.1%	25.3%	40.9%	36.2%
7/10/01	63.5%	44.7%	99.6%	92.9%	85.3%	67.3%	0.3%	68.2%	97.6%	9.7%	21.0%	67.0%
10/10/01	57.4%	46.8%	98.6%	90.7%	80.8%	57.6%	0.3%	69.2%	82.0%	8.3%	18.5%	91.2%
11/10/01	28.4%	49.0%	97.5%	87.3%	81.0%	1.0%	0.4%	57.7%	26.0%	2.5%	16.1%	26.3%
14/10/01	23.4%	24.5%	97.2%	88.1%	75.0%	1.6%	0.5%	49.2%	4.6%	1.9%	13.6%	44.6%
15/10/01	16.3%	23.3%	96.5%	90.4%	62.4%	1.4%	0.4%	45.3%	0.9%	1.1%	13.8%	14.8%

Table 7: The Sharp Reduction in the Bank of Israel Interest Rate from 5.8% to 3.8% on December 23, 2001

DATE	Index_EQ_(3.1)	Foreign exchange market liquidity	Shekel-dollar exchange rate	Tel Aviv 100 index	Inflation expectations	Bond market liquidity	Two-year bond yields	Bond spreads	Standard deviation of long term bonds	Standard deviation of short term bonds	Standard deviation of shekel-dollar exchange rate	Standard deviation of Tel Aviv 25 index
23/12/01	99.2%	100.0%	76.7%	11.8%	59.3%	100.0%	0.4%	35.3%	100.0%	100.0%	95.9%	18.5%
24/12/01	99.6%	100.0%	97.1%	10.2%	40.1%	100.0%	0.3%	71.4%	100.0%	100.0%	98.6%	11.1%
25/12/01	98.9%	100.0%	97.3%	5.8%	20.7%	100.0%	0.3%	83.6%	100.0%	100.0%	73.0%	32.0%
26/12/01	97.5%	100.0%	99.3%	4.3%	31.7%	99.8%	0.3%	89.8%	100.0%	100.0%	99.1%	11.1%
27/12/01	79.1%	81.8%	99.8%	10.5%	70.3%	21.9%	1.1%	95.5%	95.3%	81.1%	99.4%	73.8%
30/12/01	76.3%	81.2%	99.8%	4.2%	77.4%	18.8%	0.9%	93.9%	81.6%	80.3%	99.9%	49.7%
31/12/01	65.7%	64.5%	100.0%	0.1%	71.6%	36.7%	0.5%	97.3%	99.5%	60.6%	100.0%	67.9%
1/1/02	85.2%	51.5%	100.0%	5.1%	68.0%	44.5%	0.4%	97.8%	99.8%	37.3%	100.0%	87.1%
2/1/02	82.8%	40.5%	100.0%	1.5%	60.3%	55.5%	0.4%	98.6%	99.4%	33.7%	100.0%	84.3%
3/1/02	87.8%	77.2%	100.0%	1.3%	69.8%	65.7%	0.3%	99.4%	98.8%	32.6%	100.0%	88.1%
6/1/02	94.0%	77.7%	100.0%	0.9%	96.7%	57.8%	0.1%	99.9%	99.8%	52.1%	100.0%	98.1%
7/1/02	96.0%	94.6%	100.0%	1.0%	98.6%	48.3%	0.2%	99.9%	99.8%	76.0%	100.0%	98.2%
8/1/02	95.3%	98.9%	100.0%	2.0%	97.5%	29.3%	0.2%	99.9%	99.5%	76.6%	100.0%	97.4%
9/1/02	96.1%	100.0%	100.0%	3.3%	97.7%	13.7%	0.3%	99.9%	98.5%	50.6%	100.0%	93.9%
10/1/02	88.8%	94.8%	100.0%	6.4%	98.0%	8.4%	0.3%	100.0%	97.2%	23.1%	100.0%	45.0%
13/1/02	89.3%	94.4%	100.0%	4.5%	98.7%	9.3%	0.3%	99.9%	73.3%	17.0%	100.0%	97.2%
14/1/02	86.5%	94.3%	100.0%	4.3%	98.9%	14.2%	0.3%	100.0%	23.3%	17.4%	100.0%	64.4%
15/1/02	83.9%	94.0%	100.0%	6.3%	98.6%	16.6%	0.3%	99.9%	22.5%	13.4%	99.9%	63.5%
16/1/02	87.8%	93.5%	100.0%	9.8%	96.8%	48.1%	0.2%	100.0%	53.6%	34.0%	99.9%	45.5%
17/1/02	89.1%	93.4%	100.0%	7.6%	98.4%	41.2%	0.3%	100.0%	60.1%	30.8%	99.9%	60.9%
20/1/02	85.8%	93.3%	100.0%	13.3%	98.9%	34.1%	0.3%	100.0%	57.9%	42.8%	99.2%	35.6%
21/1/02	87.0%	92.6%	100.0%	11.1%	99.2%	32.3%	0.3%	100.0%	58.0%	40.8%	99.5%	41.8%
22/1/02	87.6%	91.8%	100.0%	7.9%	99.6%	10.2%	0.2%	100.0%	43.3%	31.3%	99.8%	56.8%
23/1/02	90.4%	91.4%	100.0%	15.4%	99.8%	10.0%	0.2%	100.0%	60.8%	40.7%	99.9%	89.2%
24/1/02	92.4%	91.4%	100.0%	11.3%	99.7%	12.5%	0.2%	100.0%	79.1%	46.1%	100.0%	87.2%
27/1/02	90.5%	91.1%	100.0%	21.3%	99.8%	29.2%	0.3%	100.0%	82.9%	40.6%	99.6%	43.3%
28/1/02	89.9%	90.8%	100.0%	23.3%	99.8%	36.7%	0.3%	100.0%	71.2%	18.1%	99.8%	52.5%
29/1/02	87.6%	90.3%	100.0%	17.4%	99.8%	31.2%	0.3%	99.9%	40.7%	17.5%	99.9%	59.5%
30/1/02	86.0%	90.2%	100.0%	19.5%	99.6%	18.5%	0.4%	99.8%	40.7%	17.7%	99.9%	69.3%
31/1/02	87.6%	90.2%	100.0%	10.9%	99.6%	26.4%	0.4%	99.8%	57.8%	19.9%	100.0%	62.6%
3/2/02	85.4%	90.1%	100.0%	5.0%	99.4%	22.6%	0.5%	99.8%	70.0%	37.1%	99.7%	75.4%
4/2/02	82.9%	89.7%	100.0%	6.1%	99.5%	19.5%	0.4%	99.8%	40.2%	25.0%	99.9%	41.2%
5/2/02	83.5%	89.0%	100.0%	10.2%	99.7%	12.8%	0.4%	99.9%	27.1%	29.8%	99.6%	65.3%
6/2/02	81.8%	63.6%	100.0%	9.6%	99.8%	11.9%	0.4%	99.9%	46.4%	30.7%	99.5%	40.2%
7/2/02	87.8%	62.5%	100.0%	17.1%	99.9%	13.7%	0.4%	99.9%	86.6%	34.7%	99.8%	47.3%
10/2/02	92.0%	61.0%	100.0%	40.3%	100.0%	18.6%	0.3%	99.9%	89.9%	70.0%	99.9%	49.2%
11/2/02	97.2%	99.2%	100.0%	48.5%	100.0%	40.2%	0.3%	99.9%	89.6%	96.6%	100.0%	74.4%
12/2/02	97.8%	99.8%	100.0%	46.1%	100.0%	28.7%	0.4%	99.9%	71.6%	97.3%	100.0%	92.2%
13/2/02	95.5%	99.8%	99.9%	35.1%	99.9%	20.3%	0.4%	99.9%	37.7%	95.0%	100.0%	63.5%
14/2/02	91.8%	99.3%	99.9%	36.2%	99.8%	15.7%	0.5%	99.9%	34.9%	71.4%	100.0%	20.0%
17/2/02	93.3%	96.9%	99.9%	66.6%	97.8%	62.5%	1.0%	99.8%	64.5%	71.8%	100.0%	43.0%
18/2/02	95.2%	99.7%	99.9%	58.5%	98.3%	90.4%	0.9%	99.8%	71.8%	70.7%	100.0%	72.3%
19/2/02	98.0%	100.0%	100.0%	75.9%	99.3%	99.3%	1.0%	99.7%	89.2%	79.3%	100.0%	51.3%
20/2/02	98.3%	100.0%	100.0%	78.0%	99.6%	99.4%	1.0%	99.4%	83.5%	76.1%	100.0%	97.9%
21/2/02	96.1%	100.0%	99.9%	78.1%	99.8%	69.2%	1.0%	99.3%	33.2%	72.1%	100.0%	72.0%
24/2/02	95.0%	100.0%	99.9%	75.9%	99.2%	54.7%	1.4%	96.9%	47.2%	54.9%	100.0%	77.3%
25/2/02	95.2%	100.0%	99.8%	71.1%	97.1%	87.3%	2.5%	94.9%	91.5%	53.2%	100.0%	89.3%
27/2/02	96.8%	100.0%	99.8%	48.9%	82.2%	99.7%	6.3%	77.0%	99.8%	90.4%	99.9%	88.3%
28/2/02	96.5%	100.0%	99.7%	53.2%	85.9%	99.9%	6.4%	75.9%	99.8%	95.6%	99.8%	60.8%

