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Business Cycles in Israel and Macroeconomic Crises—Their Duration and Severity

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מחזורי המיתון בישראל וזעזועים פיננסיים ומקרו-כלכליים - עיתוים ועצמתם

פולינה דובמן

תקציר

עבודה זו בוחנת את מאפייניהם של מחזורי המיתון בישראל ביחס לזעזועים פיננסיים ומקרו-כלכליים. ממצאי העבודה נבחנים בהשוואה לממצאי קרן המטבע הבין-לאומית עבור מחזורי המיתון במדינות המפותחות. נמצא כי בישראל, בשנים 1991-2009, מחזורי מיתון המזוהים עם זעזועים פיננסיים ארוכים יותר ממחזורי מיתון אחרים, וגם אובדן התוצר במהלכם גבוה יותר. תוצאה זו מנוגדת לממצאים העולים לגבי מחזורי מיתון בשנים 1960-1990. כן נמצא כי עד תחילת שנות ה-90 מאפייניהם של מחזורי העסקים בישראל דומים למחזוריים של המדינות המתפתחות יותר מאשר לאלה של המדינות המפותחות. ניתוח גמישות התוצר של המשק הישראלי ביחס לזעזועים פיננסיים ומקרו-כלכליים מעלה כי רגישותו למשברים פיננסיים ולזעזועים מוניטריים גברה במידה ניכרת אחרי שנת 1995, ואילו רגישותו לזעזועים מקרו-כלכליים אחרים פחתה. ממצא זה עולה בקנה אחד עם המעבר ליציבות מחירים ועם תהליך הביזור של הנכסים הפיננסיים בעשור האחרון.

Business Cycles in Israel and Macroeconomic Crises—Their Duration and Severity

Polina Dovman

Abstract

This study examines the time varying characteristics of business cycles in Israel in 1960-2009. During the 1990s the Israeli economy underwent many structural changes and reforms, which gradually turned it from an emerging to an advanced economy. The study shows that the characteristics of business cycles in 1991–2009 were different than those of business cycles in 1960–90. Until the 1990s, business cycles were more similar to those of emerging markets, while since the early 1990s they share more similarities with those of advanced economies. In addition, Israel's transition from an emerging to an advanced economy is reflected in its GDP elasticity to macroeconomic shocks—after 1995 economic activity became more sensitive to financial crises and monetary shocks, whereas its sensitivity to other macroeconomic shocks declined. This is consistent with the transition of Israel's economy to price stability and the decentralization of the financial sector.

1. Introduction

Business cycles are among the chief characteristics of economic activity. Therefore, the causes of business cycles and their consequences for social welfare are of great interest to economists. The multiplicity of the factors affecting business cycles makes it necessary to address the similarities and the unique characteristics of different periods of recession and growth. Such an evaluation is essential for planning policy that will support economic activity in times of economic prosperity and slowdown.

This study researches the time varying characteristics of business cycles in Israel in 1960–2009. The study distinguishes recession periods associated with financial crises from other recession periods. In particular, the question posed is whether the characteristics of recessions associated with financial crises are different from those of recessions associated with other macroeconomic stresses. The effect of different macroeconomic shocks on economic growth is also examined.

This paper proposes five “stress indices” for detecting macroeconomic stress in Israel. The method of devising the indices is based on the logit probability distribution, which is common in models of early warning systems designed to estimate probabilities of financial crises. The indices help to relate the business cycles to economic stress, and make it possible to estimate their effect on loss of per capita GDP.

The study is structured as follows: The next section presents business cycles in Israel and the basic facts of the periods of growth and recession in 1960–2009. The third section deals with characterization and analysis of recessions according to the macroeconomic stress identified with them. The fourth section presents the method of estimating the elasticity of GDP to macroeconomic stress and the estimation findings, and the fifth section summarizes the study.

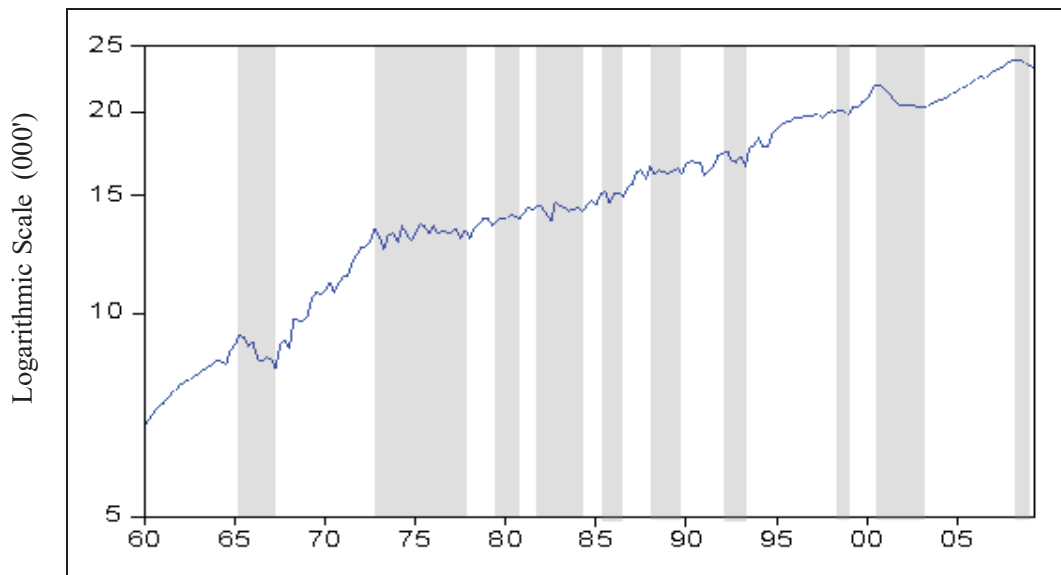
2. Business Cycles in Israel

This section presents the business cycles in Israel in 1960–2009, and the characteristics of economic activity during them. The characteristics of business cycles in Israel will be examined in comparison with the IMF’s findings¹ concerning growth and recession

¹ “From Recession to Recovery – How Soon and How Strong,” World Economic Outlook (April 2009).

cycles in the advanced economies. This study adopts the approach in which identifying boom and bust cycles in aggregate economic activity focuses on finding local minimum and maximum points in the log of GDP (see IMF, 2009; Harding and Pagan, 2001). The population growth rates in Israel during the period of the sample are not uniform. Aggregate economic activity is therefore evaluated according to per capita GDP, and the turning points are also analyzed on this basis (Figure A). Note that the business cycles identified using this method correspond to a large extent to the business cycles identified using the methods usually employed by the Bank of Israel.²

Figure A: Per Capita GDP and Business Cycles in Israel, 1960–2009*



* Periods of recession are marked in gray.

