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A Nowcasting Model for GDP and its Components

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מודל לחיזוי התוצר ורכיביו בטווח הקצר

תומר קריאף

תקציר

המדיניות המוניטרית מנוהלת בסביבה של אי-וודאות רבה לגבי המצב הכלכלי הנוכחי. לפיכך נעשה שימוש במיגוון רחב של אינדיקטורים כלכליים הזמינים בזמן אמת, אשר שופכים אור על מגזרים שונים של הכלכלה. מאמר זה מציג שיטה לשקלול האינדיקטורים לכדי תמונת מקרו כוללת במסגרת של מקורות ושימושים; זאת באמצעות מודל לחיזוי שיעור הצמיחה של השימושים, היבוא והתוצר בישראל בזמן אמת (nowcasting). שימוש במודל מאפשר לקבל אומדן מוקדם של הפעילות הכלכלית חודש עד חודשיים לפני הפרסום הרשמי של הלמ"ס. השיטה כוללת: מעבר מסט אינפורמציה חודשי – הכולל מידע מלא או חלקי על הרביע הנסקר – למערכת רבעונית; חיזוי כל אחד מרכיבי החשבונאות הלאומית (הצריכה הפרטית, ההשקעה, היצוא והיבוא) בנפרד; ואמידת התוצר באמצעות זהות מקורות ושימושים ואינדיקטורים משלימים.

התוצאות המרכזיות של המחקר הן:

(1) האינדיקטורים המרכזיים התורמים לכושר החיזוי הם נתוני סחר החוץ: יצוא ויבוא סחורות, יבוא בני-קיימא ויבוא מוצרי השקעה. תרומה נוספת מתקבלת מנתוני סקרים – מדד אמון הצרכנים, מדד מנהלי הרכש, מדד ניצולת ההון – וכן ממדדי מניות ומנתוני תקבולי המסים. יתרונם של רוב האינדיקטורים האלה הוא רוויזיות נמוכות יחסית, בפרט בנקודות מפנה.

(2) נמצא כי המודל מתפקד היטב בחיזוי-מחוץ-למדגם של התוצר, הצריכה הפרטית והיבוא, ובמידה פחותה – של היצוא; לעומתם טיב החיזוי של ההשקעה בנכסים קבועים הוא נמוך, ולא ניתן לחזות את הצריכה הציבורית.

(3) האומדן הכמותי לקצב צמיחת התוצר חשוף לטעות ממוצעת (בערך מוחלט) של 1.6 נקודות אחוז במונחים שנתיים. כושרו הגבוה של המודל בחיזוי התוצר נובע בין השאר מהשימוש בזהות מקורות ושימושים, המביא לקיזוז של הטעויות בשימושים על ידי היבוא.

(4) נמצא כי יבוא בני הקיימא הוא אינדיקטור מרכזי בחיזוי הצריכה הפרטית; זאת אף על פי שהוא מהווה פחות מ-10 אחוזים ממנה.

(5) מאמידת היצוא נמצא כי מדד מנהלי הרכש של ארצות הברית יכול לשמש מדד לביקוש העולמי, וכי משתנה זה עדיף על משתנים מוכרים אחרים – כגון הסחר העולמי והתוצר, המתקבלים באיחור ניכר.

(6) כושר החיזוי הנמוך של ההשקעה בנכסים קבועים נובע, בין השאר, מן השוני בהתפתחות בין ההשקעה בבנייה להשקעה בענפי המשק, ומהעדר אינדיקטורים טובים לחיזוי הבנייה.

(7) נתוני ההשקעה במלאי הם תנודתיים מאוד וחשופים לרוויזיות רבות, ובכל זאת נמצאו עדויות לתפקוד המלאי כ"בלם" (buffer) לפערים זמניים בין הביקוש להיצע.

(8) מהניסיון שנצבר בשימוש במודל עד כה עולה כי טיב התחזית בזמן אמת אינו נופל מטיב התחזית בדיעבד, למרות הרוויזיות שעוברים האינדיקטורים החודשיים. תוצאה זו מתקבלת ככל הנראה הודות למיתאם הגבוה שבין הרוויזיות באינדיקטורים לחיזוי השימושים לבין האינדיקטורים לחיזוי היבוא.

A Nowcasting Model for GDP and its Components

Tomer Krief

ABSTRACT

Monetary policy operates in an environment of great uncertainty regarding the current economic situation. A wide range of economic indicators available in real time are therefore used in order to shed light on various sectors of the economy. This paper presents a method for weighting the indicators in order to obtain a macroeconomic picture in a sources–uses framework, by using a nowcasting model for the rate of growth of uses, imports and GDP in Israel. Use of the model provides an estimate of economic activity to be obtained one or two months before official publication by the Central Bureau of Statistics. The method incorporates: a switch from a monthly data set that includes full or partial information on the quarter under review to a quarterly system; a separate forecast for each National Accounts component (private consumption, investment, exports and imports); and an estimate of GDP using the sources-uses identity and complementary indicators.

The main findings of this study are:

(1) The indicators that contribute most to forecasting ability are foreign trade data: goods imports and exports, imports of durables and imports of capital goods; data from surveys: the Consumer Confidence Index, the Purchasing Managers Index, the Capital Utilization Index; share price indices and data on tax revenues. The advantage of most of these indicators is their relatively low rate of revision, especially at turning points.

(2) It was found that the model functions well in out-of-sample forecasting of GDP, private consumption and imports, and to a lesser extent, of exports. The quality of the forecast of fixed capital formation was low, and public consumption could not be forecast at all.

(3) The estimate of the GDP growth rate had an average error (absolute value) of 1.6 percentage points, in annual terms. The model's good forecasting ability for GDP derives *inter alia* from the sources–uses identity, which means that errors in uses are offset by imports.

(4) It was found that imports of consumer durables are a principal indicator in forecasting private consumption, even though they constitute less than 10 percent of this consumption.

(5) The exports estimate showed that the US Purchasing Managers Index can serve as an index of global demand, and is preferable to other widely used international indicators such as world trade and GDP, which become available only after a considerable delay.

(6) The low forecasting ability for fixed capital formation derives from the difference between the development of residential and nonresidential investment.

(7) The data on inventory investment are highly volatile and subject to frequent revisions. Nevertheless, evidence was found that stocks serve as a buffer at times of temporary gaps between supply and demand.

(8) Experience gained so far from using the model shows that its nowcasting errors in real time are no greater than the out-of-sample errors, despite the numerous revisions in the monthly indicators. This is apparently due to the high correlation between the revisions to the indicators employed for forecasting uses and those employed for forecasting imports.

1. Introduction

This study presents a simple model, which is widely recognized in the economics literature and by many central banks, for the statistical estimation of economic activity. The model was developed at the Bank of Israel during 2009 as a result of the global recession and major uncertainty over economic developments. The model is a nowcasting model for predicting GDP and uses at a quarterly frequency in real time on the basis of monthly and quarterly indicators that are obtained at a time closer to the quarterly forecast than official Central Bureau of Statistics data. Monetary policy measures are taken in a climate of great uncertainty regarding the current situation, and especially with respect to real activity. An assessment of the economic situation in real time therefore requires the use of numerous monthly or quarterly indicators that preempt National Accounts data, which are received with a considerable lag.[1] The problem of using these indicators is the uncertainty regarding the relevance of each of them and the manner of weighting them into an overall, macro picture. The most notable example in Israel is the Composite State of the Economy index (Merom, Menashe and Suhari, 2003). This study presents an alternative approach to the Composite Index.

The method on which the model is based can be divided into two stages: The first stage is the forecasting of the principal National Accounts items—consumption, investment, exports and imports—by means of Bridge Equations.[2] The second stage is the use of the sources-uses identity in order to estimate GDP on the basis of uses and imports estimates. The motivation for using this method is double: First, the interest in National Accounts data for the purpose of assessing the economic situation refers not only to the rate of GDP growth, but also to the sources of the growth. Second, this method emulates the method in which actual GDP is calculated by the CBS—estimating uses and imports and deriving GDP. In order to achieve maximum GDP forecasting ability, additional variables were included in the estimation, apart from the GDP derived from the sources-uses identify, which, for both theoretical and empirical reasons, must be included in a direct estimation of GDP and not of any specific demand component. Although this approach makes it possible to deviate from the accounting identity, which is the basis of the method, it should be noted that small deviations are found in official CBS data as well. The opportunity for obtaining larger deviations is actually an advantage, as these provide additional information regarding the reasonability of the results. Alternatively, it would have been possible to impose a restriction on the simultaneous estimation of all the equations, in order for them to fulfill the identity (Angelini et al, 2008). In my opinion however, the use of the identity is merely a means for obtaining a better forecast, and not an objective in itself.

The paper is organized as follows: Section 2 presents the methodological basis of the model, Section 3 presents a brief review of the common models in the literature in the area of nowcasting, Section 4 presents the components of the model, the estimation of the model and its forecasting ability in real time, and Section 5 summarizes.

[1] As an example, data on credit card purchase variables, VAT receipts and the Consumer Confidence Index are obtained on a monthly basis, shortly after the end of the month reviewed, and are usually regarded as indicators of private consumption.

[2] Equations that bridge between data at different frequencies by converting each series to a common frequency, mostly by averaging or summation of the variables at higher frequencies. In this study, quarterly frequencies were calculated for all the monthly series (even when only partial monthly data were available).

2. The theoretical model

The model combines two standard methods used in the compilation of forecasts in general and in the forecasting of growth in GDP and its components in particular. The first method is the accounting derivation of GDP from uses and imports: Since GDP fulfills an identity of sources and uses (and in certain countries, including Israel, is calculated as such), a GDP forecast can be compiled by educated assumptions on each of its components. This is assuming that the real-time information on GDP components is more extensive than that on GDP itself. This assumption is undoubtedly fulfilled in Israel with respect to some of the components, including total imports and exports of goods, and imports of capital and consumption goods. These components are published monthly, less than two weeks after the end of the month, and account for 50 percent of total uses.[3]

Lower quality information on service imports is available, and hardly any direct information at all exists on current private consumption, which is the main component of GDP. (Most current consumption is calculated on the basis of the Household Expenses Survey, which is published with a considerable lag). Accordingly, if a method of deriving GDP from uses is to be appropriate, a reasonable manner of evaluating the unknown items in real time is necessary.