Table 8: The Second Lebanon War

DATE	Index_EQ_(3.1)	Foreign exchange market liquidity	Shekel-dollar exchange rate	Tel Aviv 100 index	Inflation expectations	Bond market liquidity	Two-year bond yields	Bond spreads	Standard deviation of long term bonds	Standard deviation of short term bonds	Standard deviation of shekel-dollar exchange rate	Standard deviation of Tel Aviv 25 index
12/7/06	1.8%	0.3%	0.0%	0.5%	26.0%	0.1%	6.8%	0.0%	0.3%	0.7%	16.7%	100.0%
13/7/06	10.7%	3.0%	0.1%	2.5%	6.8%	1.7%	10.6%	0.1%	20.9%	37.0%	98.1%	99.7%
16/7/06	35.2%	1.2%	0.1%	1.9%	29.4%	13.7%	17.8%	0.2%	89.8%	99.3%	99.8%	99.7%
17/7/06	30.0%	0.3%	0.1%	2.3%	13.8%	11.0%	20.2%	0.3%	81.9%	99.3%	99.7%	99.8%
18/7/06	8.8%	0.4%	0.0%	1.5%	33.6%	1.7%	22.6%	0.3%	5.3%	79.7%	88.0%	96.4%
19/7/06	5.2%	0.5%	0.1%	2.0%	34.4%	0.4%	27.0%	0.3%	0.4%	11.6%	92.4%	93.0%
20/7/06	3.7%	7.2%	0.0%	1.4%	12.2%	0.5%	23.5%	0.3%	0.9%	6.2%	52.8%	58.9%
23/7/06	3.0%	0.6%	0.0%	1.9%	20.7%	0.4%	21.8%	0.4%	0.3%	0.7%	71.3%	90.6%
24/7/06	2.4%	1.0%	0.1%	1.9%	14.8%	0.3%	20.9%	0.5%	0.1%	0.5%	57.5%	79.3%
25/7/06	3.1%	2.1%	0.0%	1.5%	7.4%	0.4%	19.1%	0.3%	0.1%	0.5%	92.6%	96.7%
26/7/06	2.1%	0.4%	0.0%	2.5%	4.2%	0.2%	21.3%	0.2%	0.1%	0.3%	89.9%	92.6%
27/7/06	3.1%	21.6%	0.0%	2.1%	13.9%	0.2%	22.2%	0.3%	0.1%	0.2%	73.0%	97.2%
30/7/06	4.2%	6.7%	0.0%	1.6%	13.9%	0.3%	21.6%	0.3%	0.2%	16.2%	89.1%	78.0%
31/7/06	2.0%	0.5%	0.0%	1.0%	14.3%	0.7%	22.5%	0.2%	0.9%	0.2%	52.0%	71.1%
1/8/06	1.9%	0.8%	0.0%	1.3%	7.9%	0.6%	22.7%	0.3%	0.7%	0.3%	32.6%	62.2%
2/8/06	2.8%	30.7%	0.0%	0.7%	1.6%	0.7%	16.5%	0.3%	0.5%	0.6%	47.9%	92.6%
6/8/06	2.0%	0.9%	0.0%	0.6%	2.7%	0.8%	13.3%	0.5%	0.2%	1.0%	73.7%	81.2%
7/8/06	1.6%	0.2%	0.0%	1.0%	4.3%	0.2%	14.5%	0.4%	0.2%	1.1%	71.9%	71.8%
8/8/06	1.4%	0.2%	0.0%	0.8%	2.6%	0.2%	13.1%	0.5%	0.2%	0.7%	54.3%	86.8%
9/8/06	1.2%	0.2%	0.0%	1.5%	3.6%	0.1%	12.7%	0.6%	0.2%	0.1%	60.2%	83.9%
10/8/06	2.2%	0.9%	0.0%	3.1%	7.3%	0.2%	14.8%	0.4%	0.6%	0.1%	65.4%	97.0%
13/8/06	2.1%	16.5%	0.0%	1.1%	7.7%	0.1%	14.1%	0.5%	0.3%	0.0%	88.0%	68.5%
14/8/06	1.4%	0.3%	0.0%	1.1%	8.1%	0.1%	14.6%	0.4%	0.2%	0.0%	94.2%	48.9%
15/8/06	1.4%	0.3%	0.0%	1.0%	18.5%	0.1%	14.8%	0.5%	0.1%	0.1%	94.9%	45.7%
16/8/06	1.0%	1.2%	0.0%	0.8%	5.1%	0.1%	17.6%	0.8%	0.1%	0.2%	12.9%	32.1%
17/8/06	0.5%	0.3%	0.0%	0.4%	8.2%	0.1%	12.4%	0.6%	0.0%	0.1%	12.9%	2.3%

Table 9: Height of the Subprime Crisis (October-December 2008)