Business Cycles in Israel—Stylized Facts

Ten business cycles were recorded in the Israeli economy in 1960–2009. The loss of GDP at times of recession was significantly less than its increase during the expansion cycle (Figure A): recessions in Israel featured an average loss in per capita GDP of 3.8

² In analyzing business cycles in Israel, it is customary to rely on the Composite State of the Economy Index used by the Bank of Israel to track the level of economic activity in Israel. This index was developed in the studies by Melnick and Golan (1992) and Melnick (1995), based on the method formulated in an article by Stock and Watson (1989, 1991). Melnick (2002) divides economic activity into three sub-periods: growth, slowdown, and recession. Strawczynski and Flug (2007) use Melnick’s definition (2002) to analyze business cycles in Israel, but define continuous growth periods on the basis of rates of change in per capita GDP. Marom, Menashe, and Suhoj (2003) apply the method formulated in the Markov Regimes Switching Models (MRSMS) (Kim and Nelson, 1999; Hamilton 1989).

percent, while expansion cycles featured a 16.1 percent rise in per capita GDP and a 25 percent rise in GDP. At the end of a recession, it took an average of only two quarters for GDP to return to its level before the recession began (Table A). Severe recessions (in terms of loss of per capita GDP) were usually followed by growth periods that were longer and featured stronger growth.

A comparison with the findings of the IMF study shows that on the average, recessions in Israel were longer and more frequent than recession in advanced economies. Recessions in Israel lasted an average of eight quarters, while expansion cycles lasted 12 quarters, compared with 4 quarters of recession and 22 quarters of growth in the advanced economies. It therefore follows that in the Israeli economy, 39 percent of the sample period consisted of recession, compared with an average of only 10 percent in the developed economies.

Table A: Business Cycles in Israel and the OECD Countries – Duration and Amplitude*

	Duration*			Amplitude**		
	Recession	Recovery***	Expansion	Recession	Recovery***	Expansion
Israel						
Average	7.8	1.8	11.8	-3.8	6.9	16.1
Standard Deviation	5.5	3.3	7.6	3.5	4.2	13.7
No. of Cycles	10	9	10	10	9	10
OECD countries						
Average	3.6	3.2	21.8	-4.2	2.8	11.0
Standard Deviation	2.1	2.7	17.9	2.9	3.1	17.5
No. of Cycles	122	109	122	122	112	122

* Number of quarters.

** Percent change in per capita real GDP.

*** Recovery is defined as the first four quarters of the transition to the growth cycle.

A more precise analysis of recessions in Israel, their duration, and their frequency makes it possible to identify the source of the differences between Israel and the OECD countries. An examination of the business cycles according to per capita GDP (Figure A) shows that business cycles in Israel and growth trends can be divided into three main periods: 1960–1973, when growth was very rapid; 1974-1990, when recessions were frequent and growth was slow; and 1991 until the present time, when growth has been more rapid and less volatile. Note that in Israeli economic research, it is customary to use

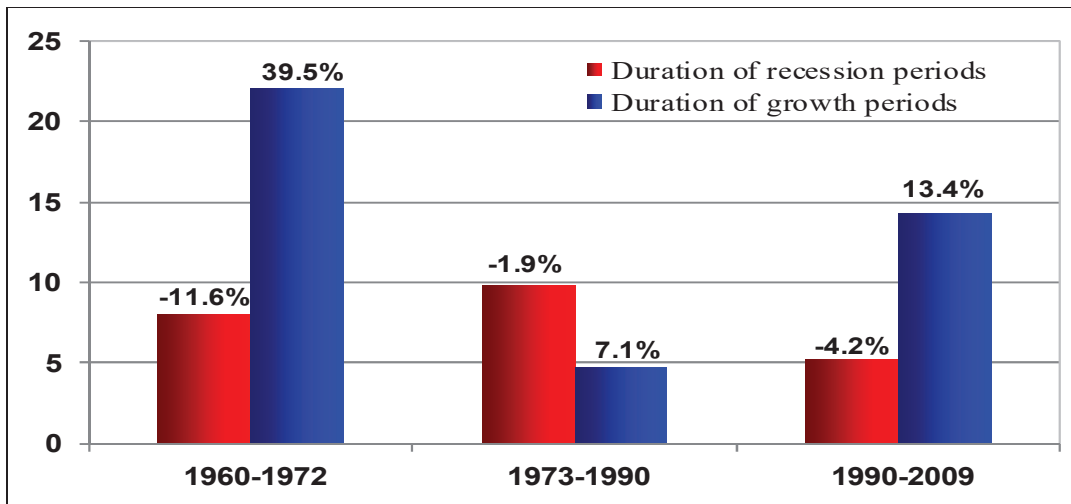
two growth trends: 1960–1973 and 1973 until the present time. However, an econometric analysis for identifying a “trend break” in time series (Kejriwal and Perron, 2009) shows that the prevailing growth trend from 1991 to the present time is stronger than and significantly different from the growth trend in 1973–1991 (see Appendix A).

Most recession periods in Israel were concentrated between 1973 (the year identified with the beginning of the “lost decade”) and 1994, when the transition to price stability was completed. During those years, business cycles in Israel were a result of an environment of high inflation, compared with developed economies and other developing economies; a chronic deficit in the government budget and in the current account of the balance of payments; repeated external shocks; serious errors in policy; and political interests.³ Evidence shows that Israel was subject to many political pressures supporting a policy – fiscal and monetary – that was unsuitable for the economy’s needs. A prominent example was the election economics of the 1970s, which promoted an expansive policy and supported low unemployment, despite the need for fiscal restraint and controlling inflation (Liviatan and Barkai, 2004, pp. 192–196). This policy led to a series of events whose cost to the economy is thought to be a prolonged recession that ended only in 1985 (in the 12 years from 1973 to 1985, per capita GDP grew by only a cumulative 10 percent) and a high public debt burden. Although the process of stabilizing the economy began in 1985, residual public distrust of monetary and fiscal policy and the burden of public debt on government spending caused a recession in 1987-1990 and another series of frequent fluctuations in GDP. This continued until late 1993, when monetary and fiscal indices and indices of public optimism greatly improved.

A different picture emerges in 1960-1974 and 1993-2009: Israel’s first decades were primarily a story of a young economy with rapid growth in GDP – a typical characteristic of developing economies – a low inflationary environment, and a public interest in establishing Israel’s economic status.

³ For further discussion, see Liviatan and Melnick (1999); Liviatan and Barkai (2004).

Figure B: Amplitude and Duration of Business Cycles in Israel, 1960–2009*



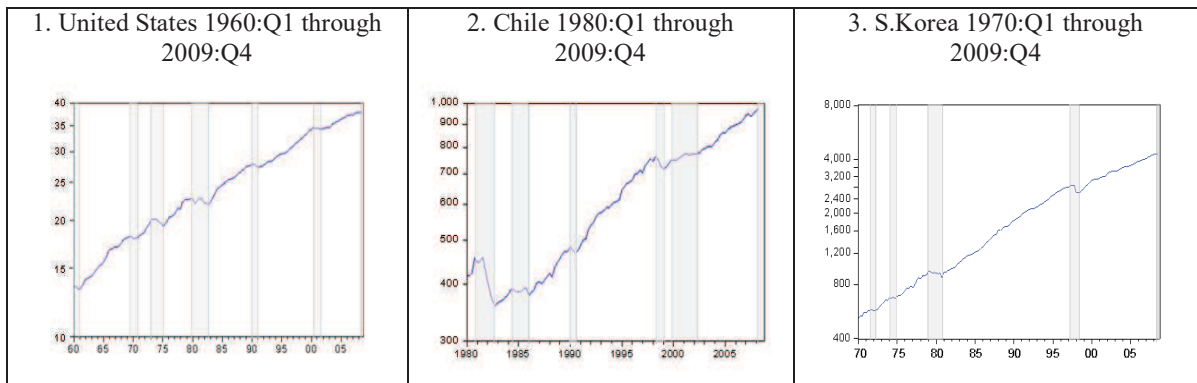
The values denote average growth in per capita GDP during growth cycles and recession.