This is where the second method integrated in the model comes into play—estimation of each use by means of a bridge equation. This equation converts high frequency data (monthly, weekly or even daily) into low frequency (quarterly) National Accounts data, and estimates the relationship between them. It is thereby possible to replace the assumption regarding the development of each component by a statistical estimate that is based on the factors that determine it, affect it or correlate with it and are known in real time. Another advantage of this method is that the model can be used during the quarter as well, when only partial data on the explanatory variables are available. This is done by assumptions on the trend of each variable until the end of the quarter.[4]

A different approach would be to estimate a direct equation for GDP itself. The decision on which method is to be preferred (accounting derivation of GDP or direct estimation) is an empirical decision that is dependent on two factors—the quantity and the quality of the information available in real time on GDP components relative to the information existing on GDP itself, and the correlation between actual GDP and accounting derived GDP.[5]

The approach that was selected in this model combines the two methods: After estimating each of the uses, a GDP equation is estimated which includes both the GDP variable derived from the identity, and other indicators that are not included in the estimation of the components. It is thereby possible to attain maximum information and maximum forecasting ability. However, a structural mismatch is created between sources and uses, a problem that can be solved in one of two ways—by imposing a restriction on the simultaneous estimation of all the equations, in order for them to match, or by means of a judgmental assessment of the deviation from the identity. In this model, the second approach was preferred.

[3] The uses component in foreign trade accounts for 30 percent of total uses and 40 percent of GDP.
[4] In this case, although the quality of the quarterly forecast will be impaired, it can certainly be compiled as a means for assessing the economic situation in the months for which data are available.
[5] The accounting identity is not totally fulfilled in the quarterly data at seasonally-adjusted fixed prices.

The formal formulation of the model's structure is as follows:

(1) $$d\log(C_t) = F^c(x^c{}_t) + \varepsilon_t \quad \Rightarrow \quad \overline{d\log(C_t)} = F^c(x^c{}_t)$$

(2) $$d\log(I^{cap}{}_t) = F^{i\_cap}(x^{i\_cap}{}_t) + \varepsilon_t \quad \Rightarrow \quad \overline{d\log(I^{cap}{}_t)} = F^{i\_cap}(x^{i\_cap}{}_t)$$

(3) $$d(I^{inv}{}_t) = F^{i\_inv}(x^{i\_inv}{}_t) + \varepsilon_t \quad \Rightarrow \quad \overline{d(I^{inv}{}_t)} = F^{i\_inv}(x^{i\_inv}{}_t)$$

(4) $$d\log(X_t) = F^x(x^x{}_t) + \varepsilon_t \quad \Rightarrow \quad \overline{d\log(X_t)} = F^x(x^x{}_t)$$

(5)
$$U_t = C_t + G_t + I^{cap}{}_t + I^{inv}{}_t + X_t \quad \Rightarrow$$
$$\overline{d\log(U_t)} = \frac{C_{t-1}}{U_{t-1}}\overline{d\log(C_t)} + \frac{G_{t-1}}{U_{t-1}}d\log(G_t) + \frac{I^{cap}{}_{t-1}}{U_{t-1}}\overline{d\log(I^{cap}{}_t)} + \frac{\overline{d(I^{inv}{}_t)}}{U_{t-1}} + \frac{X_{t-1}}{U_{t-1}}\overline{d\log(X_t)}$$

(6) $$d\log(M_t) = F^m(\overline{d\log(U_t)}, x^m{}_t) + \varepsilon_t \quad \Rightarrow \quad \overline{d\log(M_t)} = F^m(\overline{d\log(U_t)}, x^m{}_t)$$

(7)
$$d\log(Y_t) = F^y(\overline{d\log(U_t)} - \overline{d\log(M_t)}, x^y{}_t) + \varepsilon_t \quad \Rightarrow$$
$$\overline{d\log(Y_t)} = F^y(\overline{d\log(U_t)} - \overline{d\log(M_t)}, x^y{}_t)$$

where F is a linear function that is estimated in OLS, and ε is regression errors, x is a vector of explanatory variables that are known in real time (a different vector for each equation—according to the index), C is private consumption, G is public consumption, I^{cap} is investment in fixed assets, I^{inv} is investment in inventory, X is exports, U is total uses, M is imports and Y is GDP. The line above the variable means that the expression represented is a forecast. All the variables are in log-difference (approximation to the rates of change), except for investment in inventory, which is defined as an absolute change. The explanatory variables in each equation are chosen based on both economic logic and statistical importance, most of them in log-difference. (See the appendix for precise definitions of the variables).

Equations 1 to 4 are equations for the estimation of each of the uses.[6] Equation 6 estimates imports using estimated 'total uses' calculated in identity Equation 5[7] and additional indicators.[8] Similarly, Equation 7 estimates GDP using estimated 'total uses' and imports, and additional indicators. The model is estimated sequentially, on the assumption of non-dependence between the equations. This assumption is not necessarily fulfilled with respect to Equations 1 to 4, because the correlations between business cycles in the different uses could lead to major errors in the summation of uses. However, the model does have two error-correction mechanisms: The first is a negative correlation between inventory investment and exports in the inventory equation (see the results section), and the second is the use of goods import data for estimating both uses and imports, which lead to the partial offset of errors from the uses side with errors in imports in the derived GDP estimate.

[6] Except for public consumption, which is not estimated in this model, on the assumption that it is known. Since the weighting of public consumption is low, this assumption does not have a major effect on the results.

[7] Equation 5 is calculated as the rate of change in total uses, based on the weighted average of the rates of change in each of the uses that were estimated in Equations 1 to 4.

[8] As is clarified later in the paper, the results show that the estimate of total uses does not contribute to import forecasting ability. This is because extensive monthly information on imports is available.

The model is a static model: The explanatory variables are defined in advance. This contrasts with more innovative approaches, whereby the model is dynamic and the process of determining the variables is dependent on the existing set of information and is based on statistical criteria. The advantages of the statistical approach are the possibility of entering additional considerations other than the statistical consideration into the variable-selection process, such as economic logic and preference for variables of a particular type, as well as flexibility in identifying correlations outside of a fixed structure.[9]

The most important consideration in the variable-selection process was the statistical contribution to forecast ability. Other main considerations include: (1) Availability of the data in real time: The purpose of compiling the forecast is to provide information on National Accounts as early as possible. As an example, since industrial production data are published with a considerable delay after the actual activity in question, the benefit of using them for forecasting is limited, even if they provide extensive information. (2) Economic logic: Although the variables were selected according to their contribution to forecasting ability rather than on the basis of a theoretical model, only those variables whose economic logic connects them to the dependent variable were tested. Moreover, if the estimated relationship of a particular variable was in complete contrast to economic logic, the variable was not included in the estimation even if it contributed to forecasting ability. (3) Greater importance was placed on variables in which there are few revisions, with the result that the figure first published was similar to the final figure that was issued after some considerable time. This consideration is particularly relevant during a period of turnaround in economic activity, when retroactive revisions are more extensive because of the sharp change in the trend, which is not known in real time.[10] (4) Greater weight was given to data gathered by the CBS in order to construct the explained variable. As an example, use of dollar export data in order to estimate exports under accounting definitions is preferable to the use of stock exchange data, even if their forecasting abilities are similar. In this respect, the variables in the model can be divided into three types: (1) those used by the CBS to compile the official figure, such as foreign trade data, industrial production and productivity indices, and VAT data; (2) data that provide a direct picture of the state of the economy but are not used in compiling the official figure, such as industrial companies and employers surveys and the Purchasing Managers Index; (3) variables that are theoretically likely to affect or represent economic developments, such as stock indices and the Consumer Confidence Index.

The database for this study was based on the Bank of Israel data bank, and includes data from various sources: the Central Bureau of Statistics—National Accounts data, foreign trade data, and revenue and production data; the Bank of Israel—service import data, the Companies Survey; *Globes* newspaper—the Consumer Confidence Index; Bank Hapoalim—the Purchasing Managers Index; the Securities Authority—stock exchange indices; and international data banks—commodity prices.

The data were limited to the years 1995 to 2010 because of the change in National Accounts definitions since 1995, the lack of data on part of the variables in earlier periods, and the irrelevance of the short-term forecasting of historical statistical relationships in periods when the

[9] The dynamic model has to include a standard formulation for the variables (rates of change, for example), while the static model makes it possible to find the optimal formulation for each and every variable (for example, inclusion of the correct lag, the level or rate of change, the ratio between different variables and moving averages of highly volatile variables).

[10] Since the CBS estimates a trend component and a seasonality component for most of its indicators, the figure included is dependent on trend and seasonality. These change considerably retroactively, especially at turning points in economic activity.

structure of the economy was different. All the data are rates of change in quarterly terms, seasonally adjusted and at fixed prices (unless otherwise stated).[11]

3. Principal models for the assessment of activity in real time

The economic literature on the assessment of the level of economic activity in real time is extensive. Most of it comes from the "field" - from organizations that publish forecasts or that use forecasts for decision-making purposes, and especially from central banks.[12] This literature can be divided into two main approaches: The first is estimation of the level of activity as an unobserved variable. This approach derives mainly from the desire to produce a synthetic monthly indicator for the level of activity. A notable example of this approach is the Composite State of the Economy Index. An index such as this is published in many countries. Versions for calculating the index differ, and are based on a number of key principles (Boehm, 2001): selecting a set of variables covering the principal sectors of economic activity, the labor market and the balance of payments, variables that are available at a high frequency and as close as possible to the period reviewed; and deriving an index describing their joint movement, which will be characterized by low volatility and as small a number of retroactive revisions as possible. This method is practiced at the Bank of Israel for calculating the Composite State of the Economy Index. (The most recent study in this respect is Merom, Menashe and Suhari, 2003.) Another example appears in Suhari's study (2010), which estimates private consumption with the help of an SSR model. Estimated in this model is a monthly series for private consumption, which emulates the quarterly series while using monthly indicators.

This study presents a different method that has not been used in Israel to date. This method is known in the literature as nowcasting—forecasting a quarterly figure that is published with a considerable lag, such as GDP, in the middle of the quarter or immediately after the end of the quarter. Numerous techniques are covered under this approach: An economic/judgmental model, an aggregation of components, direct statistical models—statistical and dynamic, and a combination of several methods.

A basic method employed at various institutions is an aggregation of components: Assuming that the statistical information on, or the economic understanding of, each of the GDP components is greater than of GDP itself, each of the components can be assessed and the identity of the sources and uses can be employed in order to derive GDP in an accounting manner. This approach allows sensitivity tests on forecasts for errors on each of the components, and especially in the components on which the information is of low quality. With this method, the receipt of each new figure leads to an update in the forecast. The main problem with this method is that it is not actually clear whether more information is available on the components than on GDP itself. Aggregating the components sums their errors, and since the errors are correlated, the potential for errors under this method is considerable. Another problem is that the method leaves a great deal of room for discretion. As a result, it is very difficult to assess the quality of the results, both in real time and retroactively.

An alternative method is the direct method—statistical estimation of the forecast variable at a quarterly frequency by means of variables from higher frequencies that are converted to a quarterly frequency. The simplest way of doing this is by means of a bridge equation—a fixed equation that

[11] See Appendix 1 for details of each of the variables in the model.