DATE	Index_EQ_(3.1)	Foreign exchange market liquidity	Shekel-dollar exchange rate	Tel Aviv 100 index	Inflation expectations	Bond market liquidity	Two-year bond yields	Bond spreads	Standard deviation of long term bonds	Standard deviation of short term bonds	Standard deviation of shekel-dollar exchange rate	Standard deviation of Tel Aviv 25 index
5/10/08	98.7%	69.0%	3.5%	99.8%	99.9%	5.4%	95.5%	100.0%	99.7%	100.0%	93.2%	100.0%
6/10/08	99.3%	27.0%	2.8%	99.9%	99.9%	16.2%	98.1%	100.0%	100.0%	100.0%	91.6%	100.0%
7/10/08	99.4%	97.3%	4.7%	99.7%	99.4%	20.3%	94.4%	100.0%	100.0%	100.0%	96.4%	100.0%
12/10/08	100.0%	100.0%	8.8%	99.9%	99.9%	78.5%	95.7%	100.0%	100.0%	100.0%	99.8%	100.0%
15/10/08	99.8%	99.3%	45.5%	99.9%	99.9%	92.6%	97.4%	100.0%	99.9%	100.0%	99.2%	100.0%
16/10/08	99.8%	99.6%	70.2%	100.0%	99.9%	93.6%	98.6%	99.3%	99.9%	100.0%	99.5%	100.0%
19/10/08	99.6%	100.0%	73.5%	99.9%	99.9%	59.6%	97.8%	99.9%	94.2%	99.7%	99.7%	100.0%
22/10/08	99.2%	99.3%	93.6%	99.9%	99.8%	28.5%	97.4%	100.0%	88.8%	97.3%	99.8%	100.0%
23/10/08	99.2%	99.8%	94.3%	99.9%	99.8%	27.7%	97.2%	100.0%	93.1%	88.9%	99.9%	100.0%
26/10/08	99.8%	100.0%	95.4%	100.0%	99.8%	47.4%	99.1%	100.0%	96.4%	91.2%	100.0%	100.0%
27/10/08	99.8%	99.9%	94.7%	100.0%	99.9%	56.2%	99.2%	100.0%	97.7%	86.2%	100.0%	100.0%
28/10/08	99.7%	100.0%	91.2%	100.0%	100.0%	54.7%	99.7%	100.0%	98.5%	94.1%	99.9%	100.0%
29/10/08	99.9%	100.0%	91.1%	100.0%	100.0%	86.2%	99.9%	100.0%	99.9%	98.1%	100.0%	100.0%
30/10/08	99.8%	99.3%	84.6%	100.0%	100.0%	84.9%	99.9%	100.0%	100.0%	96.6%	99.9%	100.0%
2/11/08	99.7%	99.0%	85.1%	99.9%	99.9%	79.3%	99.8%	100.0%	99.8%	98.5%	100.0%	100.0%
3/11/08	99.5%	96.3%	90.9%	99.9%	99.8%	47.1%	99.7%	100.0%	94.9%	98.7%	100.0%	100.0%
4/11/08	99.0%	99.9%	93.5%	99.8%	99.8%	19.6%	99.6%	100.0%	79.6%	91.0%	99.4%	99.8%
5/11/08	99.0%	99.9%	96.4%	99.8%	99.5%	36.2%	99.1%	99.9%	87.5%	85.4%	99.9%	99.8%
6/11/08	98.7%	99.6%	96.5%	99.9%	99.4%	29.9%	99.2%	99.9%	74.7%	77.5%	99.8%	99.8%
9/11/08	98.6%	99.7%	96.5%	99.8%	99.7%	26.6%	99.4%	99.9%	60.5%	75.3%	99.9%	99.7%
10/11/08	97.7%	98.6%	92.6%	99.8%	99.8%	24.6%	99.7%	99.8%	58.6%	58.0%	98.5%	99.8%
11/11/08	98.9%	99.9%	94.4%	99.9%	99.9%	35.3%	99.8%	99.8%	90.8%	62.9%	99.1%	99.9%
12/11/08	99.5%	97.9%	98.0%	99.9%	99.9%	49.2%	99.7%	100.0%	97.6%	99.5%	99.3%	100.0%
13/11/08	99.8%	97.6%	99.0%	99.9%	100.0%	68.4%	99.8%	100.0%	95.4%	100.0%	99.4%	100.0%
16/11/08	99.9%	100.0%	99.1%	100.0%	100.0%	89.1%	99.8%	100.0%	86.0%	100.0%	99.5%	100.0%
17/11/08	99.8%	91.7%	99.2%	100.0%	100.0%	92.2%	99.8%	100.0%	74.7%	100.0%	99.5%	99.9%
18/11/08	99.5%	95.8%	99.6%	100.0%	100.0%	59.6%	99.8%	100.0%	52.3%	98.6%	99.1%	99.9%
19/11/08	99.4%	91.1%	99.5%	99.9%	100.0%	44.7%	99.8%	100.0%	65.2%	77.4%	99.3%	100.0%
20/11/08	99.6%	100.0%	99.7%	100.0%	100.0%	25.8%	99.9%	100.0%	66.4%	36.6%	97.3%	99.9%
23/11/08	99.7%	100.0%	99.6%	100.0%	100.0%	25.6%	99.9%	100.0%	69.7%	53.9%	99.5%	100.0%
24/11/08	99.3%	80.5%	99.6%	100.0%	100.0%	47.1%	99.9%	100.0%	88.5%	84.5%	99.6%	100.0%
25/11/08	99.5%	93.8%	99.5%	99.9%	100.0%	80.3%	99.6%	99.9%	99.2%	93.7%	99.3%	100.0%
26/11/08	99.6%	99.8%	98.5%	99.9%	99.9%	78.5%	99.5%	99.9%	99.8%	92.5%	99.3%	99.9%
27/11/08	99.2%	97.5%	98.6%	99.9%	100.0%	68.0%	99.3%	99.9%	99.8%	72.4%	98.4%	99.9%
30/11/08	99.0%	99.7%	98.4%	99.8%	100.0%	33.7%	99.2%	99.8%	96.5%	83.7%	98.7%	99.9%
1/12/08	98.6%	99.1%	99.4%	99.8%	100.0%	27.4%	98.9%	99.9%	45.9%	83.7%	98.8%	99.9%
2/12/08	98.9%	99.9%	98.9%	99.8%	100.0%	52.4%	98.7%	99.9%	47.6%	96.7%	93.6%	99.9%
3/12/08	98.6%	97.4%	99.0%	99.7%	99.9%	79.0%	97.1%	99.9%	83.7%	94.9%	95.6%	99.8%
4/12/08	98.8%	98.5%	98.5%	99.5%	99.9%	92.6%	95.1%	99.8%	98.4%	97.4%	91.3%	99.6%
7/12/08	98.7%	100.0%	98.1%	99.2%	99.8%	83.4%	94.3%	99.5%	98.3%	89.5%	83.9%	99.8%
8/12/08	89.3%	69.3%	94.8%	97.6%	99.5%	43.0%	84.0%	97.9%	85.5%	33.1%	73.1%	96.3%
9/12/08	74.3%	30.4%	93.0%	96.7%	98.6%	9.2%	77.6%	97.0%	25.8%	8.2%	60.0%	95.1%
10/12/08	70.7%	26.3%	89.9%	96.2%	98.2%	5.7%	73.9%	96.7%	9.6%	7.2%	58.2%	98.4%
11/12/08	71.4%	46.1%	88.2%	95.7%	99.4%	8.9%	69.7%	97.2%	31.1%	4.5%	34.6%	92.4%
14/12/08	70.5%	35.2%	86.0%	96.2%	99.3%	6.8%	76.2%	96.2%	26.5%	12.0%	16.9%	94.9%
15/12/08	74.6%	17.8%	76.9%	96.8%	99.4%	5.6%	83.6%	96.4%	43.9%	49.5%	38.8%	91.1%
16/12/08	64.7%	11.1%	70.6%	95.9%	99.2%	2.7%	75.5%	97.8%	19.4%	41.4%	17.1%	87.5%
17/12/08	84.9%	84.3%	45.9%	95.1%	98.6%	69.2%	32.2%	98.7%	96.7%	52.5%	69.7%	82.4%
18/12/08	84.6%	18.1%	21.7%	93.6%	97.8%	88.7%	28.3%	97.9%	98.7%	83.6%	94.0%	79.0%
21/12/08	98.1%	100.0%	23.7%	95.1%	98.2%	91.3%	29.8%	98.3%	98.5%	91.9%	94.4%	77.7%
22/12/08	86.6%	67.4%	75.2%	96.4%	96.0%	73.7%	32.0%	99.1%	88.1%	82.5%	86.5%	86.0%
23/12/08	71.2%	96.8%	78.5%	97.4%	98.5%	3.5%	29.2%	99.3%	7.1%	7.2%	36.6%	92.0%
24/12/08	76.5%	62.1%	86.6%	97.9%	98.2%	14.0%	20.4%	99.5%	19.7%	15.2%	87.8%	86.3%
25/12/08	88.3%	100.0%	81.9%	96.6%	96.0%	38.7%	10.1%	99.3%	55.9%	49.2%	89.6%	68.5%
28/12/08	96.2%	100.0%	76.7%	95.7%	89.2%	32.5%	6.4%	99.2%	49.8%	96.5%	90.4%	84.3%
29/12/08	78.8%	67.5%	84.2%	97.7%	86.9%	62.8%	8.6%	99.5%	47.6%	38.2%	82.6%	87.7%
30/12/08	83.5%	88.2%	63.1%	97.2%	91.3%	84.3%	6.5%	97.2%	20.9%	85.8%	99.2%	81.8%
31/12/08	84.7%	76.7%	72.0%	96.2%	85.5%	98.0%	4.1%	97.7%	15.9%	98.4%	97.7%	73.6%

Table 10: Unrest in Egypt Begins

DATE	Index_EQ_(3.1)	Foreign exchange market liquidity	Shekel-dollar exchange rate	Tel Aviv 100 index	Inflation expectations	Bond market liquidity	Two-year bond yields	Bond spreads	Standard deviation of long term bonds	Standard deviation of short term bonds	Standard deviation of shekel-dollar exchange rate	Standard deviation of Tel Aviv 25 index
25/1/11	0.2%	0.0%	0.0%	0.0%	77.3%	0.7%	0.3%	0.0%	0.8%	0.5%	1.5%	0.1%
26/1/11	0.2%	0.3%	0.0%	0.0%	61.3%	0.1%	0.2%	0.0%	0.0%	0.2%	7.4%	0.1%
27/1/11	0.2%	0.1%	0.1%	0.0%	58.8%	0.0%	0.3%	0.0%	0.0%	0.2%	28.2%	0.2%
30/1/11	1.7%	0.4%	0.1%	0.0%	86.3%	0.0%	0.1%	0.0%	5.2%	89.2%	79.9%	3.0%
31/1/11	1.8%	0.1%	0.6%	0.0%	89.9%	0.1%	0.1%	0.0%	71.2%	94.0%	8.5%	1.6%
1/2/11	3.5%	0.5%	0.4%	0.0%	94.5%	0.3%	0.1%	0.0%	70.9%	97.7%	83.2%	1.7%
2/2/11	1.8%	0.2%	0.3%	0.0%	98.8%	0.3%	0.2%	0.0%	7.6%	36.0%	79.1%	0.9%
3/2/11	1.5%	0.2%	0.3%	0.0%	98.0%	0.3%	0.2%	0.0%	1.9%	7.3%	88.2%	0.8%
6/2/11	1.2%	0.7%	0.3%	0.0%	98.9%	0.6%	0.2%	0.0%	4.2%	0.8%	56.0%	0.3%
7/2/11	1.3%	0.9%	0.3%	0.0%	99.3%	1.7%	0.2%	0.0%	4.0%	2.1%	55.0%	0.1%
8/2/11	0.7%	0.1%	0.3%	0.0%	99.0%	0.3%	0.2%	0.0%	0.6%	0.4%	66.7%	0.2%

Table 11: European Debt Crisis Expands, US Credit Rating Downgraded, and Domestic Social Protest Continues