The growth trend that began in 1990 and picked up steam in 1994 introduced a return to stable prices, fiscal and monetary support of sustainable growth, a reduction in the weight of the public sector in GDP, reform in the capital markets, and a rise in productivity. Processes of globalization and integration of Israel into the global market also supported the expansion of domestic economic activity during this period. As a result, periods of growth were longer in 1960–1973 and 1990–2009, recessions were less frequent, and above all, business cycles were less volatile. This contrasts with 1973–1990, which featured shorter periods of growth and frequent fluctuations in GDP caused by a variety of exogenous shocks (Figures A and B).⁴ During these years, most of the variation in the per capita GDP series is attributable to fluctuations around its trend, and the fluctuations in GDP were exceptional in comparison with both developed economies and emerging economies (Figures C1-3). Aguiar and Gopinath (2007) found that in contrast to developed economies, variation in GDP in emerging economies was due primarily to shocks to the growth trend. Note that despite the many crises and high inflation, recession during these years did not feature large loss of GDP, a fact that can be attributed to extensive government involvement in economic activity and frequent salary adjustments. Nevertheless, government subsidization contributed to the channeling of investment to

⁴ Melnick (200) found that business cycles following the stabilization plan were essentially different from those preceding it, reflecting more fundamental economic processes and endogenous forces contributing to their formation.

inefficient objectives, and GDP growth during these years was accordingly rather low. On the other hand, the two most severe recessions were in 1960–1973 and 1990–2008, in which loss of GDP reached 10 percent of per capita GDP (Figure B).

Figure C: Per Capita GDP and Business Cycles in Selected Countries (‘000)



In summary, it appears that most of the differences between Israel and OECD countries in the characteristics of their business cycles, according to the IMF’s findings, originate in the comparison period: while Israel is an OECD member, and is considered a developed economy according to the indices of many international organizations, the process of becoming a developed country began only in the late 1990s; up until then, the characteristics, duration, and frequency of recessions in Israel were much more similar to those of emerging economies like Chile.

3. Recession and Macroeconomic Shocks

This section describes the attributes of recessions identified with macroeconomic shocks, and assesses the attributes of the recessions in relation to the macroeconomic shock with which the recession is identified. In particular, the question is posed whether recessions identified with various financial crises differ significantly from recessions identified with other macroeconomic shocks.

3.1 Recessions in Israel and Macroeconomic Shocks—Attributes

The method of describing the attributes of recessions identified with macroeconomic shocks is based on establishing rules for identifying shocks: financial crises, defense shocks, monetary restraint, fiscal restraint, and external demand shocks. These rules are based on qualitative indices or sharp changes in numerical series indicating the existence

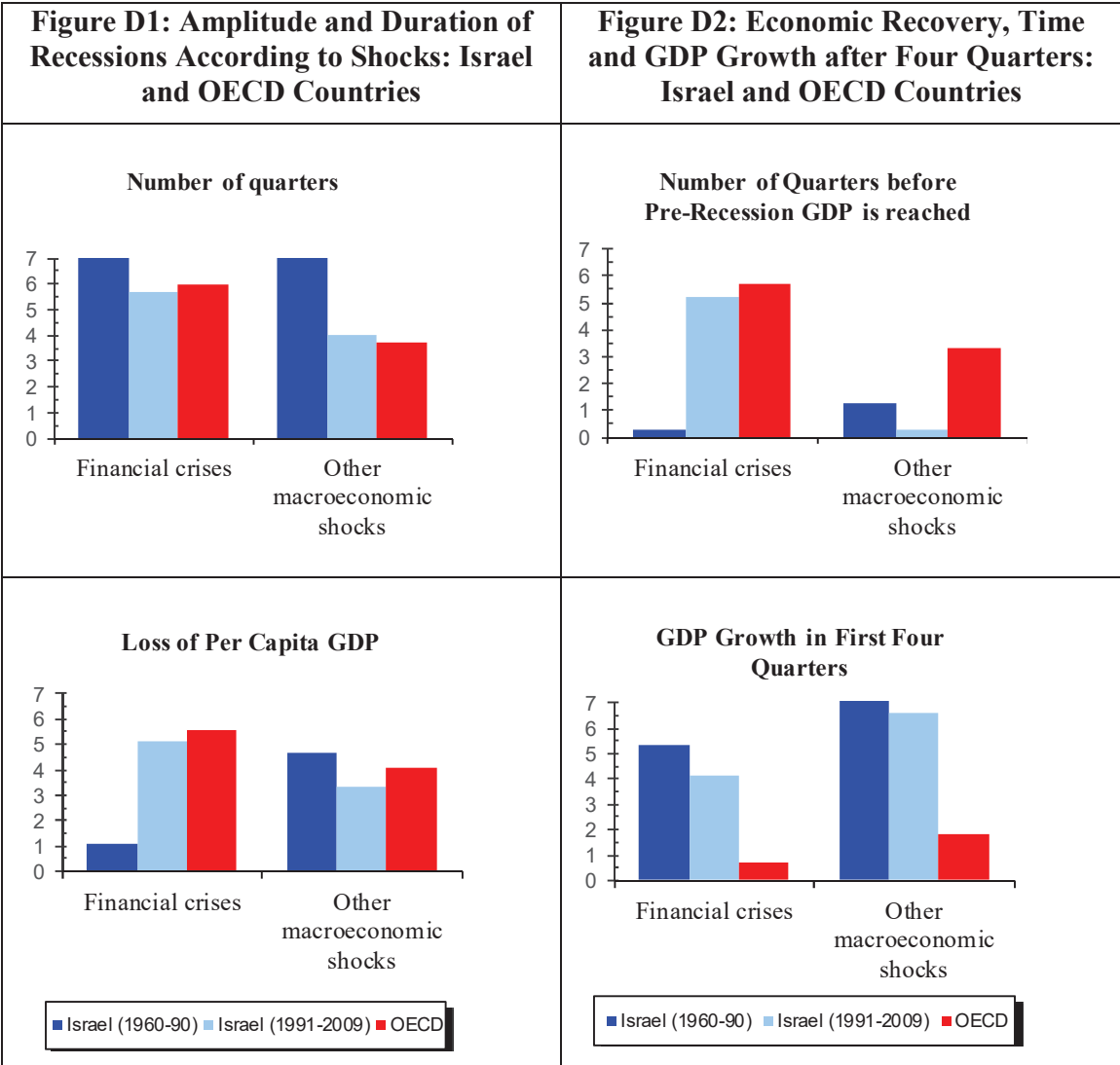
of a shock (see Appendix 2). A recession is identified with a shock if the shock appeared during the recession, or up to four quarters before it. Note that simultaneous influence of a number of shocks on economic activity is possible, and reciprocal relations exist between various sectors in which shocks can take place. For example, a monetary shock is liable to cause a simultaneous response in the financial sector, and vice-versa. For this reason, the proposed method cannot identify the exogenous shock that caused the recession, and the test set forth in this section is not designed to distinguish the marginal effect of each shock on the recession. Table B displays the recessions in Israel according to the various shocks identified with them.