[12] See for example: "Short-Term Monthly Forecasts of Economic Activity in the Euro Area", *ECB Monthly Bulletin*, April 2008.

is re-estimated every quarter, and the missing information is usually completed via assumptions regarding the trend until the end of the quarter. As an example, Baffigi et al (2004) estimate the GDP of France, Germany, Italy and the Eurozone using bridge equations.

A dynamic version of this method is used to estimate a separate model for each set of information: Instead of making assumptions regarding missing information, a model matching the partial information known in real time is estimated in advance. An example of this model is MIDAS[13] (Ghysels, Santa-Clara and Valkanov, 2004), which instead of converting all monthly indicators to quarterly indicators uses each month of the quarter as a separate explanatory variable.[14]At every point in time, the model uses only variables that are available for forecasting purposes. Application of this method for forecasting private consumption in Israel is presented in Suhari (2010).

Another set of dynamic methods are methods in which the model itself changes with each estimation, on the basis of the existing information and on the basis of statistical criteria for the selection of variables.[15] The advantage of this method is the opportunity for re-adjusting the model every quarter. The disadvantage is that it is difficult to assure economic logic in the results. For a review of dynamic methods and their functioning in the direct forecasting of GDP in Israel, see Dafnai and Sidi (2010).

Obviously, the distinction between the different methods is not clear-cut and a series of methods exists, according to authors' needs and preferences. As an example, Angelini et al (2008) combine most of the methods that were presented above and present a nowcasting model for the monthly forecasting of GDP as an unobserved variable by estimating each of the GDP components and GDP itself, and by imposing a technical limitation on the estimation which necessitates the existence of a sources-uses identity.

As was explained above, the method employed in this study combines a static bridge equation for each of the uses and sources with a non-compelling accounting identity limitation. The limitation is that the result of the accounting identity estimated from the GDP components is one of the explanatory variables in the GDP equation estimation. Although the model is static, it has two versions, one for complete information that is available two weeks after the end of the quarter (a month before the figure is officially published by the CBS), and the other for partial information that is available two weeks before the end of the quarter (two months before publication of the official CBS figure). At this point in time, the figure for the third month of the quarter for most of the variables in the model is lacking.

4. The results

The results section is comprised of two parts. The first part contains a detailed presentation of the model's components—private consumption, investment in fixed assets, inventory investment, exports, imports and GDP—as well as the results of the estimation and the quality of the forecasting. The second part focuses on additional aspects related to real-time forecasting ability, including revisions in the explanatory variables, the model's functioning with partial data, and the experience accrued with the model to date.

[13] Mixed Data Sampling Regression Model.

[14] When the model is generalized for higher frequencies as well (for example, daily data on securities), the problem of numerous parameters for estimation arises. This problem can be solved by imposing limitations on the coefficients.

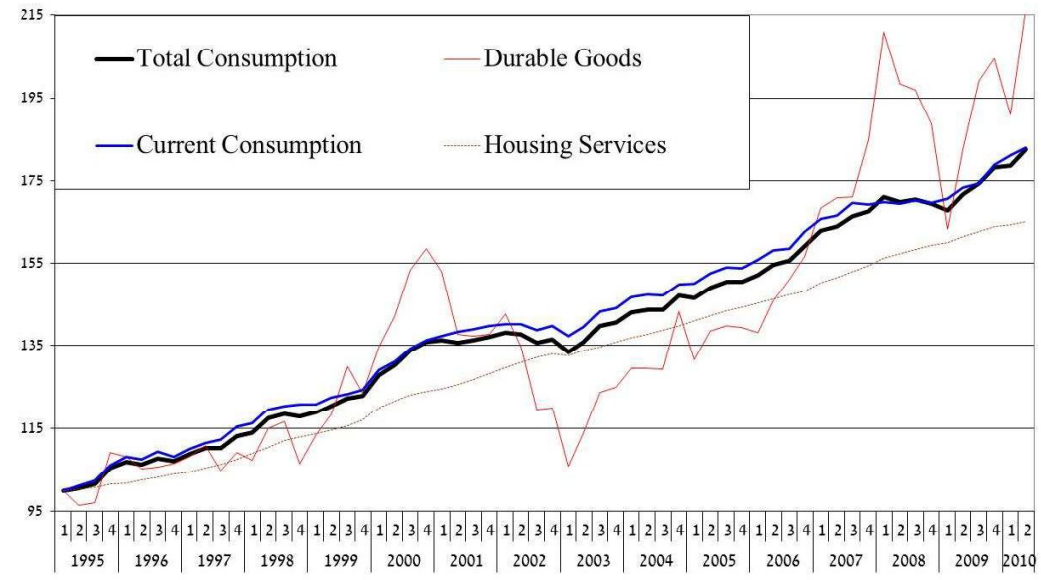
[15] An example of a simple criterion is: Select k from n variables leading to the lowest AIC value.

4.1 The model's components

The uses side

Private consumption is a principal component of domestic demand and of GDP as a whole. This component includes total goods and services consumed in the economy[16], which can be divided into a number of main items with different characteristics: the purchase of consumer durables, current consumption (goods and services except for housing and durables) and imputed housing services. The composition of the long-term consumption basket remains relatively fixed during the estimation period. In the short-term however, and especially at a time of change in direction in the business cycle, each of the components develops differently: The purchase of consumer durables is notable for high volatility matching the business cycle, current consumption is less volatile but also matches the business cycle, while the imputed housing services is not affected by the business cycle at all and is notable for very low volatility. (This is because it reflects the stock of housing rather than a flow of new housing services). Despite the differences in variability between the purchase of durables and current consumption, a correlation between them is apparent. This confers an advantage in the estimation in view of the prior information on durables imports available from foreign trade data (as presented below).

Figure 1: Private consumption and its components, I/1995 to II/2010 (Index: I/1995=100, quarterly data, seasonally adjusted and at fixed prices)



A wide range of indicators are available in real time, before National Accounts data is published, relevant to private consumption. Such data include imports of consumer goods, VAT, trade and services revenue indices, industrial production indices, sales at the marketing chains, the use of credit cards, the Consumer Confidence Index and the stock index. Some of these indicators are used by the CBS in the initial estimate of private consumption, but this estimate is subject to major revisions following the receipt of Household Expenses Survey data, which are published with a lag

[16] Except for government consumption and consumption by non-profit organizations. Private consumption includes consumption of tourism services abroad.

of over a year.[17] In practice, the explanatory ability of most indicators with respect to private consumption is low, and the main variable explaining it is durables imports, even though durables only account for 10 percent of total consumption. Additional variables contributing to explanatory ability are VAT receipts, the Consumer Confidence Index, the health and nursing services revenue index, raw material imports and the explained variable with a lag (which deals with serial correlation). Table 1 presents the private consumption estimation results. The numbers in the table are regression coefficients and below them, in parentheses, the standard errors.[18] Each of the columns in the table is a separate regression that includes only the variables for which coefficients appear.[19] Both coefficients and the confidence levels are relatively stable in different specifications, and total explanatory ability increases with the addition of variables. Accordingly, the best fit to the data is obtained in the full regression in column 8. It can also be seen that the optimum forecasting ability (minimum out-of-sample AMFE) [20] is achieved by the full regression in column 8.

Table 1: The determinants of private consumption
(quarterly percent change, seasonally adjusted and at fixed prices)

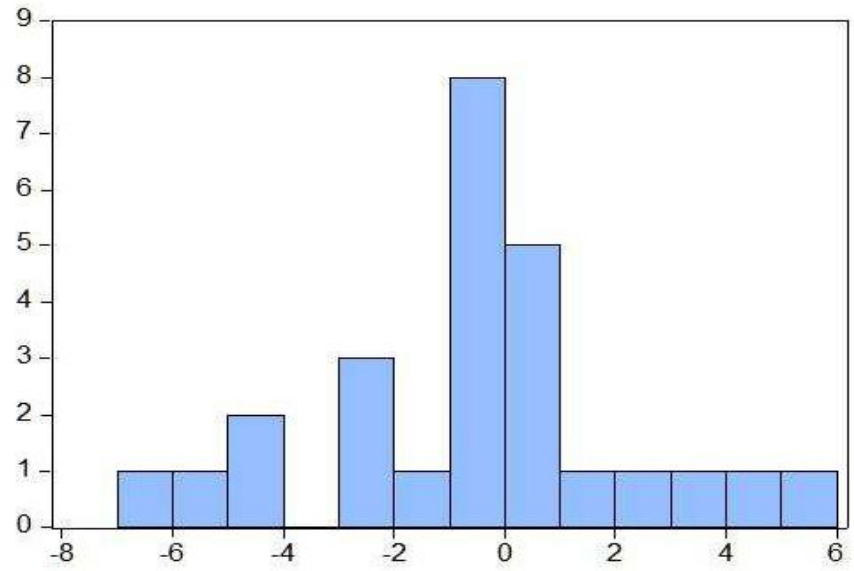
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
IMPORT OF DURABLES	0.12***	0.12***	0.11***	0.11***	0.1***	0.1***	0.1***	0.09***
	(0.015)	(0.015)	(0.015)	(0.014)	(0.014)	(0.014)	(0.014)	(0.013)
VAT	0.09***	-	0.05**	0.05***	0.03*	0.04**	0.04**	0.04**
	(0.025)	-	(0.019)	(0.018)	(0.017)	(0.017)	(0.017)	(0.016)
Consumer Confidence	0.12	-	-	0.21**	0.28***	0.24***	0.24***	0.28***
	(0.122)	-	-	(0.084)	(0.081)	(0.081)	(0.081)	(0.079)
Stock Market	0.05***	-	-	-	0.03***	0.03***	0.03**	0.03***
	(0.013)	-	-	-	(0.01)	(0.01)	(0.01)	(0.01)
Revenue (branch L)	0.04	-	-	-	-	0.11*	0.12*	0.14**
	(0.085)	-	-	-	-	(0.06)	(0.06)	(0.058)
IMPORT OF INPUTS	0.08***	-	-	-	-	-	0.02	0.03*
	(0.027)	-	-	-	-	-	(0.019)	(0.019)
D-V lag	-0.01	-	-	-	-	-	-	-0.20**
	(0.13)	-	-	-	-	-	-	(0.083)
Constant	-	0.009***	0.01***	-0.01	-0.05***	-0.04***	-0.04***	-0.05***
	-	(0.001)	(0.001)	(0.007)	(0.014)	(0.014)	(0.014)	(0.014)
Sample	-	1995Q2 -	1997Q3 -	1997Q3 -	1997Q3 -	1997Q3 -	1997Q3 -	1997Q3 -
	-	2010Q2	2010Q2	2010Q2	2010Q2	2010Q2	2010Q2	2010Q2
Obs.	-	62	53	53	53	53	53	53
D.W.	-	2.286	1.969	2.195	2.601	2.501	2.642	2.356
R^2 adj.	-	0.523	0.584	0.624	0.679	0.695	0.696	0.725
RMSE		0.835%	0.770%	0.725%	0.663%	0.639%	0.632%	0.594%
AMFE		1.154%	0.572%	0.636%	0.592%	0.583%	0.574%	0.521%

- The first column presents the coefficient of each variable in a separate regression.
- The numbers under the coefficients in parentheses are the standard errors.
- Asterisks represent significance levels: one asterisk—significant at a level of 10%; two asterisks—5%; three asterisks—1%.
- Out-of-sample error is calculated based on a one-period-ahead rolling regression for the period: I/2004-II/2010.