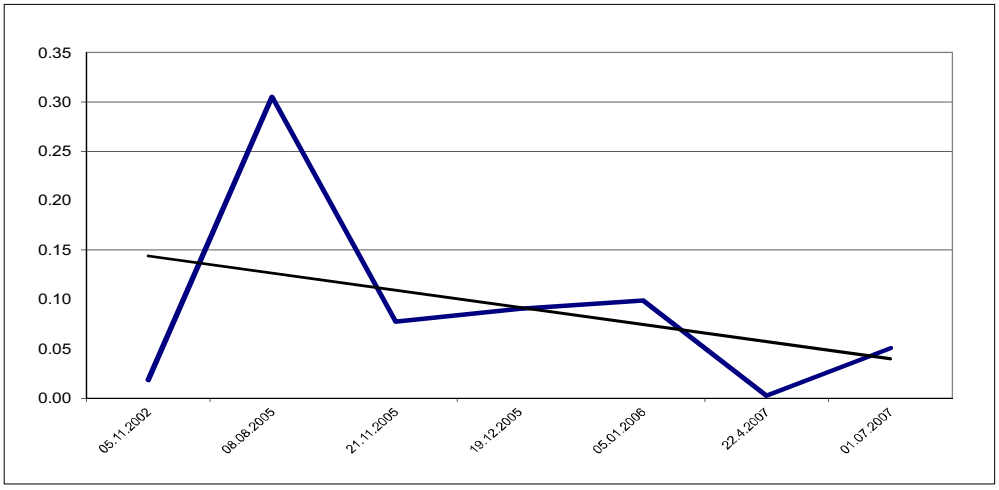
DATE	Index_EQ_(3.1)	Foreign exchange market liquidity	Shekel-dollar exchange rate	Tel Aviv 100 index	Inflation expectations	Bond market liquidity	Two-year bond yields	Bond spreads	Standard deviation of long term bonds	Standard deviation of short term bonds	Standard deviation of shekel-dollar exchange rate	Standard deviation of Tel Aviv 25 index
31/7/11	6.4%	33.5%	0.0%	6.3%	16.7%	0.7%	30.0%	6.9%	0.3%	21.2%	18.5%	67.2%
1/8/11	4.9%	0.1%	0.0%	15.7%	46.8%	0.7%	40.4%	9.5%	1.4%	6.6%	5.2%	91.3%
2/8/11	7.8%	0.3%	0.1%	26.7%	65.0%	0.7%	44.1%	5.6%	4.8%	17.1%	18.4%	75.5%
3/8/11	12.1%	0.5%	0.1%	40.6%	54.4%	32.1%	47.4%	10.3%	3.9%	8.1%	29.6%	60.7%
4/8/11	25.5%	2.5%	0.2%	69.9%	71.6%	95.2%	51.8%	17.8%	0.3%	1.5%	62.0%	98.2%
7/8/11	95.1%	10.7%	0.6%	99.6%	99.7%	92.2%	93.6%	98.6%	34.2%	29.8%	99.6%	100.0%
8/8/11	96.4%	8.0%	3.3%	99.4%	99.9%	72.7%	95.7%	98.6%	76.9%	57.3%	99.4%	100.0%
10/8/11	99.7%	61.2%	2.9%	99.9%	99.9%	76.8%	98.4%	100.0%	100.0%	99.4%	99.9%	100.0%
11/8/11	99.9%	66.2%	7.4%	99.9%	99.9%	94.0%	93.4%	100.0%	100.0%	99.9%	100.0%	100.0%
14/8/11	99.7%	95.5%	8.6%	99.6%	99.9%	96.7%	95.7%	99.8%	100.0%	99.1%	98.9%	100.0%
15/8/11	98.7%	16.4%	7.2%	99.8%	99.9%	90.6%	95.5%	99.3%	100.0%	98.6%	99.2%	100.0%
16/8/11	95.9%	33.2%	12.0%	99.9%	99.8%	47.2%	91.0%	99.6%	99.2%	76.7%	99.4%	99.7%
17/8/11	95.4%	46.3%	8.1%	99.6%	99.7%	81.9%	90.6%	98.8%	99.9%	82.1%	96.9%	98.1%
18/8/11	99.0%	91.7%	20.2%	99.9%	99.7%	95.6%	88.9%	99.5%	100.0%	88.1%	99.7%	100.0%
21/8/11	99.2%	100.0%	20.9%	99.9%	99.9%	69.5%	93.4%	99.7%	99.4%	70.5%	99.9%	100.0%
22/8/11	93.0%	44.2%	47.6%	99.0%	99.9%	7.0%	97.0%	99.3%	50.9%	21.6%	99.0%	100.0%
23/8/11	94.5%	72.8%	47.0%	99.8%	99.8%	9.9%	96.0%	99.4%	58.2%	17.2%	99.4%	100.0%
24/8/11	94.0%	90.6%	62.4%	99.7%	99.8%	10.9%	94.4%	99.3%	63.3%	16.7%	98.3%	99.9%
25/8/11	93.0%	70.3%	59.9%	99.9%	99.7%	3.4%	93.3%	99.6%	18.4%	12.8%	98.1%	100.0%
28/8/11	95.1%	100.0%	59.4%	99.8%	99.7%	10.7%	91.4%	99.6%	35.8%	10.9%	94.0%	99.9%
29/8/11	88.7%	60.0%	59.7%	99.5%	99.5%	6.5%	92.2%	99.4%	78.1%	10.9%	95.2%	98.1%
30/8/11	87.4%	11.7%	40.0%	99.5%	99.2%	11.0%	87.7%	99.3%	98.8%	14.0%	93.7%	96.1%
31/8/11	88.4%	85.5%	31.9%	99.1%	99.5%	10.4%	89.6%	98.6%	96.9%	11.0%	83.2%	98.2%
1/9/11	79.9%	10.5%	42.0%	99.0%	99.7%	3.2%	91.4%	98.4%	61.9%	28.3%	90.4%	93.0%
4/9/11	97.2%	98.0%	50.6%	99.8%	99.7%	25.8%	91.2%	99.6%	69.5%	93.4%	98.9%	100.0%
5/9/11	97.8%	44.0%	81.6%	99.9%	99.8%	48.1%	92.7%	99.7%	51.6%	99.6%	98.7%	100.0%
6/9/11	99.0%	71.4%	89.5%	100.0%	99.8%	40.1%	95.7%	99.9%	86.4%	99.6%	99.9%	100.0%
7/9/11	98.4%	90.5%	93.3%	99.9%	99.7%	43.6%	95.3%	99.9%	95.9%	95.6%	98.0%	100.0%
8/9/11	97.8%	43.2%	94.6%	99.9%	99.6%	31.4%	94.6%	99.9%	97.9%	55.8%	99.7%	99.9%
11/9/11	97.2%	69.8%	94.3%	100.0%	99.5%	27.3%	94.2%	100.0%	67.1%	19.0%	99.3%	100.0%
12/9/11	98.6%	89.6%	98.2%	100.0%	99.8%	21.6%	98.2%	100.0%	93.5%	13.4%	99.7%	100.0%
13/9/11	98.6%	64.7%	97.7%	99.9%	99.9%	53.5%	98.6%	99.9%	99.2%	22.7%	99.6%	99.9%
14/9/11	98.5%	47.9%	97.9%	99.9%	99.9%	68.0%	98.7%	99.9%	99.4%	36.1%	99.6%	99.9%
15/9/11	97.0%	29.2%	96.1%	99.8%	99.9%	45.7%	98.4%	99.6%	96.8%	29.0%	99.2%	99.8%
18/9/11	96.7%	100.0%	96.1%	99.7%	99.5%	2.6%	97.1%	99.6%	38.7%	50.0%	99.1%	99.6%
19/9/11	94.1%	61.8%	97.3%	99.9%	99.4%	2.8%	97.3%	99.7%	50.0%	60.7%	95.5%	99.6%
20/9/11	94.9%	97.5%	95.9%	99.6%	99.4%	2.6%	96.3%	99.6%	53.8%	69.1%	93.6%	99.8%
21/9/11	91.7%	79.9%	96.7%	99.5%	99.2%	3.1%	95.2%	99.4%	50.6%	45.4%	84.1%	99.6%
22/9/11	92.5%	77.1%	98.4%	99.8%	99.4%	3.8%	94.9%	99.7%	17.6%	6.4%	87.1%	100.0%
25/9/11	95.2%	99.5%	98.4%	99.7%	99.6%	2.6%	95.9%	99.5%	25.2%	10.0%	97.5%	99.9%
26/9/11	92.1%	32.0%	98.6%	99.6%	99.6%	2.0%	94.6%	99.3%	40.1%	30.0%	93.3%	99.9%
27/9/11	92.8%	44.1%	97.9%	99.3%	99.2%	22.7%	90.5%	98.8%	85.2%	41.1%	87.9%	99.7%
2/10/11	98.1%	100.0%	97.9%	99.5%	99.5%	77.5%	91.9%	99.2%	85.8%	99.7%	2.7%	99.9%
3/10/11	99.3%	36.3%	99.3%	99.4%	99.7%	99.8%	92.0%	99.5%	84.6%	100.0%	60.7%	99.6%
4/10/11	99.6%	57.9%	99.3%	99.7%	99.8%	100.0%	91.4%	99.7%	73.2%	100.0%	85.3%	99.6%
5/10/11	98.8%	52.5%	98.5%	99.5%	99.8%	100.0%	92.5%	99.5%	48.9%	100.0%	75.9%	99.8%
6/10/11	98.6%	94.8%	97.8%	99.3%	99.7%	100.0%	89.8%	99.4%	26.4%	100.0%	59.1%	98.2%
9/10/11	99.7%	100.0%	97.9%	99.5%	99.7%	100.0%	89.6%	99.5%	6.3%	100.0%	80.8%	97.8%
10/10/11	96.5%	95.4%	98.5%	99.7%	100.0%	28.8%	98.3%	99.8%	15.5%	36.1%	95.7%	99.6%
11/10/11	96.8%	96.1%	98.8%	99.6%	99.9%	47.4%	98.5%	99.7%	54.8%	40.0%	89.6%	99.5%
10/10/11	92.9%	78.0%	98.2%	97.9%	99.9%	70.1%	97.6%	98.7%	63.7%	31.3%	71.3%	95.0%
17/10/11	92.0%	90.1%	92.9%	97.8%	99.8%	78.5%	97.7%	98.4%	62.0%	34.1%	75.7%	84.7%
18/10/11	91.3%	88.3%	95.2%	98.0%	99.8%	35.6%	96.9%	98.1%	30.5%	26.7%	73.8%	99.1%
23/10/11	96.5%	100.0%	95.4%	97.1%	99.7%	30.7%	96.7%	98.0%	16.3%	35.0%	94.8%	96.8%
24/10/11	92.4%	93.6%	94.8%	97.4%	99.6%	62.5%	94.6%	98.1%	40.5%	54.8%	93.1%	95.8%
25/10/11	85.5%	67.3%	89.1%	94.6%	98.7%	72.0%	85.6%	96.5%	51.6%	49.9%	79.1%	91.4%
26/10/11	84.8%	59.0%	91.1%	94.5%	98.7%	63.6%	83.7%	95.4%	72.6%	47.5%	75.2%	88.4%
27/10/11	76.6%	80.0%	76.6%	85.7%	97.9%	56.6%	77.0%	88.7%	57.7%	29.7%	64.9%	81.1%
30/10/11	78.2%	99.8%	74.3%	90.9%	98.4%	10.4%	74.3%	92.1%	15.5%	29.2%	69.9%	81.0%
31/10/11	64.2%	9.3%	64.0%	92.4%	98.2%	85.6%	72.3%	94.4%	5.9%	15.2%	47.1%	94.8%