Table B: Recession and Macroeconomic Shocks

	Defense Shocks	External Demand	Financial Crises	Monetary Restraint	Fiscal Restraint
1965:Q3 – 1967:Q2					
1973:Q1 – 1978:Q1	*	*			
1979:Q2 – 1980:Q4		*	*		
1982:Q1 – 1984:Q2	*	*	*		
1985:Q4 – 1986:Q3	*			*	*
1988:Q2 – 1989:Q4					*
1992:Q3 – 1993:Q2					
1998:Q4 – 1999:Q1			*	*	
2000:Q4 – 2003:Q2	*	*	*	*	
2008:Q3 – 2009:Q2		*	*		

3.2 Recession in Israel, Financial Shocks, and Other Shocks: An Analytical Survey

An assessment of recessions in relation to macroeconomic shocks shows that the characteristics of recessions in 1960–1990 identified with financial crises differ from those in 1991–2009. During the earlier period, recessions identified with financial crises did not differ significantly from other recessions. In recessions identified with financial crises during this period, loss of per capita GDP was even lower than in other recessions. Such recessions were not longer than other recessions, and recovery from them was rapid (Figures D1-D2). In 1991–2009, however, the situation was different, in line with the findings of the IMF for OECD countries: recessions identified with financial crises were longer and more severe, and recovery from them was slower than for other recessions.



It appears that the source of the difference between the findings for the two periods (1960-1990 and 1991-2009) lies in the character of the Israeli economy during the sample period. As mentioned earlier, the transition in Israel from a hyperinflationary economy with financial suppression and unsuccessful efforts at stabilization to an economy with macroeconomic characteristics similar to those of developed economies was completed only 15 years ago. Two of the five recessions identified with financial crises occurred in 1973-1985, when the Israeli economy – before the stabilization plan – featured financial suppression, with limited involvement by the public in the capital market and frequent salary adjustments, which significantly limited the effect of the shocks in the financial markets on the public welfare. Furthermore, government involvement in the market at

that time had a major influence on development of the macroeconomic indices before, during, and after recessions. Government involvement was especially intense in periods of recession that featured financial crises. The financial crises during these periods were due mainly to unsuccessful stabilization efforts preceding them, and government involvement during these crises was particularly prominent; it reduced the negative short-term impact on GDP, but had long-term consequences, reflected in high public debt that has persisted until this day. The process of recovery from these recessions was usually quick, and was also fueled by massive government intervention. The enactment of reforms boosted optimism among the public, caused a steep increase in bank credit, and contributed to increased consumption and improvement in the balance of trade, but the government's backpedaling on the reforms, such as the Hurvitz reform in 1979, sent the economy back into recession. The most prominent expression of this phenomenon was in the recession identified with the 1984–85 bank shares crisis. Formulation of the stabilization plan and bringing inflation down to two digits increased public optimism and a feeling of being well off, which contributed to economic recovery and a rapid return to the growth trend (Liviatan and Barkai, 2004). In contrast to earlier years, the period starting in the 1990s until the present has featured a process of dispersal of the public's assets, improvement of the capital market, and a drop in the government's weight in business activity. These factors bolstered the economy's immunity to macroeconomic shocks, but at the same time increased the public's exposure to sharp fluctuations in the financial markets.

Note that the multiplicity of attributes in the recessions, compared with a small number of episodes, makes it difficult to isolate the contribution of the various shocks to the economic indicators: most of the recessions that featured financial crises were also identified with other shocks. Furthermore, five of the 10 recessions in the sample period are identified with financial crises. It therefore follows that estimating the effect of the various shocks on GDP growth must be accompanied by econometric control of their duration and severity.

4. Recessions and Macroeconomic Stresses—Estimation and Findings

The goal of this section is to estimate the effect of stress on economic growth. The advantages of econometric estimation are derived from the problems discussed in the preceding sections. Econometric estimation expands the sample size to the number of quarters investigated, thereby making it possible to estimate the elasticity of GDP to macroeconomic shocks in various periods. In addition, recessions in Israel feature many shocks and a multiplicity of factors, making it difficult to isolate the marginal effects of the various stresses on economic growth. This problem is made all the more acute by the small number of observations (recessions). Econometric estimation makes it possible to control the duration and severity of the various shocks, and to estimate their effect on development of GDP during the sample period. This section presents an estimation of the elasticity of GDP to macroeconomic shocks.

4.1 Macroeconomic Shocks – Constructing Stress Indices

Macroeconomic estimation requires the construction of numeric series representing macroeconomic forces having a negative impact on economic activity – macroeconomic shocks. The method of estimating the shocks is based on construction of indices for assessing the degree of pressure in series representing these forces. In periods of shock, the indices will receive high values indicating pressure, and in the next stage, it will be possible to estimate the effect of the stress indices on GDP growth.

Macroeconomic shocks are usually reflected in a number of economic series; for this reason, pressure series are constructed by consolidating the representative series into a single series. The usual method of consolidating series is based on the principal component method – a method that generates one series that is a linear combination of a number of observed variables. The covariance matrix of the variables determines their weights (for further discussion, see Johnson and Wichtern, 1992). In this study, I use a different method to consolidate the series, because in order to construct stress indices, it is necessary to filter out the noise in the series, and to give greater weight to sharp changes, depending on the direction of the change representing the shock. Construction of the stress indices is therefore based on a method introduced by Nelson and Perli

(2005)⁵ and applied in Israel in the study by Saadon (2007). In this method, macroeconomic shocks are estimated using a binomial model based on the logit probability distribution. The regression equation is displayed in Equation (1).

$$(1) \quad z_t^{(i)} = L^{(i)} \left(\beta_0^{(i)} + \sum_{j=1}^N \beta_j^{(i)} x_{t,j}^{(i)} \right) ; P(S_t^{(i)} = 1) = \frac{1}{1 + e^{-z_t^{(i)}}}$$

$x_j^{(i)}$ represents the j macroeconomic series identified with shock i . $z_t^{(i)}$ is a dummy variable that receives the value 1 in periods in which shock i is defined, and is used to calibrate the index. The series obtained from estimating equation (1) ($P(S_t^{(i)} = 1)$) will receive values between 0 and 1. Values close to 1 will indicate the appearance of macroeconomic shock i .