[17] This is in contrast to current investment, imports and exports indicators, which are key components in the calculation of the final figure.
[18] The level of significance is marked by asterisks: one asterisk—significant at a level of 10 percent; two asterisks—5%; three asterisks—1%.
[19] Except for the first column in which the coefficient of each variable in a single-variable regression appears. The order of adding the variables is determined according to their contribution to explanatory ability.
[20] Absolute Mean Forecast Error. Errors outside of the sample are calculated by means of a forecast one period ahead in a rolling regression for the period I/2004 to II/2010.

Figure 2 presents the distribution of the average out-of-sample error in the period from I/2004 to II/2010 for the full regression included in the model (column 8 in Table 1). The average error in absolute value amounts to 2.1 percent annualized, and the forecast is slightly downward-biased—an average error of -0.4 percentage points and a median error of -0.5 percentage points. The center of the distribution is not symmetrical either, 65 percent of it is in the range of -3 to 1 percent.

Figure 2: Distribution of errors in the out-of-sample estimation for the period I/2004 to II/2010 (size of error in percent, annualized)



- The horizontal axis is the size of the error in annual terms, and the vertical axis is the frequency.

Public consumption was not estimated in the model because no variables were found that give any indication of it in real time. The forecast for public consumption is determined by the trend line. The sensitivity of the GDP forecast to an error in the public consumption forecast is low, due to the low ratio of changes in public consumption in the overall change in GDP. Under a simulation of the entire model, an error in public consumption (one standard deviation) of 5.0 percentage points annualized leads to a 0.4 percentage point annualized error in the GDP estimation.

Gross domestic investment is comprised of a number of components with different characteristics, from the aspect of their development over time and from the aspect of the factors affecting them and indicators suitable for forecasting them: investment in machinery, equipment and transport vehicles; investment in intangible assets; investment in residential and non-residential construction; and inventory investment. Figure 3 presents the development of the investment components, and shows that the volatility of investment considerably exceeds that of private consumption. The diagram also reveals differences between the different investment items. Particularly notable are the decline in investment in construction throughout most of the sample period and the trendless volatility of inventory investment. Despite these differences, investment was broken down in the model into only two components—investment in fixed assets and inventory investment. This is because it was found that such a distinction leads to better results due to the lack of suitable indicators for forecasting investment in construction.

Figure 3: Gross domestic investment and its principal components, I/1995 to II/2010 (NIS billion, seasonally adjusted quarterly data, at fixed prices)

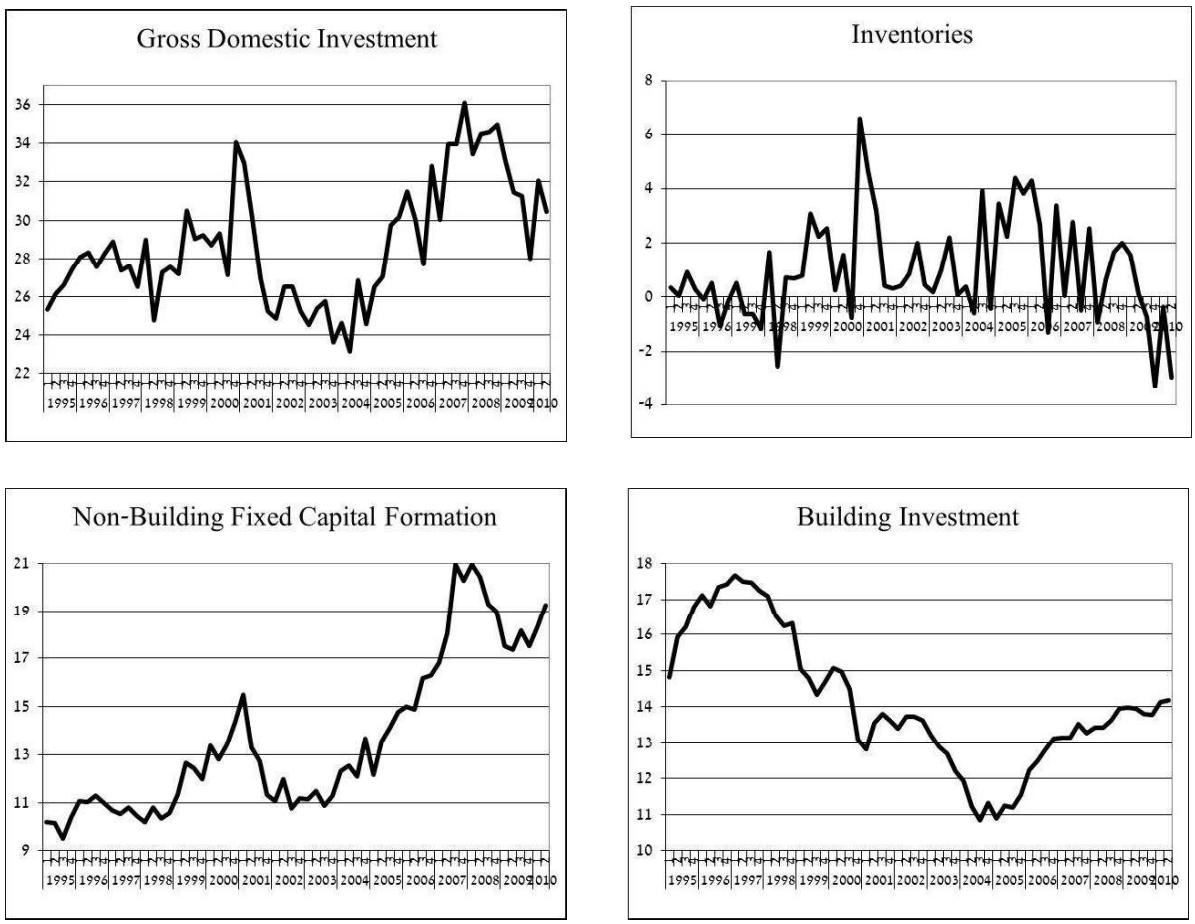


Table 2 presents the model's estimation of **fixed capital formation**. Unlike private consumption, very few real-time indicators for investment exist, and the final model contains the following variables: imports of capital goods, inventory investment with a lag of a quarter, the purchasing managers index, capital utilization with a lag of a quarter, and adjustment for serial correlation (lag dependent variable).

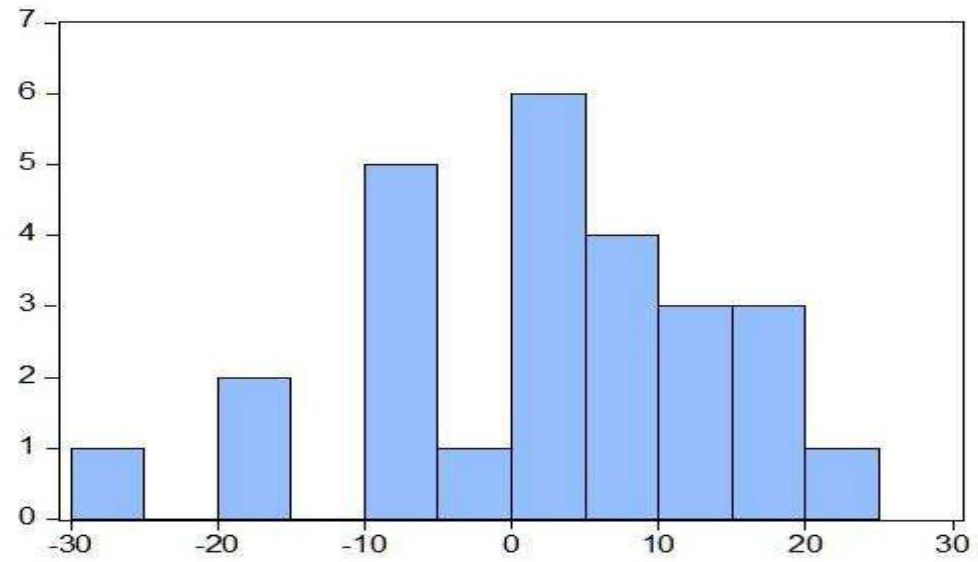
The model shows that the stability of the coefficients and the confidence levels are less than in the private consumption equation, and the same applies to explanatory and forecasting ability as well. Figure 4 presents the distribution of the average out-of-sample error in the period I/2004 to II/2010 for the full regression included in the model (column 6 in Table 2). The average error at absolute value amounts to 10.7 percent annualized, and the forecast is downward-biased: The average error amounts to 2.3 percentage points and the median error 3.9 percentage points. The center of the distribution is not symmetrical either, 73 percent of the distribution is within the range of -10 to 15 percent. The size of the errors is not surprising in view of the major volatility of fixed-asset investment: The average rate of change in absolute value is 11.7 percent (compared with an average rate of change of only 5.3 percent in private consumption). However, part of this result derives from the development of construction investment over time, which differs from that of other fixed-asset investment items, and from the lack of indicators of construction investment in real time.

Table 2: The determinants of fixed capital formation
(quarterly percent change, seasonally adjusted and at fixed prices)

	(1)	(2)	(3)	(4)	(5)	(6)
Import of Capital Goods	0.28***	0.28***	0.26***	0.21***	0.21***	0.18***
	(0.05)	(0.05)	(0.04)	(0.05)	(0.05)	(0.05)
Inventories (lag)	0.06***	-	0.05***	0.05***	0.04**	0.03*
	(0.02)	-	(0.02)	(0.02)	(0.02)	(0.02)
PMI	0.25***	-	-	0.12*	0.10	0.16**
	(0.07)	-	-	(0.06)	(0.07)	(0.06)
Utilization (lag)	0.08**	-	-	-	0.04	0.08***
	(0.03)	-	-	-	(0.03)	(0.02)
D-V lag	-0.23*	-	-	-	-	-0.39***
	(0.13)	-	-	-	-	(0.1)
Constant	-	0.00	-0.00	-0.07**	-0.05	-0.08**
	-	(0)	(0)	(0.03)	(0.03)	(0.03)
Sample	-	1995Q2 -	1995Q2 -	1996Q1 -	1996Q1 -	1996Q1 -
	-	2010Q2	2010Q2	2010Q2	2010Q2	2010Q2
Obs.	-	61	61	58	58	58
D.W.	-	2.45	2.41	2.59	2.74	2.21
R^2 adj.	-	0.38	0.44	0.45	0.46	0.58
RMSE		2.75%	2.60%	2.52%	2.48%	2.18%
AMFE		3.48%	3.36%	3.74%	2.63%	2.54%

- The first column presents the coefficient of each variable in a separate regression.
- The numbers under the coefficients in parentheses are the standard errors.
- Asterisks represent significance levels: one asterisk—significant at a level of 10%; two asterisks—5%; three asterisks—1%.
- Out-of-sample error is calculated based on a one-period-ahead rolling regression for the period: I/2004-II/2010.