5d. The economy's increased resilience to political and security-related events

In addition to the analysis of the index's movement and its composition in response to various events, the stress index allows us to examine the markets' resilience to events which are exogenous to the financial markets. At the time this study was prepared, it was our assumption that market participants "mature", or "learn" the financial markets, over time, which would lead to increasing economic resilience to political and security-related events over time. To test this hypothesis, we classified all the events in the period under review by topic (political, financial, security-related, and other events), and examined the index values obtained in each category of events.

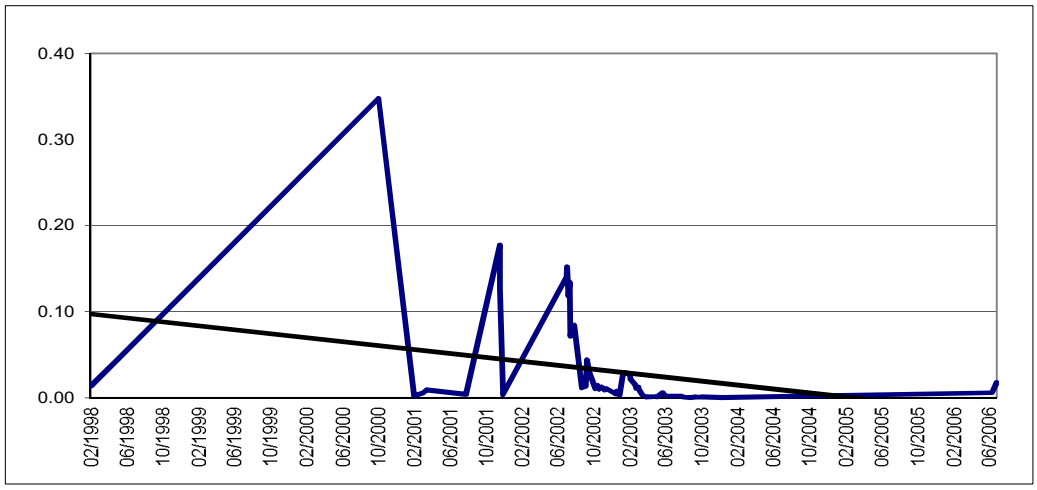
First, we focused on what we defined as political events, including a coalition crisis, resignation of the Minister of Finance, and the physical collapse of Prime Minister Ariel Sharon. We isolated all the political events that did not occur during what we defined as a period of financial crisis, and examined the values obtained by the index in response, apparently, to those events. Results are presented in Figure 7. It can be seen that the index in fact obtained increasingly lower values over time in response to such events. In other words, the economy's sensitivity to such events declined over time.

Figure 7: The Economy's Resilience to Political Events (2002–07)



We repeated the procedure for security-related events, such as terror attacks, shooting incidents, etc. We similarly extracted all the security-related events that did not occur during periods of financial crisis, as we defined this term. The results, presented in Figure 8, show a downward trend in this case as well. In other words, the index obtained increasingly lower values over time in response to security-related events.

Figure 8: The Economy's Resilience to Security-Related Events (1998-2006)



Of course, it may be argued that the decline in the index values stems from the declining intensity of the security-related events over time. Therefore we had to classify events by their intensity, to distinguish terror attacks that caused many injuries and fatalities from terror attacks that caused injuries only. To this end, we applied the methodology described in Appendix 8c. Even after controlling for event intensity, the stress index values create a downward trend line over time. In summary, the two procedures described above indicate that the economy's resilience to political events and to security-related events increased over time.

6. Summary and Conclusions

In this study, we introduced two stress indices for financial markets: a calibrated index and a synthetic index. Both indices incorporate variables representing four categories: liquidity, volatility, risks, and economic activity. Variables selected from each category were aggregated into 11 series, which were grouped into three series: the Level series (simple mean of the selected 11 series), the Common Correlation series (mean of the cross-correlation coefficients of the 11 series in the most recent 50-day period), and the Volatility series (sum of the squared daily changes in the Level series in the most recent 50-day period). To construct the calibrated index, we entered the three series into the equation, in which the dependent variable obtains a value of 1 during what was defined as periods of financial stress (the LTCM crisis of 1998 and the 2002 crisis) and a value of 0 in other periods. Results for all three series were statistically significant. In contrast, the synthetic index comprises partial indices and is not committed to a specific event.

The calculated indices represent the level of stress in the financial markets at a daily frequency, and allow us to track the state of the market on a daily basis in a simple and understandable manner. These indices take into consideration the economy's changing environment, including the changes in the distribution of the original series resulting from the fact that they are based on a moving standardization. The recommendation that emerges from this study is to use the index based on a moving standardization, as the distribution of the original series is fixed in the long run.

Such indices can be used to monitor the state of the financial markets on a regular basis. Their purpose is to assign an objective score to the impact of any market event, replacing subjective assessments that have been used to date. Events that occurred in recent years were reflected in changes in indices, but commentators differed in the interpretations they gave, or in other words, in their different diagnoses of the intensity of the impact of these events on the financial markets in real time. From a historical perspective extending over the past decade, it appears that the indices captured events that had an impact on financial stability, and offer a different view on events that appeared to threaten financial stability as they occurred. The application of a uniform, objective interpretation to assess the impact of various events on the financial markets can be expected to simplify decision making.

This study therefore illustrates that we can use the final index value to track the state of the financial markets in an ongoing manner. Furthermore, this study proposes two additional applications that may contribute to the analysis of events that affect the financial markets: (1) a comparison of the index values obtained in response to two similar events (such as the resignation of Minister of Finance Netanyahu and the physical illness of Prime Minister Sharon, two terror attacks, etc.) may offer insights on financial markets' resilience and stability. One conclusion to emerge from this study is that the economy developed resilience to security-related and political events over time; (2) By constructing 11 partial indices (the number of original series taken from various financial markets), we can analyze the development of each crisis or event and identify which markets were more strongly affected, how much time elapsed from when initial information on the event is obtained to the event's effects in each market, the development of each effect, etc. This analytic method offers improved accuracy in policy required to maintain the stability of financial markets.

In conclusion, it is important to emphasize that index values are affected by the composition of their underlying series. In our study, the series and their weights were determined after repeated tests with multiple series, against the backdrop of the relative weight of each of the markets (represented by series) in the public's portfolio of financial assets. We reiterate that the purpose of this index is not to forecast crises, but rather to assist policy makers in making real-time identifications of crises and responding accordingly. Regular measurement of the state of the financial markets using an index calibrated on the basis of the markets' response to previous crises allows policy makers to respond to stress situations as they emerge, and to avoid responding inappropriately to non-stress events.

7. References

Amihud, Y. (2002), "Illiquidity and Stock Return Cross-Section and Time-Series Effects", *Journal of Financial Markets*, 31-56.

Bank of America Merrill Lynch (2010), "Launching GFSI," Bank of America Merrill Lynch Global Financial Stress Index Research Report.

Benita, G., & Schreiber, B. (2003), "On Implied and Actual Volatility and the Differences between Them" (Foreign Currency Issues, Discussion Series, 3/03). [Hebrew]

Berg, A. and C. Pattillo (1999a), "What Caused the Asian Crises: An Early Warning System Approach", *Economic Notes* 28(3) (November), 285-334.

Berg, A. and C. Pattillo (1999b), "Are Currency Crises Predictable? A Test", IMF Staff Papers 46(2) (June), 107-138.

Berg, A. and C. Pattillo (1999c), "Predicting Currency Crises: The Indicators Approach and an Alternative" (1999), *Journal of International Money and Finance* (August), 18(4), 561-586.