Another model, proposed in the article by Nelson and Perli (2005), condenses the series representing the $x^{(i)}$ shock into three series through the use of statistical analyses. In this method, the series are first standardized with respect to their average and standard deviation. Three new series composing the representative series are then calculated: a simple arithmetic average of the standardized series ($\lambda^{(i)}$), a series of the changes in the average series ($\delta^{(i)}$), and a series representing the extent of correlation in the variation of the series ($\rho^{(i)}$), calculated using the principal component method. This model is represented by Equation (2).

$$(2) \quad P(S_t^{(i)} = 1) = \frac{1}{1 + e^{-z_t^{(i)}}} ; \quad z^{(i)} = L^{(i)}(\lambda^{(i)}, \delta^{(i)}, \rho^{(i)})$$

The rationale behind the second model is based on the correlation existing in most of the representative series in periods in which extreme data is obtained. This estimation will also smooth sharp fluctuations in the index stemming from extreme movement in one of the series (for further discussion, see Saadon (2007)).

In the current study, five stress indices for macroeconomic shocks were estimated: monetary restraint (M), financial crises (F), shocks in external demand (E), defense shocks (DEF), and fiscal restraint (G). In the initial stage, the observed variables

⁵ The US Federal Reserve Board uses this method for its regular assessment of the state of the financial markets.

representing the various shocks were selected (see Appendix 3). In the second stage, the periods of shocks were defined, and were used to calibrate the five stress indices. These periods constituted a basis for the construction of five binary series used as an dependent variable in Equations (1) and (2) ($z_t^{(i)}$). The choice of the periods for calibrating the series coefficients (the variable $z^{(i)}$ in Equations (1) and (2)) was based to a large extent on rules for identifying shocks presented in section 3.1 (see Appendix 2).⁶ In the third stage, five models were estimated by the method described in Equations (1) and (2). In the final stage, the coefficients of the estimated model are used to calculate the stress indices.

Table C displays the estimation results for these five stress indices. The models for the stress indices for monetary restraint, financial crises, and external demand shocks were estimated on the basis of Equation (2), because the series from which these models are composed feature high correlation during periods of shock. In contrast, the series from which the other models are composed – the stress index for defense shocks and the stress index for fiscal restraint – do not feature one-to-one correlation, and it was therefore found that Equation (1) was more suitable for estimating them.

Table C: A Summary of the Equations for the Models

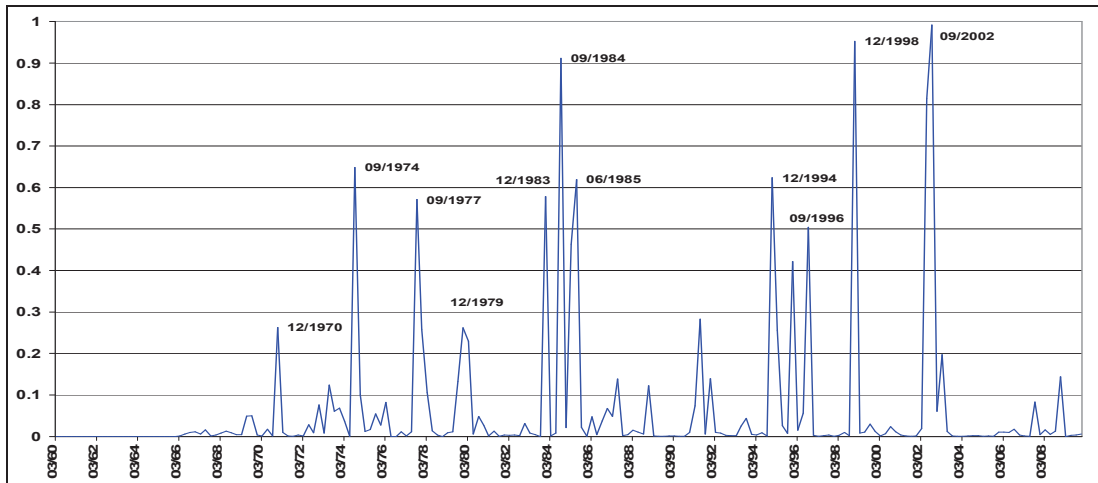
(5)	(4)	(3)	(2)	(1)	
G	DEF	E	F	M	
-1.68 (-6.3)	-2.28 (-7.6)	-3.15 (-6.8)	-5.25 (-5.7)	-6.35 (-5.6)	Intercept
		-1.43 (-3.3)	4.97 (4.3)	4.57 (4.3)	The average series - λ^i
		-1.90 (-4.2)			The correlations series - $\rho^{(i)}$
	0.03 (2.2)				Number of fatalities
	-0.09 (-3.6)				Tourist entries
-0.36 (-3.8)					Cyclically adjusted deficit
-3.86 (-1.8)					Government investment (percent change)
-4.67 (-2.9)					Current transfers (percent change)
0.31	0.25	0.47	0.58	0.53	McFadden

⁶ For defense shocks, the variable $z^{(DEF)}$ receives the value 1 during Israel's wars. The dummy variable for fiscal restraint, $z^{(G)}$, receives the value 1 in the two periods in which comprehensive reforms for reducing the deficit and the weight of government spending in the economy were put into effect. The first reform for reducing the weight of public spending in the economy went into effect in 1985 in the framework of the stabilization plan, and the second reform in 2003 during Benjamin Netanyahu's term as Minister of Finance. The variable for monetary restraint, $z^{(M)}$, receives the value 1 when the change in the real expected interest rate rises 1.75 standard deviations above the average. Financial crises, $z^{(F)}$, are identified by extreme government intervention in the capital market and by a marked and steep rise in the risk indices. The variable for external demand shocks, $z^{(E)}$, receives the value 1 when the proportion of developed countries in recession, one of which is the US, exceeds 40 percent. For details of the periods, see Appendix 2.

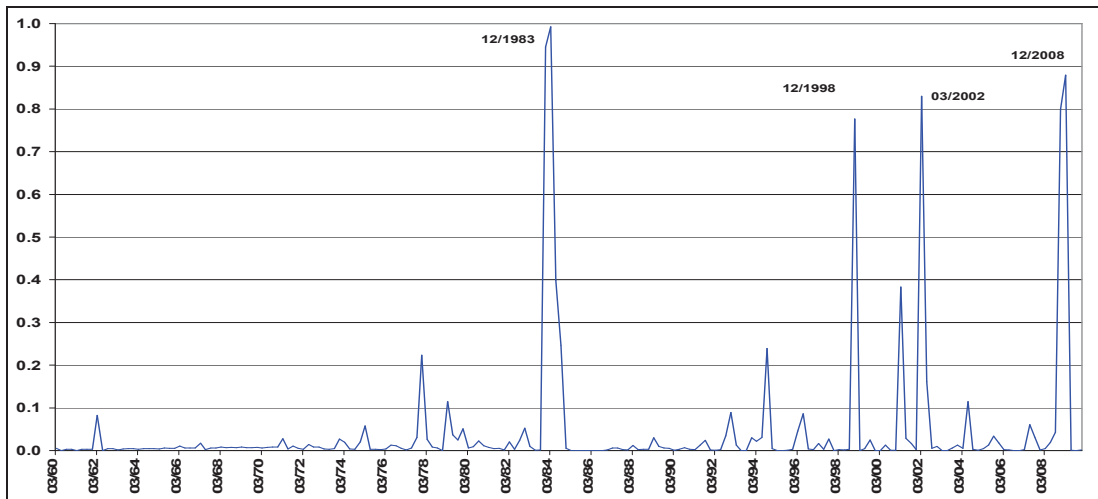
The stress indices obtained are displayed in Figures E1-E5. The indices make it possible to describe the attributes of macroeconomic stresses, and to estimate their effect on GDP growth. To a large extent, the stress indices estimation results match the shocks known to us from Israel's economic history.