Figure 4: Distribution of errors in the out-of-sample estimation for the period I/2004 to II/2010 (size of error in percent, annualized)



- The horizontal axis is the size of the error in annual terms, and the vertical axis is the frequency.

Inventory investment[21] is estimated separately because of its unique characteristics as a particularly volatile series, without an uptrend over time and which averages approximately one billion shekels per quarter. Inventory investment includes the change in the level of final goods and raw materials inventories (industrial and agricultural goods, diamonds and energy) and start-up companies' imputed inventory.[22] Since inventory investment can be negative, it is possible to estimate only the amount and not the rate of change in it. Table 3 presents the model's estimation of inventory investment. The variables that were included in the estimation of inventory are: two variables of a serial correlation—one is AR(2) and the other is the level of inventory in the previous quarter leading to convergence toward the average; inventory investment in start-ups[23]; and demand and supply variables. Supply is represented by the average of the trade and services revenue index and the industrial production index of the traditional technology industries, and demand is represented by exports of goods. The logic behind the use of these variables is that when a surprise occurs in the level of demand relative to actual production, inventory constitutes a buffer for bridging the gap. As an example, if an upward deviation in industrial production occurs, the level of inventories will increase, while an upward deviation in exports will lead to a reduction in inventories.

Table 3: The determinants of inventory investments
(quarterly change, seasonally adjusted and at fixed prices)

	(1)	(2)	(3)	(4)	(5)	(6)
Start Up Inventories	0.61***	0.61***	0.61***	0.46***	0.52***	0.52***
	(0.18)	(0.18)	(0.18)	(0.15)	(0.14)	(0.11)
Export of Goods	-701	-	-1454	-3786	-8243*	-9656***
	(5787)	-	(5325)	(4331)	(4664)	(3316)
Revenue+	-7387***	-	-	-6787***	-6828***	-6999***
Industrial Production	(1255)	-	-	(1200)	(1162)	(1091)
Inventories (lag)	14641	-	-	-	38024**	40313***
	(21266)	-	-	-	(17376)	(12577)
AR(2)	0.41***	-	-	-	-	0.58***
	(0.12)	-	-	-	-	(0.12)
Constant	-	-27	2	714**	640**	642
	-	(270)	(294)	(269)	(263)	(454)
Sample	-	1995Q2 -	1995Q2 -	1995Q2 -	1995Q2 -	1995Q4 -
	-	2010Q2	2010Q2	2010Q3	2010Q2	2010Q2
Obs.	-	62	62	62	62	60
D.W.	-	3.27	3.27	2.38	2.34	2.08
R^2 adj.	-	0.15	0.14	0.44	0.47	0.63
RMSE		2,095	2,094	1,681	1,614	1,361
AMFE		2,062	2,168	1,838	1,858	1,223

- The first column presents the coefficient of each variable in a separate regression.
- The numbers under the coefficients in parentheses are the standard errors.
- Asterisks represent significance levels: one asterisk—significant at a level of 10%; two asterisks—5%; three asterisks—1%.
- Out-of-sample error is calculated based on a one-period-ahead rolling regression for the period: I/2004-II/2010.

[21] Inventory investment is defined in the model as the difference between gross domestic investment and investment in fixed assets, both of them at seasonally adjusted fixed prices. This definition conforms to one of the CBS definitions, although the CBS does not publish inventory investment data at these prices.

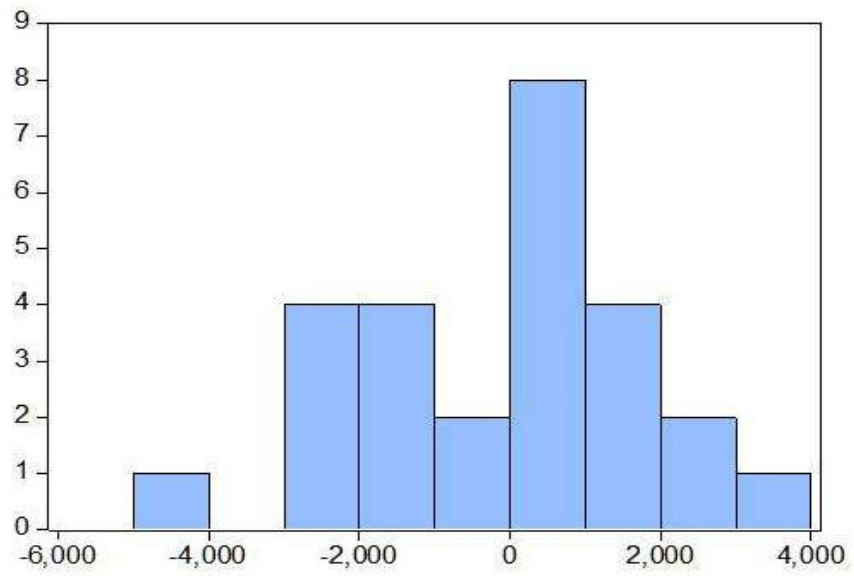
[22] Investment at start-ups is recorded in National Accounts as inventory investment, and the sale of start-ups is counted as exports and is deleted from inventory.

[23] Although this variable is not known in real time, its inclusion is intended to correct the historical deviation in the level of inventory that was created in 2000 as a result of the massive sale of start-ups. Since then, this variable has comprised a negligible part of inventory. It should be remembered that if a major error regarding this component occurs, it will have not have any effect on GDP due to the double-listing method.

The coefficients obtained in this estimation differ from those in the other estimations. While the coefficients in the other estimations can mostly be interpreted as elasticities, in this table the dependent variable is not in the rate of change, and can therefore be construed as semi-elasticity. (For example, an increase of one percentage point in exports is correlated with a NIS 96 million decrease in inventory investment).

The model shows that the explanatory ability of the model is reasonable, and that it leads to a considerable decrease in the size of the average error within both the sample and the forecast. However, some of the coefficients are not stable in the different estimations and the out-of-sample error remains large, amounting to NIS 1.5 billion or 0.75 percent of GDP. This error is twice the size of the error in the forecast that was estimated for fixed-asset investment, and a simulation of the entire model shows that a deviation of this kind in the inventory forecast leads to an annualized 0.9 percentage point error in the GDP forecast. In contrast to the previous estimations, no systematic error was found in the inventory forecast.

Figure 5: Distribution of errors in the out-of-sample estimation for the period I/2004 to II/2010 (size of error, annualized)



- The horizontal axis is the size of the error, and the vertical axis is the frequency.

Exports of goods and services is the second largest component after private consumption and, from certain aspects, is the most important component for assessing the state of the economy. The principal components of exports are industrial exports, service exports (mainly transportation services, insurance services and other business services), diamond exports and exports of tourism services). The export component underwent numerous changes in the sample period: Tourism exports fell from 13 percent of total exports in 1995 to only 3 percent in 2007. This was due to the large decrease in tourism exports at the beginning of the decade resulting from the security situation, as well as the large increase in other export components. Although diamond exports rose during the period, their proportion of total exports fell greatly. During the most recent recession, these exports suffered a severe blow and their volume decreased by over 50 percent. Notable characteristics of exports are a high correlation—in all export items—with the global business

cycle and relatively small fluctuations within the business cycle. Exports of goods and services thereby differ from private consumption, which is less sensitive to the business cycle, and from investment, which is both sensitive to the cycle and highly volatile.

Figure 6: Export and its principal components, I/1995 to II/2010
(NIS billion, seasonally adjusted quarterly data, at fixed prices)