Blass, A., Yafeh, Y., & Peled-Levy, O. (2002), "The Price of Raising Capital in Israel in the Era of Globalization: Economic Policy, Political Events, and 'Contagion"', Economic Quarterly, 49, 658–692. [Hebrew]

Brave, S., and R. A. Butters (2011), "Monitoring Financial Stability: A Financial Conditions Index Approach", *Federal Reserve Bank of Chicago Economic Perspectives*, pp. 22-43, First Quarter.

Delgado, J. and J. Saurina (2004*), Credit Risk and Loan Loss Provisions. An Analysis with Macroeconomic Variables*, Directorate General Banking Regulation, Bank of Spain.

Dovman, P. (2010), "Business Cycles in Israel and Macroeconomic Crises—Their Duration and Severity", Discussion Paper Series 2010.08.

English, W., K. Tsatsaronis, and E. Zoli (2005), "Assessing the Predictive Power of Measure of Financial Conditions", *Bank of International Settlements Papers, 22.*

Frankel, J. and A. Rose (1996), "Currency Crashes in Emerging Markets: Empirical Indicators", *NBER Working Paper No. 5437*(January).

Galay, D., Schreiber, B. (2003), "The Information Embedded in Shekel-Dollar Strategies and Options in Israel's OTC Market (Foreign Currency Issues, Discussion Series, 6/03). [Hebrew]

Goldstein, M., G. Kaminsky and C.M. Reinhart (2000), *Assessing Financial Vulnerability: An Early Warning System for Emerging Markets*, Institute for International Economics, Washington DC.

Grimaldi, M. B. (2010), "Detecting and Interpreting Financial Stress in the Euro Area", ECB Working Paper Series, Number 1214.

Hakkio, C. and W.R. Keeton, "Financial Stress: What Is It, How Can It Be Measured, and Why Does It Matter?", Federal Reserve Bank of Kansas City*, Economic Review – Second Quarter 2009.*

Hanschel, E. and P. Monnin (2003), *Measuring and Forecasting Stress in the Banking Sector: Evidence from Switzerland*, Swiss National Bank.

Hecht, Y., Haim, Y., & Schreiber, B. (2002), "A Foreign Currency Market Model, Applied to Israel", Foreign Currency Supervision, Research Unit. [Hebrew]

Hoggarth, G. and L. Zicchino (2004), *Stress Testing the UK Banking System using a VAR Approach*, Bank of England, mimeo.

Hui, B. and Heubel, B. (1984), "Comparative Liquidity Advantages among Major U.S. Stock Markets", Technical Report, DRI Financial Information Group Study Series No. 84081.

Illing, M. and Y. Liu (2006), "Measuring Financial Stress in a Developed Country: An Application to Canada", *Journal of Financial Stability*, Vol. 2, No. 3, October.

IMF 2008, *World Economic Outlook*, October.

Kaminsky, G. (1998), "Currency and Banking Crises: The Early Warnings of Distress", *International Finance Discussion Paper No. 629*, IMF, Washington.

Kaminsky, G., S. Lizondo and C.M. Reinhart (1998), "Leading Indicators of Currency Crises", *IMF Staff Papers, 45(1*) (March), 1-48.

Kaminsky, G., S. Lizondo and C.M. Reinhart (1999), "The Twin Crises: The Causes of Banking and Balance-of-Payments Problems", *American Economic Review 89(3)* (June), 473-500.

Kliesen, K., and D. Smith (2010), "Measuring Financial Market Stress," *Federal Reserve Bank of St .Louis Economic Synopses*, 2.

Kritzman, M., Y. Li, S. Page, and R. Rigobon (2010), "Principal Components as a Measure of Systemic Risk," MIT Sloan School Working Paper 4785-10.

Laeven, L. and G. Majnoni (2003), "Loan Loss Provisioning and Economic Slowdowns: Too Much, Too Late?", *Journal of Financial Intermediation 12*, 178-197.

Nelson, W.R. and R. Perli (2005), "Selected Indicators of Financial Stability", *Irving Fisher Committee's Bulletin on Central Bank Statistics,* 23, 92-105.

Oet, M., R. Eiben, and T. Bianco (2011), "Financial Stress Index: Identification of Systemic Risk Conditions," Federal Reserve Bank of Cleveland mimeo.

Salas, V. and J. Saurina (2002), "Credit Risk in Two Institutional Regimes: Spanish Commercial and Savings Banks", *Journal of Financial Services Research 22* (issue 3), 203-224.

Shoham, A., Rosenboim, M., Malul, M., and Saadon, Y. (2011), "Core and Periphery — The Dual Effect of Terror," *Peace Economics, Peace Science and Public Policy*: Vol. 17: Iss. 1, Article 9, 2011.

Sorge, M. (2004), "Stress Testing Financial System: An Overview of Current Methodologies", *BIS working Paper No. 165.* (December).

Swiss National Bank (2006), *Financial Stability Report*.

Van Den End, J W (2006), "Indicator and Boundaries of Financial Stability", *De Nederlandsche Bank, Working Paper, 097/2006.*

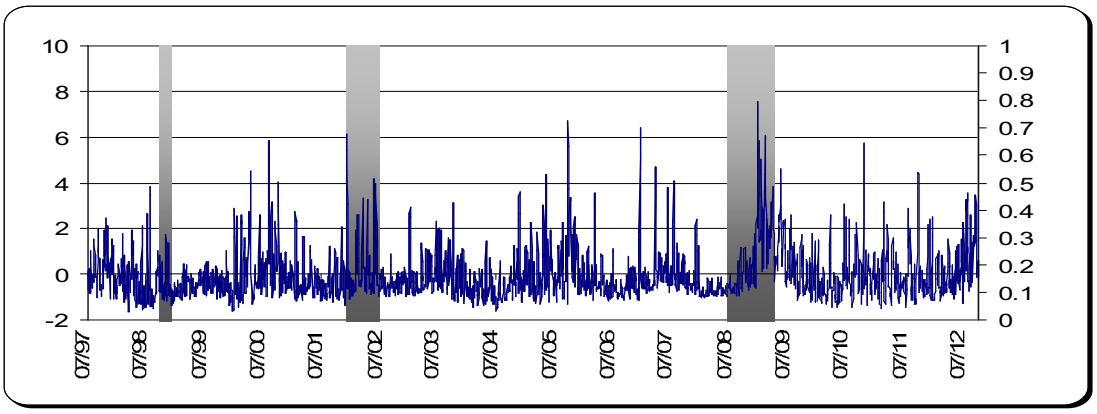
Yiu, M.S., W.A. Ho and L. Jin (2010), "A Measure of Financial Stress in Hong Kong Financial Markets – The Financial Stress Index", *Hong Kong Monetary Authority, Research Note 02/2010.*

Zussman, A., N. Zussman and Nielsen O.M. (2006), "Asset Market Perspectives on the Israeli-Palestinian Conflict", Discussion Paper No. 2006.02.

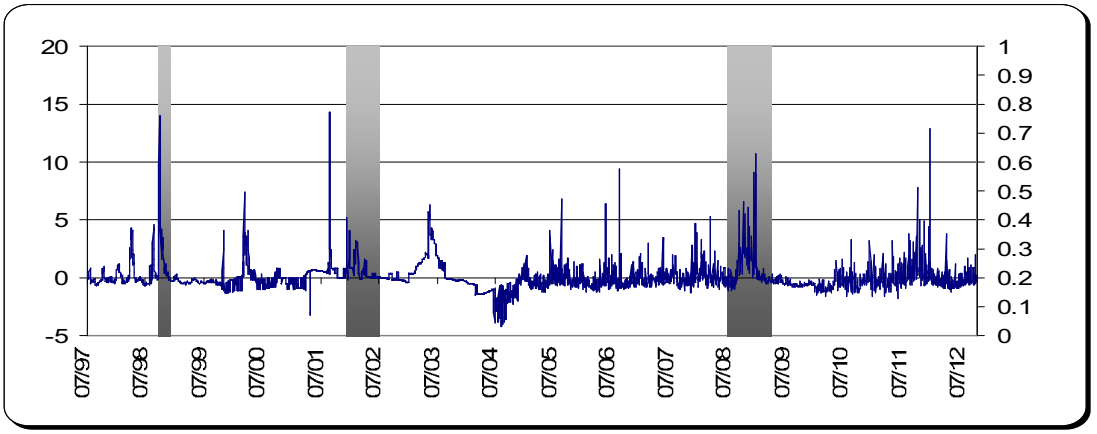
8. Appendices

8a. The eleven series (after standardization) that make up the stress index [33]