Figure E: Macroeconomic Shocks, 1961:Q1–2008:Q4

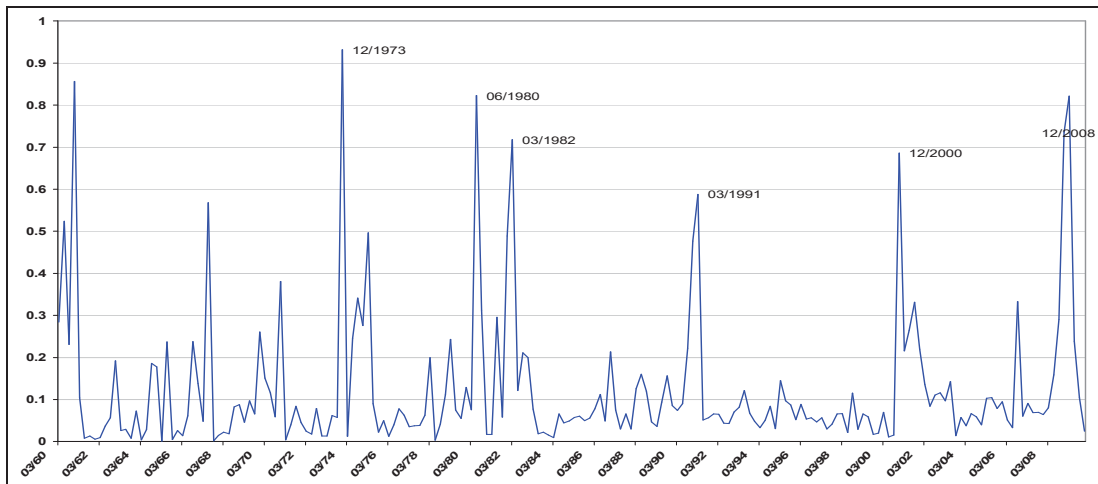
E1: Monetary Restraint



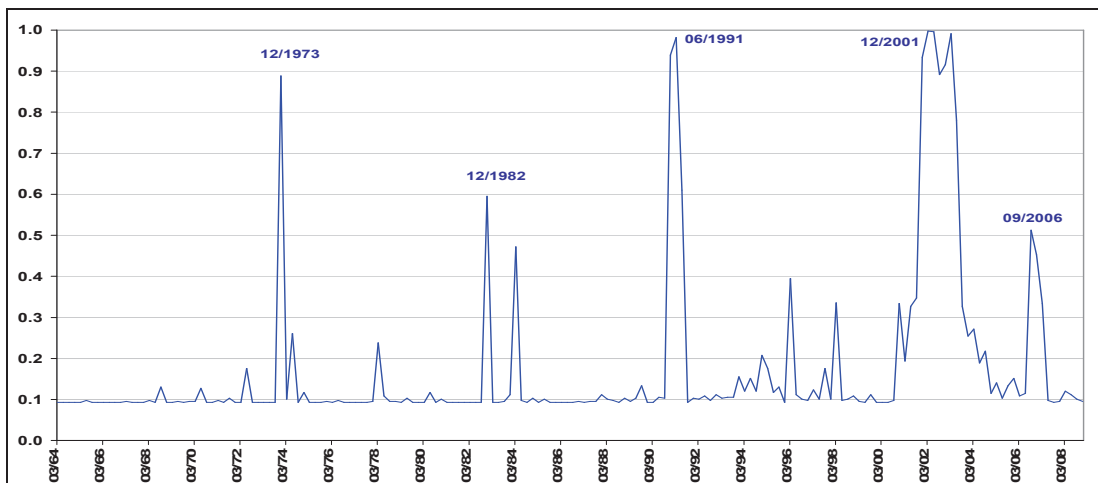
E2: Financial Crises



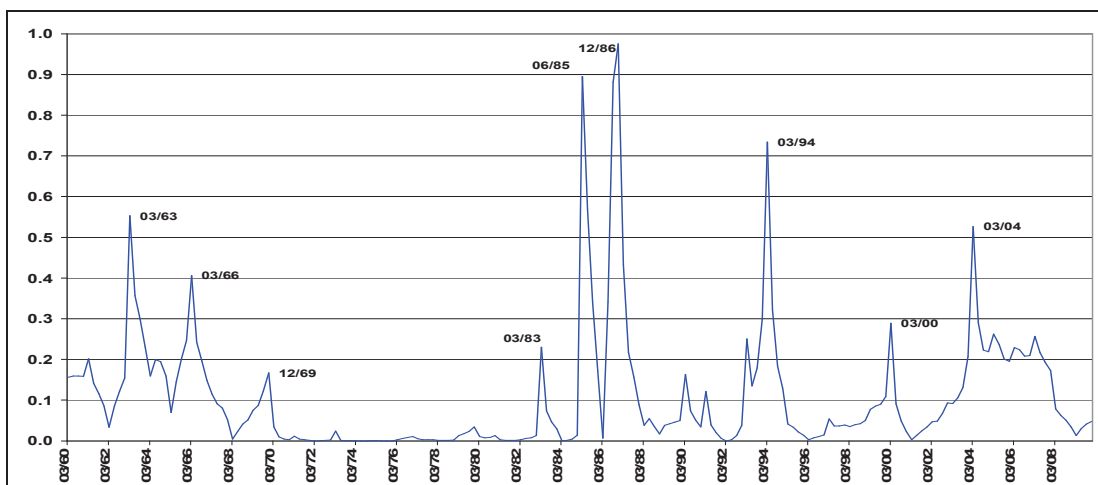
E3: External Demand Shocks



E4: Defense Shocks



E5: Fiscal Restraint



4.2 Elasticity of GDP to Macroeconomic Stresses

This section presents an estimate of the elasticity of GDP to the stress indices estimated in Section 4.1. The theoretical framework for this estimation is based on the assumption that the pace of growth depends on the growth rate in the preceding period and on shocks regis

tered in the current period. GDP growth can therefore be expressed according to Equation (3).

$$(3) \quad \Delta \log(y / pop)_t = a_0 + \sum_{i=1}^n \gamma_i S_{i,t} + \beta \cdot \Delta \log(y / pop)_{t-1} + u_t$$

Where $S_{i,t}$ denotes shock i to GDP in period t .