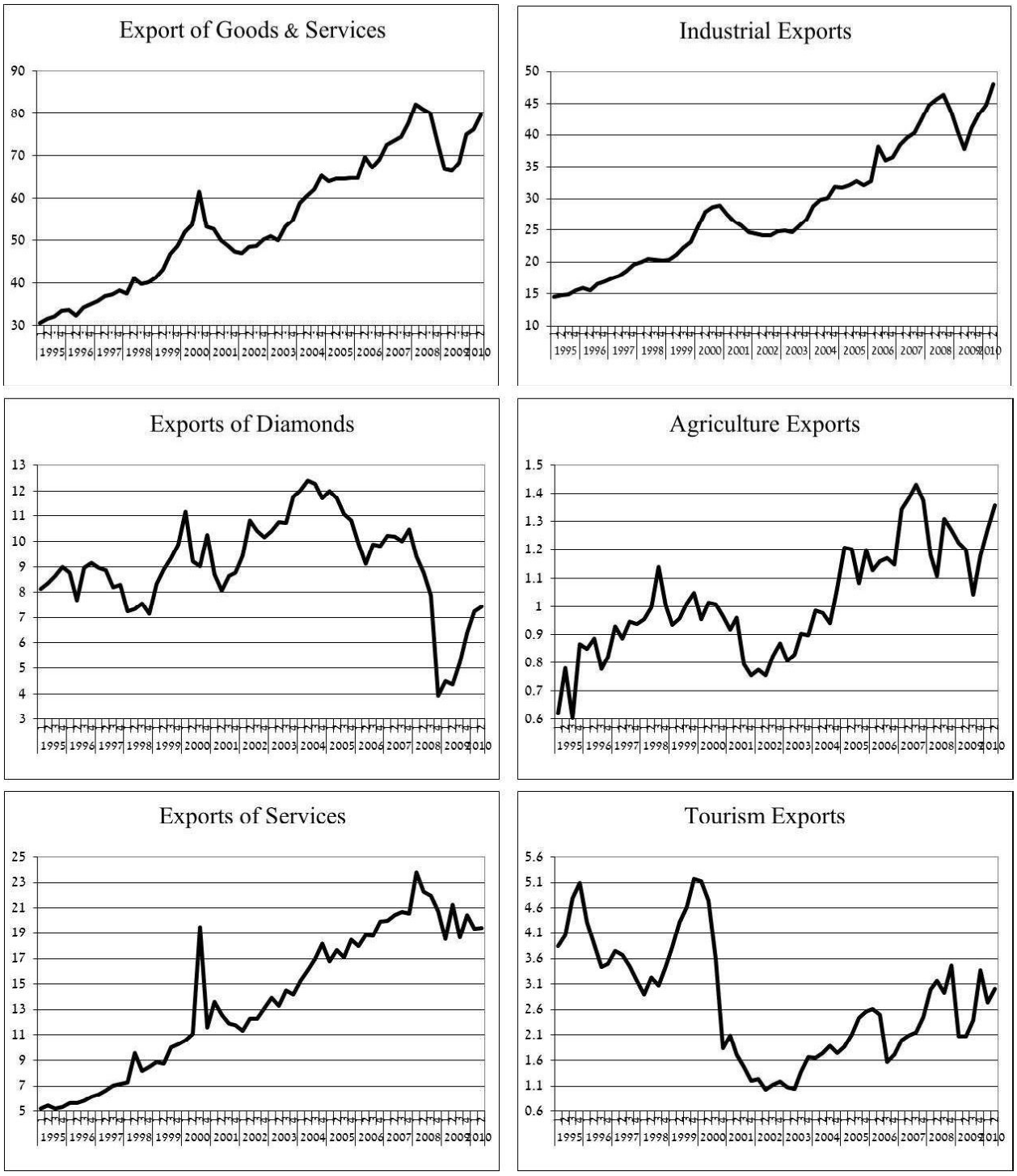


Table 4 presents the model's estimation of exports, which includes the following variables: exports of goods multiplied by the proportion of exports of goods to total exports; the US purchasing managers index; start-up companies' inventory[24]; and a first order serial correlation AR(1). As the table shows, the explanatory ability of the model is high despite the non-inclusion of data on service exports.[25] This is because of the high proportion of goods exports to total exports and the correlation between goods exports and service exports. The high correlation is obtained even though goods export data are dollar-denominated and at current prices, while overall export data are shekel-denominated at fixed prices. Conversion of foreign trade data to a fixed price or shekel basis actually impairs the results.

Table 4: The determinants of exports of goods and services
(quarterly percent change, seasonally adjusted and at fixed prices)

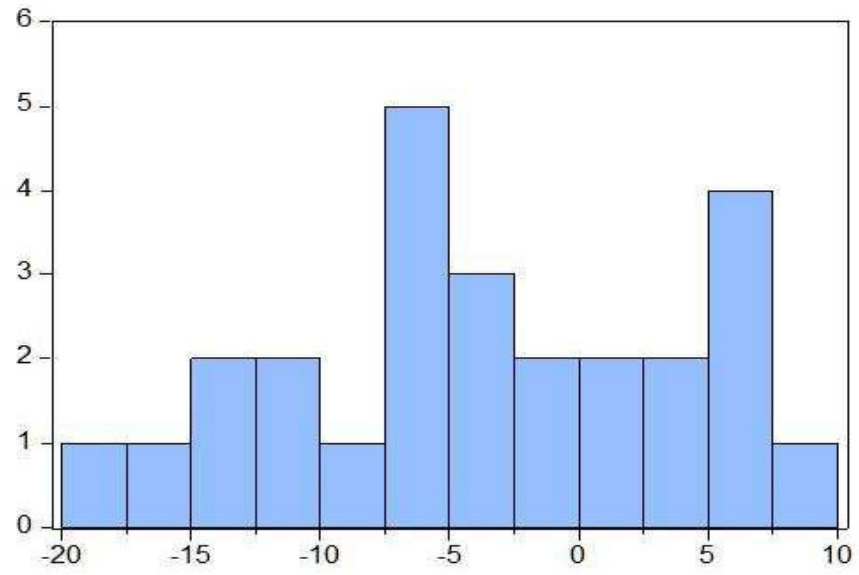
	(1)	(2)	(3)	(4)	(5)
Export of Goods	0.81***	0.81***	0.61***	0.66***	0.66***
(Multiplied by its' Weight)	(0.13)	(0.13)	(0.166)	(0.104)	(0.091)
PMI - USA	0.48***	-	0.21*	0.19**	0.2***
	(0.095)	-	(0.113)	(0.071)	(0.058)
Start Up Inventories	-0.02***	-	-	-0.02***	-0.02***
	(0.003)	-	-	(0.002)	(0.002)
AR(1)	0.05	-	-	-	-0.3**
	(0.13)	-	-	-	(0.132)
Constant	-	0.01	-0.10*	0.08**	0.07*
	-	(0.01)	(0.06)	(0.04)	(0.04)
Sample	-	1995Q2 -	1995Q2 -	1995Q2 -	1995Q3 -
	-	2010Q2	2010Q2	2010Q2	2010Q2
Obs.	-	62	62	62	61
D.W.	-	3.02	3.11	2.58	1.97
R^2 adj.	-	0.39	0.41	0.77	0.79
RMSE		3.49%	3.39%	2.11%	2.02%
AMFE		2.88%	3.04%	3.09%	1.81%

- The first column presents the coefficient of each variable in a separate regression.
- The numbers under the coefficients in parentheses are the standard errors.
- Asterisks represent significance levels: one asterisk—significant at a level of 10%; two asterisks—5%; three asterisks—1%.
- Out-of-sample error is calculated based on a one-period-ahead rolling regression for the period: I/2004-II/2010.

Figure 7 presents the out-of-sample average error distribution for the period I/2004 to II/2010 for the full regression included in the model (column 5, Table 4). The graph shows that despite the high explanatory ability of the model, its forecasting ability is relatively low. The average error in absolute value amounts to 7.5 percent annualized, and the forecast is downward biased: The average error amounts to -3.7 percentage points, and the median error -4.0 percentage points. Apart from that, and unlike the forecasting errors in the other equations whose distribution is close to normal, the distribution of the errors in the export equation is almost uniform.

[24] The inclusion of this variable is intended to correct the historical deviation in the level of inventory that was created in 2000 as a result of the massive sale of start-ups. (See Footnote 23).
[25] Although monthly indicators on service exports and tourist arrivals are available, and these considerably increase the model's explanatory ability, it was found that they also greatly increase the out-of-sample forecast error.

Figure 7: Distribution of errors in the out-of-sample estimation for the period I/2004 to II/2010 (size of error in percent, annualized)

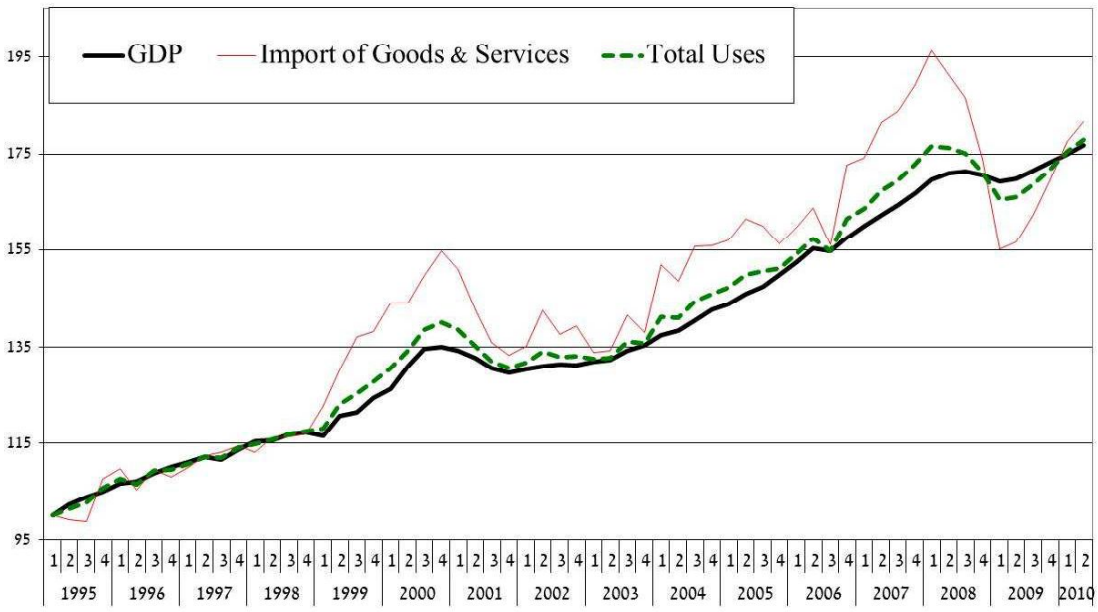


- The horizontal axis is the size of the error, and the vertical axis is the frequency.

The sources side

GDP and imports are the sources for the uses in the economy—consumption, investment and exports—thus an identity exists between them. After estimating each of the uses separately, it is therefore possible to summarize them and obtain an estimate for total uses, which equal total sources. However, an estimation of total sources does not facilitate a distinction between imports and GDP, because their relative share in total sources varies from quarter to quarter according to the type of uses that were created in every quarter. As an example, private consumption includes durables consumption, which is import-biased, and current consumption, which is domestic production-biased and the proportion of each of them in total consumption varies from quarter to quarter. Accordingly, in order to estimate imports and GDP, additional indicators apart from the estimate of total uses need to be used. Imports are estimated first in this model, and only thereafter is GDP estimated, for several reasons: Dollar data on both goods and service imports are available in real time, and are used by the CBS for compiling the National Accounts import figure; the total uses forecasting error is reflected in the import forecast as well and offsets it, resulting in a more stable GDP forecast (This phenomenon is particularly apparent in actual data. As Figure 8 shows, fluctuations in total uses are expressed by large fluctuations in imports and by moderate fluctuations in GDP.); and finally, this is also the official method employed by the CBS for deriving GDP from the sources-uses identity.

Figure 8: Total uses, imports and GDP, I/1995 to II/2010
(Index: I/1995=100, quarterly data, seasonally adjusted and at fixed prices)



Imports of goods and services constitute a source for the uses in the economy—for the supply of raw materials and energy for purposes of production and supply of final goods that are not produced in Israel. Table 5 presents the model's estimation of imports, which includes dollar goods and services imports and total actual uses variables (column 4) and the estimated uses variable (column 5). Each estimation includes a first order serial correlation correction. The table shows that the three variables are effective in explaining imports, and each of them contributes to explanatory ability. However, despite the contribution of the "total uses" variable to explanatory ability within the sample, this variable does not have an out-of-sample contribution, and even leads to a large increase in the average error of the forecast, both with the inclusion of actual uses and with the inclusion of the uses estimate.[26] This is because the information inherent in monthly data on imports is quite adequate. For this reason, the total uses figure was not included in the model.