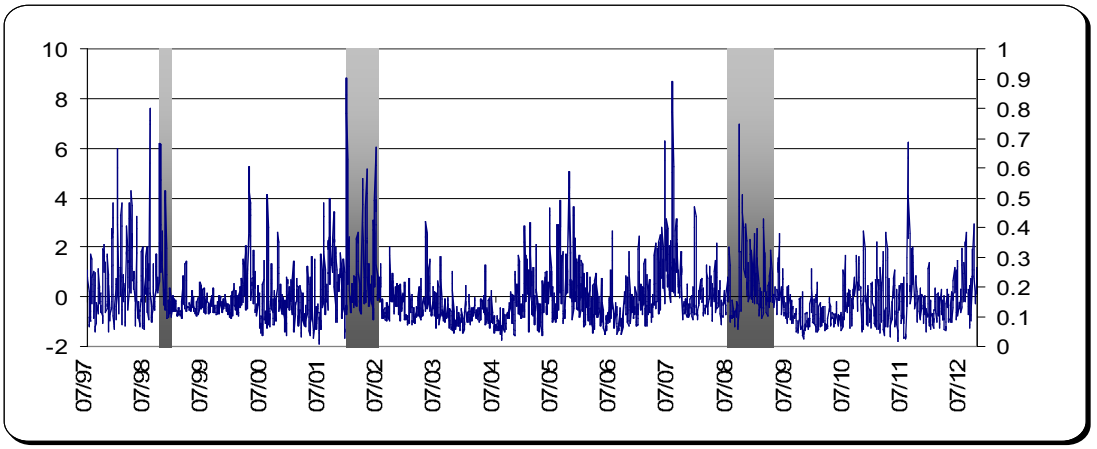
Bond market liquidity index



Foreign exchange market liquidity

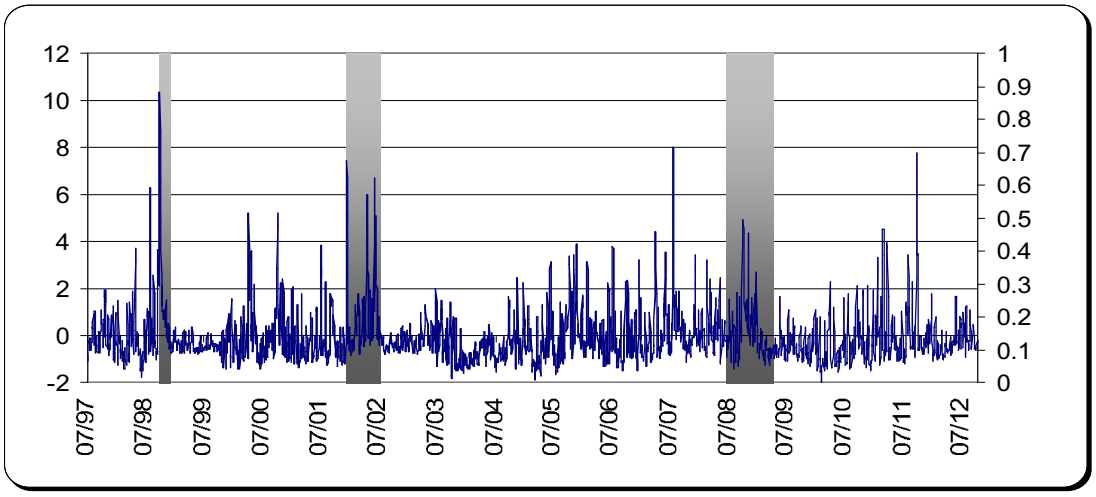


Standard deviation of long-term bonds

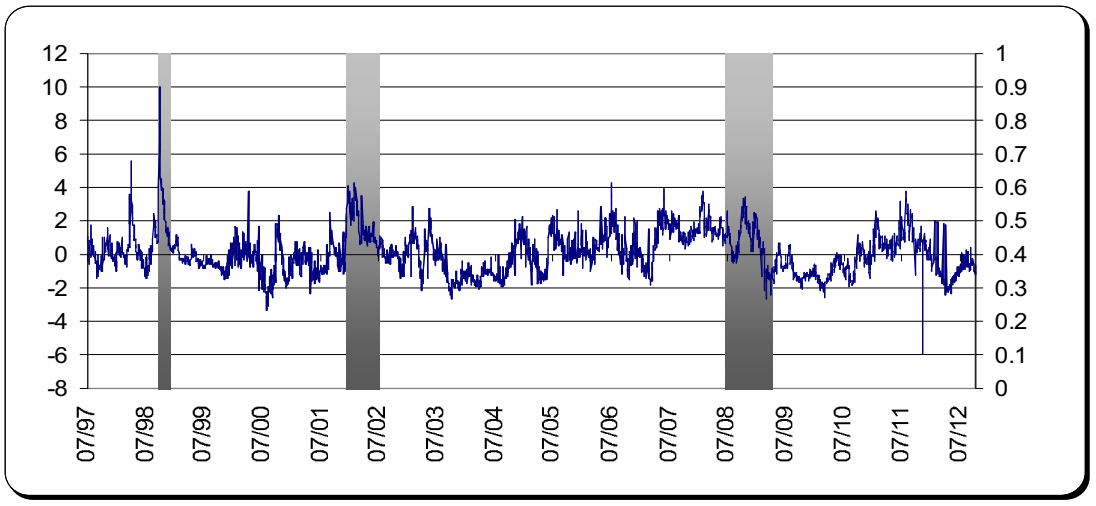


[33] For a detailed discussion of the series, see Section 3a.

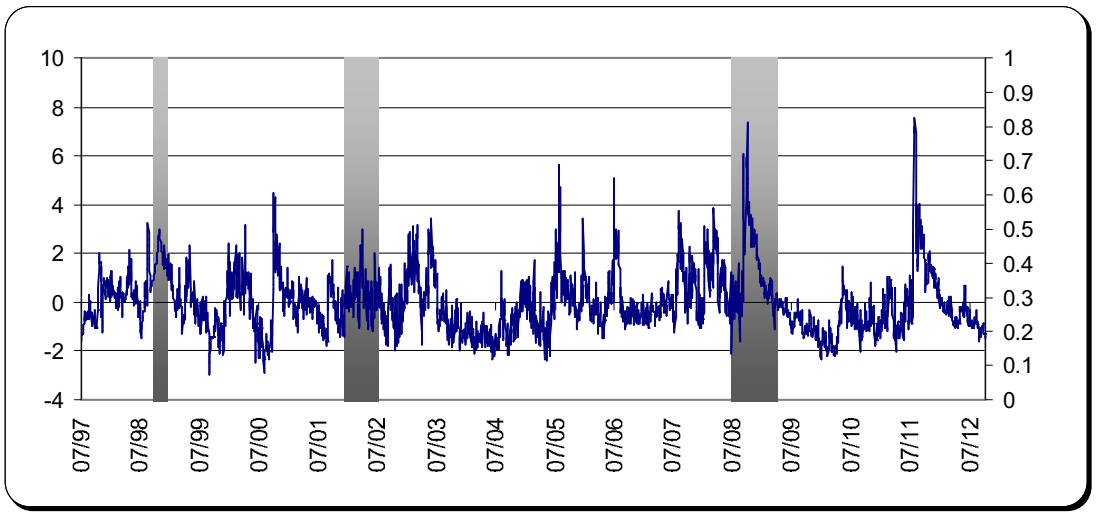
Standard deviation of short-term bonds



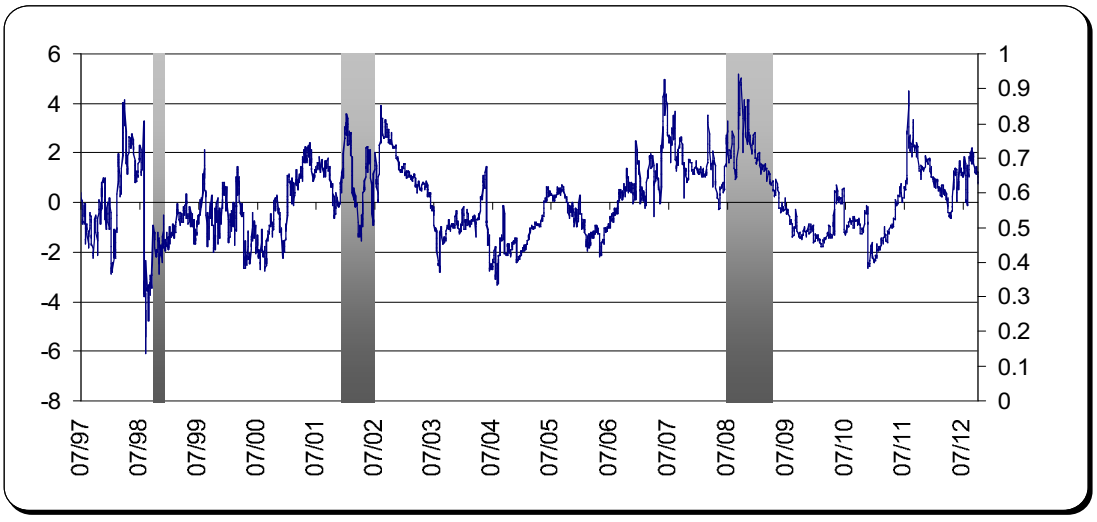
Implied volatility in NIS/$ exchange rate options