Opening the equation forward makes it possible to express GDP growth as process MA(q), as follows:

$$(3') \quad \Delta \log(y / pop)_t = a_0 + \sum_{j=0}^q \sum_{i=1}^n \delta_{i,j} S_{i,t-j} + \beta \cdot \Delta \log(y / pop)_{t-q-1} + v_t$$
$$v_t = \sum_{j=0}^q w_j u_{t-j}$$

The estimation results of Equation (3') are displayed in Table D. The dependent variable in the regression equation is the rate of change in per capita GDP growth. Note that a simultaneity problem in the equation estimated on the basis of Equation (3') is possible. For example, a change in per capita GDP caused by an external demand shock can affect the financial crises stress index. All the stress indices variables were therefore inserted at a lag – except for external demand shocks, whose exogenous character was assumed. The table displays values of the variable coefficients at only a single lag.

Equation (1) in Table D indicates that the elasticity of per capita GDP to financial crises and monetary restraint is not significant. Elasticity to external demand is 1.9 percent, but is lower than the elasticity of GDP to defense shocks and fiscal restraint. If the sample period is shortened to 1995–2009, Equation (2) in Table D gives a different picture. The elasticity of per capita GDP to monetary shocks and financial shocks is estimated at 1.5 percent and 0.9 percent, respectively. On the other hand, the elasticity of GDP to external demand shocks drops to 1.6 and the elasticity of GDP to fiscal restraint and defense shocks is not significant.

To a large extent, the estimation results appear to correspond to the development of the Israeli economy during the sample period. First of all, the high proportion of exports in Israel GDP naturally increases its sensitivity to external demand. The chronic deficit in the current account typical of the Israeli economy during the period preceding the stabilization plan increased the sensitivity of business activity to external demand shocks still further. For example, Liviatan and Barkai (2004) showed that the jumps in the shekel devaluation and inflation levels in 1974, 1979, and 1982 followed external shocks caused by the global oil crises. Together with the exogenous effects, financial suppression and massive government intervention in economic activity took place, which were typical of Israel during those years, tempered the influence of the financial crises on business activity. The dependence of GDP on the government budget was also considerable, due to the large weight of the government in economic activity. The monetary shocks coefficients are also consistent with what we know about the Israeli economy. Up until 1985, monetary policy was almost completely subject to political interests and the government's financing needs (Liviatan, 2003; Liviatan and Barkai, 2004). From a long-term perspective, therefore, it appears that this variable has no effect on per capita GDP. Restricting the sample period to the era of stable prices in Israel, however, augments the influence of monetary restraint. The financial crises coefficient in Equation (2) also increased as a result of the dispersal of the assets held by the public, improvement of the capital market, and a drop in the weight of the government in business activity. On the other hand, the sensitivity of GDP to external demand shocks fell.

**Table D: Elasticity of Per Capita GDP to the Stress Indices in Recessions
(the t statistic is in parentheses)**

Dlog(YP) 1995:Q1–2009:Q4	Dlog(YP) 1962:Q2–2009:Q4	Dependent variable
76	191	Sample period
(2)	(1)	Number of observations
0.004 (1.5)	0.010 (3.3)	Equation Number
- 0.016 (-2.7)	- 0.019 (-2.0)	C
- 0.003 (-0.4)	- 0.025 (-3.3)	E
0.012 (0.6)	- 0.031 (-1.7)	DEF(-1)
- 0.015 (-2.7)	- 0.011 (-1.0)	G (-1)
- 0.009 (-1.7)	0.006 (0.6)	FIN(-1)
	- 0.120 (-1.4)	M(-1)
		Dlog(YP(-8))
0.147 (1.3)		Dlog(YP(-3))
0.50	0.31	Adj R²
1.98	1.99	Durbin–Watson
2	7	Q

5. Summary

An analysis of business cycles in Israel shows that in contrast to the other developed economies, recessions identified with financial shocks are not particularly longer, and that the loss of GDP during these recessions does not differ from loss of GDP in other recessions. It was also found that recessions in Israel are longer than in OECD economies, while growth cycles were shorter. The principal explanation for this result is that until 1995, the characteristics of business cycles in Israel were more similar to those of the developing economies.

Econometric estimation indicates the vulnerability of Israeli GDP to various shocks. The estimation coefficients are unstable, and are affected by the sample period – a result of the structural changes that occurred in the Israeli economy in 1960–2009. An analysis of the elasticity of GDP to “stress indices” in 1960–2009 shows that the effect of financial and monetary shocks on loss of GDP is not significant, while restricting the sample period to 1995–2009 greatly increases the sensitivity of GDP to these shocks, and makes their coefficients significant. In any case, the elasticity of GDP to external demand shocks is greater than its elasticity to financial crises and monetary restraint shocks.

6. Bibliography

- Liviatan, Nissan, and Haim Barkai (2004), *The Israeli Economy from a Historical Perspective*, Bank of Israel: 50 Years of Striving for Monetary Control, Jerusalem: Bank of Israel.
- Liviatan, Nissan, and Rafi Melnick (1999), *Inflation and Disinflation by Steps in Israel*, in Leo Leiderman (ed), *Inflation and Disinflation in Israel*, Research Department, Bank of Israel.
- Melnick, Rafi (1995), *Forecasting Short-Run Business Fluctuations in Israel*, Bank of Israel Economic Review, 69, pp. 2-20.
- Melnick, Rafi (2002), *Business Cycles in Israel*, The Economic Quarterly 49, June, pp. 219-244.
- Strawczynski, Michel, and Karnit Flug (2007), *Persistent Growth Episodes and Macroeconomic Policy Performance in Israel*, Bank of Israel Economic Review, 80, pp. 73-103.
- Saadon, Yossi, “Devising a State of the Economy Index for Monitoring the Financial Markets in Israel,” Working Paper (forthcoming), Bank of Israel.

- Agiar, M. and G. Gopinath (2007), "Emerging Market Business Cycles: The Cycle is the Trend," *Journal of Political Economy*, 115 (1), pp. 69-102.
- Hamilton, J. (1989), "A New Approach to Economic Analysis of Non-Stationary Time Series and Business Cycle," *Econometrica*, 57(2), pp. 357-384.
- Harding, D. and A. Pagan (2001), "Dissecting the Cycle: A Methodological Investigation," *Journal of Monetary Economics*, 12, pp. 363-98.
- IMF (2009), "From Recession to Recovery: How Soon and How Strong," *World Economic Outlook*, April.
- Kim C. and C.R. Nelson (1999), "State-Space Models with Regime Switching," Cambridge, Mass.
- Liviatan, N. (2003), "Fiscal Dominance and Monetary Dominance in the Israeli Monetary Experience," *Bank of Israel, Discussion Paper No. 2003*, p. 17.
- Marom, A., Y. Menashe and T. Suhoy (2003), "The State of the Economy Index and Probability of Recession: The Markov Regime-Switching Model," *Bank of Israel, Discussion Paper No. 2003*, 05.
- Nelson, W.R. and R. Perli (2005), "Selected Indicators of Financial Stability", *Irving Fisher Committees Bulletin on Central Bank Statistics*, 23, pp. 92-105.
- Kejriwal, M., and P. Perron (2009), "A Sequential Procedure to Determine the Number of Breaks in Trend with an Integrated or Stationary Noise Component," *Purdue University Economic Working Papers*.
- Reinhart, C. and S. Rogoff (2008a), "This Time is Different: A Panoramic View of Eight Centuries of Financial Crises," *NBER Working Paper No. 13882*.
- Stock, J. and M. Watson (1991), "Probability Model of Coincident Economic Indicators" in Lahiri and Moore (eds.), *Leading Economic Indicators: New Approaches and Forecasting Records*, Cambridge University Press, New York, pp. 63-85.