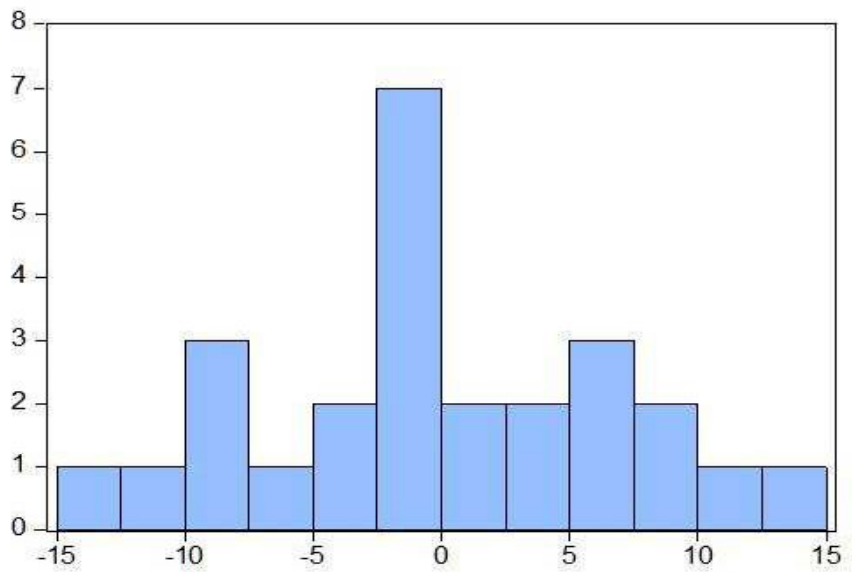
[26] In both cases, the forecast was calculated on the basis on the forecast figure for uses. The difference is in the size of the coefficient estimated for the effect of uses on imports.

Table 5: The determinants of imports of goods and services (quarterly percent change, seasonally adjusted and at fixed prices)

	(1)	(2)	(3)	(4) Actual uses	(5) Estimated uses
Import of Goods	0.72***	0.79***	0.77***	0.43***	0.61***
	(0.07)	(0.05)	(0.04)	(0.07)	(0.06)
Import of Services	0.16**	-	0.1***	0.05**	0.07**
	(0.06)	-	(0.03)	(0.02)	(0.03)
USES	2.10***	-	-	1.06***	0.58***
	(0.24)	-	-	(0.18)	(0.17)
AR(1)	0.07	-0.57***	-0.60***	-0.48***	-0.64***
	(0.13)	(0.11)	(0.11)	(0.12)	(0.11)
Constant	-	0.00	0.00	-0.01***	-0.00*
	-	(0.00)	(0.00)	(0.00)	(0.00)
Sample	-	1995Q3 -	1995Q3 -	1995Q3 -	1997Q4 -
	-	2010Q2	2010Q2	2010Q2	2010Q2
Obs.	-	61	61	61	52
D.W.	-	2.12	2.27	2.15	2.44
R^2 adj.	-	0.77	0.81	0.88	0.86
RMSE		1.83%	1.68%	1.33%	1.45%
AMFE		1.43%	1.29%	1.77%	1.83%

- The first column presents the coefficient of each variable in a separate regression.
- The numbers under the coefficients in parentheses are the standard errors.
- Asterisks represent significance levels: one asterisk—significant at a level of 10%; two asterisks—5%; three asterisks—1%.
- Out-of-sample error is calculated based on a one-period-ahead rolling regression for the period: I/2004-II/2010.

Figure 9: Distribution of errors in the out-of-sample estimation for the period I/2004 to II/2010 (size of error in percent, annualized)



- The horizontal axis is the size of the error, and the vertical axis is the frequency.

Figure 9 presents the distribution of the out-of-sample average error in the period I/2004 to II/2010 for the regression included in the model (column 3, Table 4). The size of the average error is 5.7 percent annualized, and the forecast is downward-biased to a very small and insignificant extent. The size of the error is relatively small compared with the other items estimated, especially in view of the fact that imports is the most volatile item, with an average rate of change of 13.1 percent.

Gross domestic product is calculated in the National Accounts system as the sum of all final uses minus imports. In order to estimate GDP in the model by a similar method, a synthetic variable was therefore built, comprised of the average forecast growth in each of the uses (and imports) weighted by their relative size in total uses. In the second stage, the relationship between this synthetic variable and GDP was estimated, including additional explanatory variables that contribute to explanatory and forecasting ability whose direct effect on GDP, rather than their indirect effect via uses, was a factor that warranted examination. Those variables are indirect tax receipts, income tax receipts and the Tel Aviv Stock Exchange's trade and services share index. These variables reflect the level of activity in the economy as a whole and not necessarily a specific sector such as consumption, investment or exports.[27] Table 6 presents the estimation results. These results show that although each of the explanatory variables plays a major role in forecasting ability, most of the contribution to forecast ability derives from the synthetic variable of GDP estimates, and the addition of the other variables enhances the quality of the forecast to a moderate extent.

Table 6: Estimating Gross Domestic Product
(quarterly percent change, seasonally adjusted and at fixed prices)

	(1)	(2)	(3)	(4)	(5)
Estimated GDP (Uses-Imports)	0.54***	0.54***	0.5***	0.46***	0.34***
	(.117)	(.117)	(.118)	(.113)	(.107)
Indirect Tax Revenue	0.07**	-	0.05*	0.06**	0.06**
	(.031)	-	(.028)	(.027)	(.024)
Income Tax Revenue	0.03**	-	-	0.03**	0.03**
	(.016)	-	-	(.014)	(.012)
Stock Market Index	0.02***	-	-	-	0.01***
	(.004)	-	-	-	(.004)
Constant	-	0.005***	0.005***	0.005***	-0.011**
	-	(.002)	(.002)	(.001)	(.004)
Sample	-	1997Q3 -	1997Q3 -	1997Q3 -	1997Q3 -
	-	2010Q2	2010Q2	2010Q2	2010Q2
Obs.	-	53	53	53	53
D.W.	-	1.59	1.55	1.72	2.07
R^2 adj.	-	0.28	0.30	0.37	0.49
RMSE		0.85%	0.83%	0.79%	0.69%
AMFE		0.44%	0.43%	0.43%	0.40%

- The first column presents the coefficient of each variable in a separate regression.
- The numbers under the coefficients in parentheses are the standard errors.
- Asterisks represent significance levels: one asterisk—significant at a level of 10%; two asterisks—5%; three asterisks—1%.
- Out-of-sample error is calculated based on a one-period-ahead rolling regression for the period: I/2004-II/2010.

[27] The General Share Index enters into consumption and investment as well but for other, theoretical reasons: With private consumption, the share index expresses the wealth effect, and with investment it expresses expectations regarding the future state of the economy and investment feasibility.

Figure 10 presents actual GDP versus the GDP estimated within the model and out-of-sample forecast GDP for the period I/2004 to II/2010. This period includes a long period of stable growth, as well as the period of the recent recession and the exit from it. The graph shows that the model discerns the growth environment and changes in the business cycle during the period reviewed, but not always to the right extent. For example, the model functions well in forecasting the recent recession, which began in the second half of 2008, from the aspect of timing and from the aspect of the extent of the change in trend relative to the preceding years. However, the rate of activity downturn forecast at the height of the recession was considerably larger than the actual decline in GDP. It should be noted that the moderate drop in GDP during the recession was indeed surprising and is difficult to explain even retroactively, especially in view of the large decrease in all uses (and imports in particular).

Figure 10: Actual GDP, estimated GDP and out-of-sample forecast, II/2004 to II/2010 (annualized seasonally adjusted real percentage change)

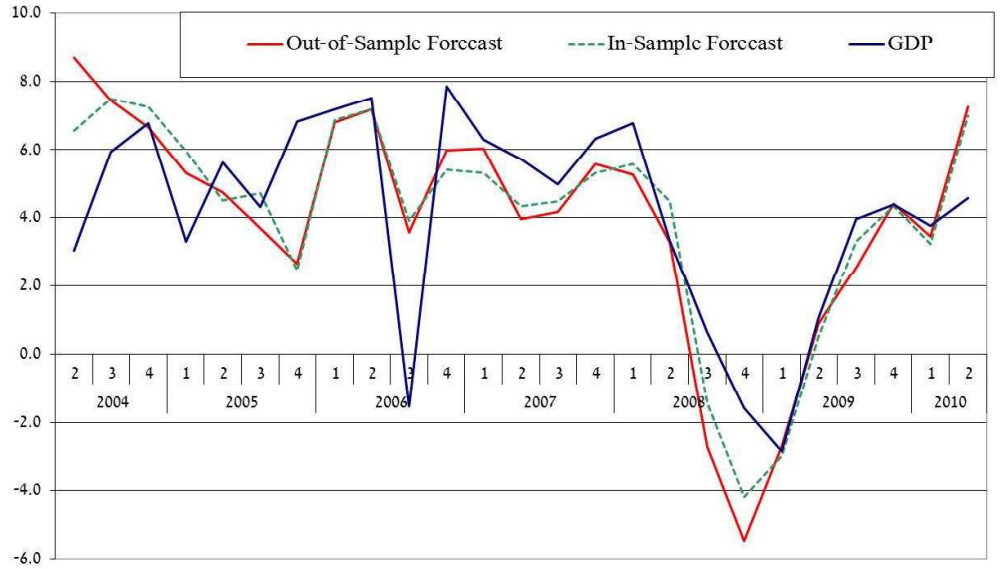
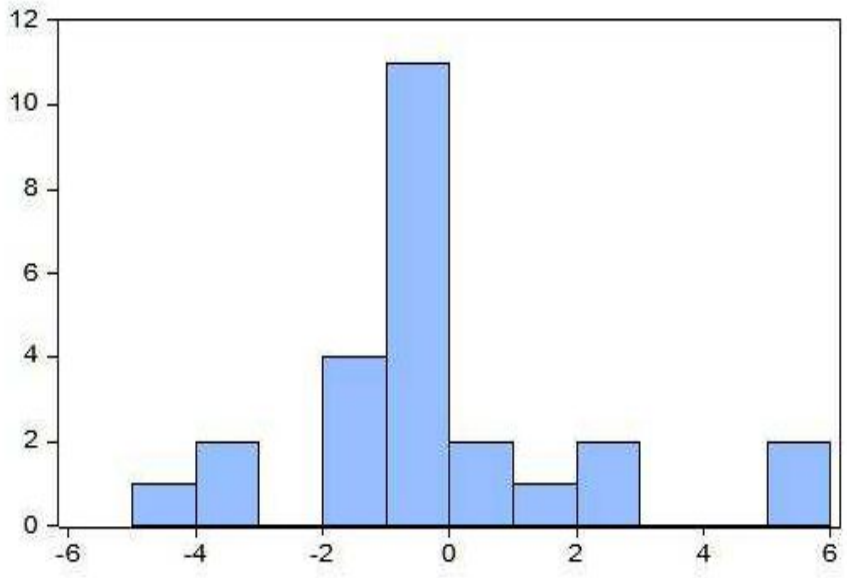


Figure 11 presents the distribution of the out-of-sample average error for the period I/2004 to II/2010. The average error in absolute value amounts to 1.6 percent annualized, and 72 percent of the distribution is within the range of -2 to 2 percent. In addition, the forecast is downward-biased to a minor and insignificant extent: The average error amounts to -0.2 percentage points, and the median error -0.3 percentage points.