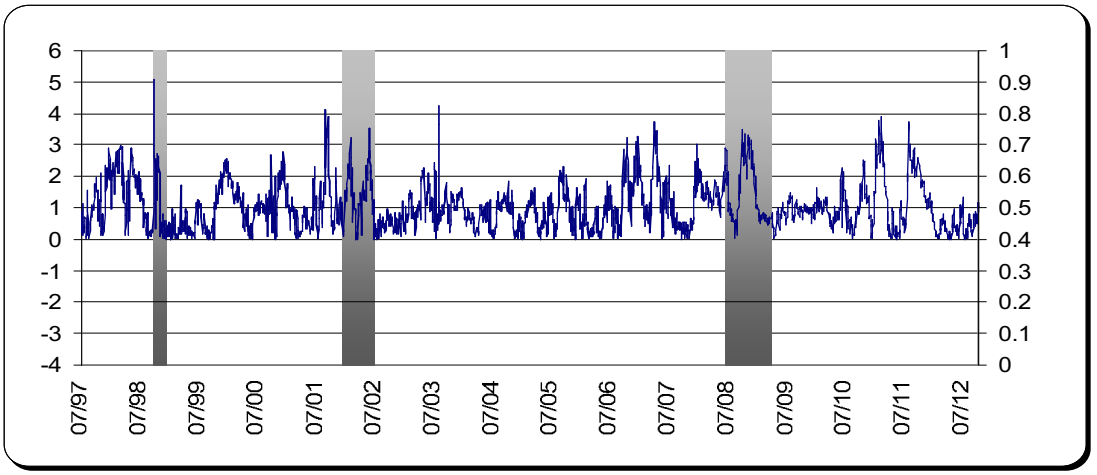
Implied volatility in Tel Aviv 25 Index options



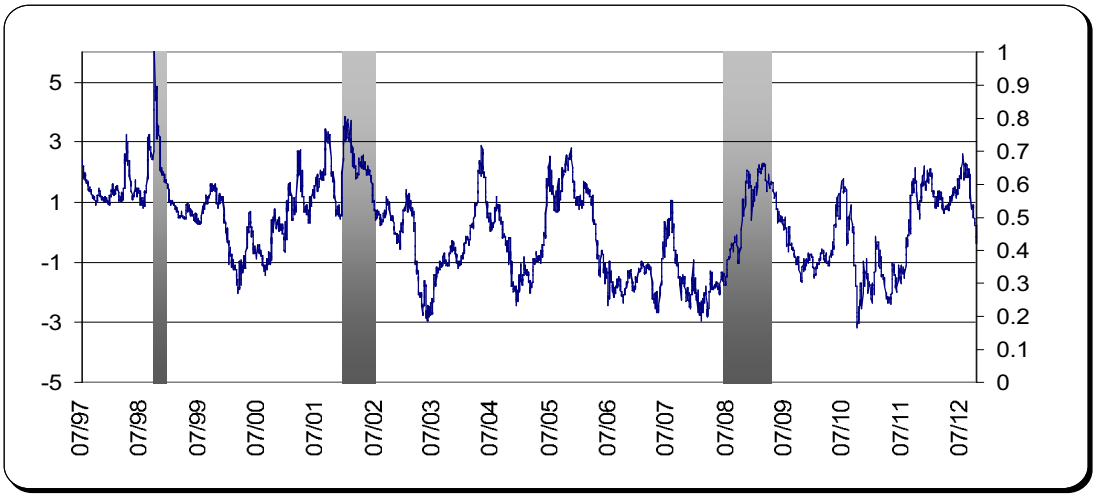
Corporate bond spreads



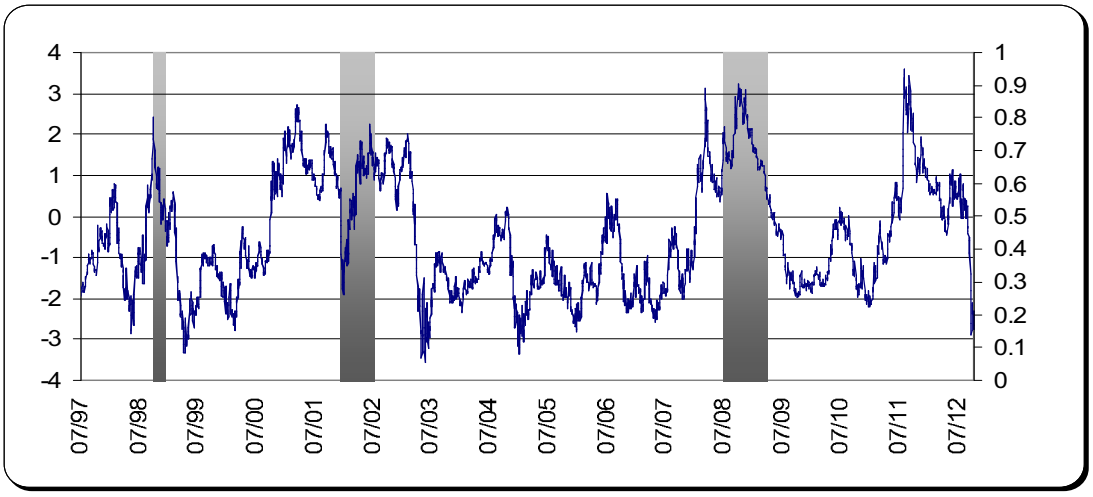
1-year inflation expectations



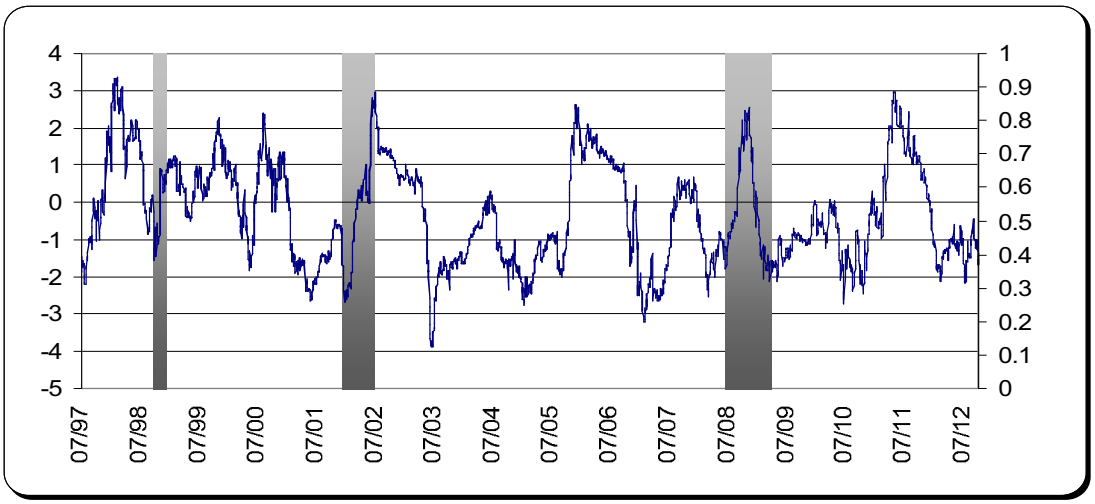
NIS/$ exchange rate



Tel Aviv 100 Index



Implied yield on CPI-indexed bonds



8b. The NIS/$ bid-ask spread

The spread series had been updated since August 1999 by the Bank of Israel dealing room (the most common spread of the trading day, in percent)[34]. In August 2011, the series ceased being updated, so it became necessary to use an alternative series that could be updated on a continuous basis going forward.

Interbank NIS/$ trading takes place via various systems—telephone, Chat systems (Reuters Dealing, Bloomberg), Single Bank Portal systems (systems of foreign banks, installed at Israeli banks [foreign bank market maker]), brokers (ILS Brokers, TFS, Global Box) and anonymous platforms (Matching).

Most trading today takes place through Chat systems, brokers, and matching, and the trading method, quantities, and spreads vary among the various systems. Trading at the Bank of Israel takes place over the phone or through brokers—the series through August 2011 provided to us by the dealing room was based on verbal quotes received from the brokers. In order to construct an alternative series, we turned to Reuters, and they provided us with data from the matching system from November 2003. In order to get the daily series, we excluded data that was outside of trading hours (10:00–17:00), we excluded outliers, and we calculated a weighted average spread (based on the length of time of the quote) for each day.

In order for the Reuters series to be taken into account in estimation, and for at least one crisis to be taken into account (the recent financial crisis), it was decided to use the series beginning from November 2003. That is, our series is ultimately constructed from two different, aligned, series and after various checks it appears that using one instead of the other does not change the estimation results.

[34] Since our sample period begins from July 1996, we had to concatenate the series backward, and we did that via the liquidity index we built for the foreign exchange market.

8c. The economy's resilience to security occurrences

We first differentiated between acts of terrorism and explosive events. We classified the strength of acts of terrorism in accordance with the number of fatalities and injuries: each fatality increased the strength of the event by 1 points, and every 3.86 injuries (the number of injuries in the sample period divided by the number of fatalities) increased the strength of the event by 1 point.

In the subgroup "explosive events", we included events such as massive firing of Katyusha rockets toward cities in the North (September 15, 1998), the eruption of riots in October 2000 (October 17, 2000), the beginning of mortars being fired toward the southern city of Sderot (March 19, 2001), and the death of 16 Palestinians by IDF forces (March 4, 2002). The strength of each explosive event was assessed as the average strength of acts of terrorism in the sample period.

In the second stage, we divided the events into 6 categories in accordance with their strength: 0–5 – Category 1; from 5–10 - Category 2; from 10–15 - Category 3; from 15–20 - Category 4; from 20–30 - Category 5; 30 and higher, Category 6. For each category, we examined the movement of the stress index over time. The six graphs below portray the results.