Appendix 1 – Estimating the Break in the Growth Trend of Per Capita GDP from the 1970s

LOG(GDP/POP)	The dependent variable
1960Q1-2008Q4	The sample period
196	The number of observations
9.25 (509.2)	C
-0.40 (-19.2)	Dummy variables for years 1960-1973 (D6073)
-0.06 (-1.7)	Dummy variables for years 1991-2008 (D9108)
0.004 (18.7)	@TREND
0.007 (18.7)	Interaction variable @TREND*D6073
0.001 (2.8)	Interaction variable @TREND*D9108
0.99	Adj. R ²

Appendix 2 – Rules for Determining Macroeconomic Shocks

Defense shocks – defense shocks identified with Israel’s wars: the Six-Day War, the Yom Kippur War, the First Lebanese War, the First Gulf War, the Second Intifada, and the Second Lebanese War.

Fiscal restraint – Fiscal policy is represented by the change in the past four quarters in the cyclically adjusted deficit. Fiscal restraint is defined as a period in which the change in the cyclically adjusted deficit was 1.75 standard deviations lower than the average change. Defining a deviation of 1.75 standard deviations above the average as a criterion for identifying shocks is based on the IMF’s definition of macroeconomic shocks in developed economies. According to this definition, two episodes of fiscal contraction were found: 1976, the beginning of the creeping devaluation regime, and 1985, the beginning of the stabilization plan, until the first quarter of 1988.

Monetary restraint – Monetary policy is represented by the change in the Bank of Israel expected real interest rate. However, since the expected real interest rate has been available only since 1994, monetary policy is represented by the effective real interest rate in the period before 1994 (the interest on bank deposits at the Bank of Israel, divided by actual inflation). Monetary restraint is defined as a period in which the change in the real interest rate was 1.75 standard deviations higher than the average change of the series. Here, too, identification of the shock is based on the IMF’s method for identifying macroeconomic shocks. According to this definition, the following periods of monetary restraint were found: 1984:Q4, 1985:Q2–1985:Q3, 1994:Q4–1995:Q1, 1996:Q3, 1998:Q4, and 2002:Q3.

Financial crises – Financial crises are defined as a state of severe dysfunction in the financial market. This study adopts the definition presented in the study of Saadon (2007), according to which a financial crisis can be identified according to an exceptional response of the government in the capital market and according to a sharp increase in the risk indices. Five suitable periods were found using this method: 1979:Q3 – capital flight, monetary dumping, and a reversal of the Hurvitz reform; 1983:Q4–1984:Q4 – the bank shares crisis, nationalization of the banking institutions, and triple-digit hyperinflation; 1998:Q4 – the LTCM crisis and a worsening in the stability indices; 2002:Q1–2002:Q2 –

public concern about government insolvency and a sharp rise in the Bank of Israel interest rate; and 2008:Q4 – the fall of Lehman Brothers, a global crisis, and a sharp cut in the Bank of Israel interest rate.

External demand shocks – External demand is usually represented by the economic situation of trading partners. Most of Israel’s foreign trade is with the developed countries; a shock in external demand is therefore defined as a situation in which the proportion of developed economies in recession, which includes the US, exceeds 40 percent: 1974:Q1–1975:Q1, 1980:Q1–1980:Q2, 1981:Q3–1982:Q4, 1990:Q3–1991:Q1, 2001:Q2–2001:Q4, and 2008:Q1–2009:Q2.

Appendix 3 – Selecting the Representative Series for Estimating the Stress Indices

Defense shocks – The most prominent indicator of the severity of the defense shock is the series of the number of casualties from acts of terrorism. At the same time, the economic effects of the defense situation should also be taken into account. For this reason a series of tourist entries was also inserted. The two series are:

- The number of fatalities from acts of terrorism
- Tourist entries (percentages of deviation from the trend)

Fiscal restraint – Fiscal policy is usually represented by the cyclically adjusted deficit. At the same time, government policy sometimes discriminates among various sectors. In this situation, it is possible that fiscal restraint will not be reflected in the deficit series, and the components of government spending should therefore be taken into account. An example of this is found in the first recession in the researched period (1965:Q2–1967:Q2) – fiscal restraint was exercised through government spending on the capital account. Nevertheless, the deficit series did not indicate a change in the fiscal policy trend (Liviatan and Barkai, 2004, pp. 110-111). Three series in this category were selected:

- The change in government investment;
- The change in regular transfer payments;
- The change in the cyclically adjusted deficit.

Monetary restraint – The key tool in managing monetary policy is the central bank interest rate. In order to obtain an estimate of the force of monetary restraint, the changes in the central bank interest rate should therefore be examined in relation to the prevailing macroeconomic conditions. These are reflected in the real long-term interest rates, inflationary expectations, and the “global interest rate.” Six series were accordingly selected to represent monetary policy:

- The change in the interest rate gap between three-month STLs and the real 10-year interest rate;
- The change in the gap between the Bank of Israel interest rate and the US Federal Reserve Board interest rate;
- The change in the Bank of Israel interest rate;
- The real five-year interest rate (deviations from the trend);
- The real 10-year interest rate (deviations from the trend);
- The real five-year interest rate (the series of the change in deviations from the trend).

Financial crises – The indicators of a financial crisis are surveyed in depth in the article by Reinhart and Rogoff (2008a, 2008b, 2009). These include bankruptcy of financial institutions, insolvency of a country, accelerating inflation, and a devaluation in the exchange rate. The selected series represent these indicators, and reflect the inherent risks in the capital market:

- The change in gross government debt;
- Accelerating inflation in the past 12 months;
- Accelerating depreciation in the exchange rate over the past 12 months;
- The change in the standard deviation of the general shares index.

Note that many series exist that reflect the information and risks in the financial markets, but for the majority of them, data for the earlier years of the sample period is unavailable. Furthermore, estimation of the model shows that the four series described above cover to a great extent the information contained in the market. A comparison of the estimation results for 1995-2009 with the estimated model results using the 10 series and method described by Saadon (2007) for similar years shows that the two models produce similar results.

External demand shocks – External demand is reflected in exports, international trade, and the economic situation of trading partners. The following three series were therefore selected to represent external demand:

- The rate of change in the World Trade Index;
- The rate of change in exports;
- The rate of change in US GDP.