Figure 11: Distribution of errors in the out-of-sample estimation for the period I/2004 to II/2010 (size of error in percent, annualized)



- The horizontal axis is the size of the error, and the vertical axis is the frequency.

4.2 Quality of the nowcasting

The principal statistics for assessing the quality of the model and the forecast are explanatory ability and the average error within and outside the sample. Although these statistics provide extensive information on the quality of the model, they do not show the entire picture because they are calculated retroactively. The quality of nowcasting is dependent on a number of additional factors—the effect of revisions in the explanatory variables, the amount of data available (full quarter compared with only two months) and the effect of discretion. This section presents indications of these factors and actual nowcasting ability.

Revisions in the explanatory variables

Initial CBS monthly data undergo major changes and revisions until the final figure is obtained. This results from the receipt of additional and more accurate information, from the crossing of data from different sources and in particular, from changes in trend, which are only discovered retroactively and affect *inter alia* the seasonal adjustments made by the CBS. While the model's estimates are based on final CBS data, the nowcasting is based on initial data that are expected to undergo revisions. In order to assess the error potential deriving from the use of initial data, Table 7 presents the errors in each of the variables in the model that are exposed to revisions for the period I/2004 to II/2010.[28] This period is notable for sharp changes in the business cycle, and therefore also for larger revisions than in periods of stability.

[28] The size of the revision in percentage points from the initial publication to the latest publication available at the time when the study was compiled. The data are presented in quarterly terms because of the high volatility of the indicators.

Table 7: Revisions size in monthly data – from the first to the last publication (quarterly percentage points)

	Durable Imports	Input Imports	Revenue (branch L)	Import of Capital Goods	Export of Goods[1]	Wieghted Average[2]	Import of Goods[1]
	Consumption Equation			Investment Equation	Export Equation	Total Uses	Import Equation
II/2008	5.4	-0.3	0.8	1.6	1.7	2.8	1.5
III/2008	2.2	-2.6	2.5	-1.3	-3.8	-1.0	-2.5
IV/2008	3.9	0.6	0.3	-5.8	-0.2	0.2	-1.6
I/2009	2.4	2.0	0.3	-0.3	0.6	1.1	0.3
II/2009	-0.6	1.3	2.0	3.7	0.9	0.9	1.6
III/2009	-2.1	-2.1	0.6	-4.4	1.4	-1.2	-2.4
IV/2009	8.5	2.3	0.8	0.3	2.9	4.2	0.8
I/2010	0.8	-0.7	0.1	-0.2	0.4	0.3	-0.3
II/2010	-0.7	0.1	0.3	0.0	3.8	1.1	-0.2
Average revision	2.2	0.1	0.9	-0.7	0.9	0.9	-0.3
Average Absolute revision	3.0	1.3	0.9	2.0	1.7	1.4	1.2
Average Absolute Growth rate	6.4	6.4	1.1	5.5	6.6	5.9	8.6
Correlation With revision in Imports	0.35	0.71	-0.08	0.82	0.54	0.79	1.00

1. Excl. ships, aircraft and diamonds.
2. Weighted average of the revisions in all indicators in the table.

The table shows that revisions were indeed made in the variables, averaging 1.4 percentage points—approximately 20 percent of the average size of the change in these indicators. However, the revisions were smaller then in industrial production and revenue data (variables that are used for compiling the Composite Index), and very high correlation (0.8) was found between the revisions used for estimating uses and the revisions in imports. Therefore, the model's mechanism for offset between imports and uses also leads to some offset of the errors deriving from the revisions.

Table 8: Average out-of-sample error (MAFE) – partial vs. full data (quarterly percentage points)

	Private Consumption	Fixed Capital Formation	Inventories[1]	Exports	Imports	GDP
Full Data	0.50%	2.32%	1,309	1.68%	1.29%	0.40%
Partial Data	0.58%	2.44%	1,309	1.87%	2.27%	0.45%

1. NIS millions.

Data available

The purpose of the model is to produce a forecast for GDP and uses in real time, as close as possible to the quarter forecast. Full data on the quarter are obtained two weeks after the end of the quarter, and at that time the model provides a forecast a month before official CBS data (one monetary decision earlier). Use of only partial data makes it possible to bring forward the forecast by another month (two monetary decisions earlier), at the expense of the model's level of accuracy, which declines because most of the variables are based on a two-month period only. In order to use the model when data on only two months are available, the same regressions that were presented previously are used, on the basis of historical data that do not include the third month in each quarter. This is done in order to obtain coefficients suited to the information available at the time when the forecast is compiled. Table 8 presents a comparison between the size of the out-of-sample average error in each of the model's equations in a situation of full data availability (two weeks after the end of the quarter), and a situation of partial data availability (two weeks before the end of the quarter). The table shows that the use of partial data does indeed increase the average error, but only to a moderate extent, with the result that the quality of the forecast in this situation is adequate.

Experience gained with the model

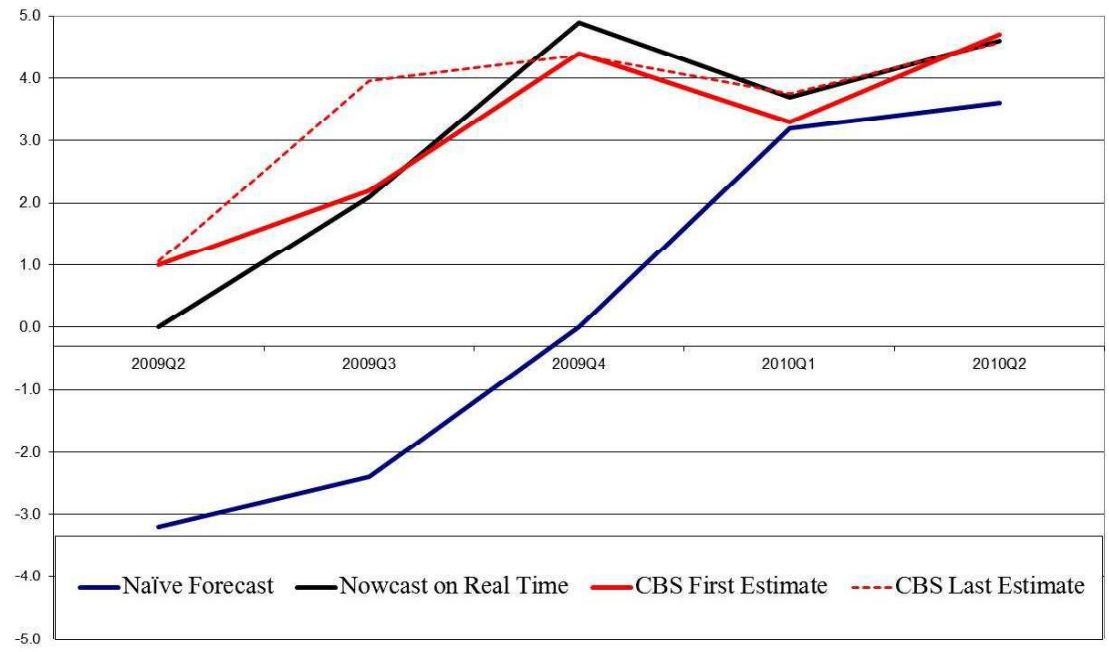
Apart from the previously mentioned error factors, another factor outside the bounds of the model enters in real time, and this is the judgmental factor: A judgmental element enters into every model, in real time, even in a statistical model such as this—especially when the results obtained do not conform to the existing situation assessment or to out-of-model indicators. The judgmental element—discretion—can be expressed in numerous ways, mostly in the form of sensitivity tests on the model's results by removing a specific variable that is suspected of biasing the forecast. Since the effect of this factor is unclear, the use of discretion can lead to either an improvement or a deterioration in the quality of the forecast. In order to obtain a better indication of the quality of the nowcasting, experience gained in the model's usage over the past year is used. This is a very short period (only five observations) in which major changes occurred in the business cycle, thus the conclusions should be taken with a grain of salt.

Figure 8 presents the GDP growth forecasts published by the monetary committee during the past year, as compared to actual data at two points in time: at the time of the first publication and at the time of the last publication. Also presented in the graph is a naïve forecast based on a growth assessment before publication of the nowcasting.[29] The graph shows that the nowcasting provided a very good indication of the official CBS data (an average error of 0.17 percentage points), and particularly of the first CBS estimate (an average error of 0.1 percentage points). The forecast is considerably better than the naïve forecast (an average error of 0.8 percentage points), and even slightly better than the forecast obtained retroactively (an average error of 0.22 percentage points). This is despite the effect of revisions, which are supposed to reduce the quality of the nowcasting. These results support the assessment that the employment of judgmental discretion with respect to the model's results leads to a better forecast than the raw results. The inaccuracy of the forecasting of the final figure for the third quarter of 2009 should be noted: The CBS updated this figure substantially, from 2.2 percent in the first publication to 4.0 percent in the last publication, due to a

[29] The data for 2009 are based on the quarterly pattern that was published at the beginning of 2009, and the data for 2010 are based on the quarterly pattern that was published at the beginning of 2010.

large downward-adjustment in imports. The model predicted the first figure adeptly, but not the final figure.

Figure 12: GDP growth rate nowcast compared with actual growth data, II/2009 to II/2010 (annualized seasonally adjusted real percentage change)



5. Summary

This study presents a method for assessing the economic situation in real time, before the receipt of official CBS data, involving the use of monthly indicators for estimating principal source-uses items and deriving GDP from them. Using the model makes it possible to obtain an initial estimate of economic activity one or two months before the official CBS publication, depending on the level of accuracy required. The principal indicators contributing to the forecasting ability are foreign trade data. Other contributors are activity and expectations indices (the Consumer Confidence Index, stock indices and the Purchasing Managers Index), and data on tax receipts. The advantage of most of these indicators is the relatively low level of revision in them, especially at turning points. It was found that the model functions well in forecasting GDP, private consumption and imports, while the quality of investment forecasting is low. The high GDP forecasting ability results from the structure of the model, which offsets errors in uses by the errors in import. It was also found that the model functions well in forecasting turning points in GDP growth, and that the quantitative estimate is exposed to average error at an absolute value of 1.6 percentage points in annual terms. Experience gained in using the model to date shows that the quality of the nowcasting is no less than that of retroactive forecasting, despite the revisions that are made in monthly indicators. This result appears to derive from the high correlation between the revisions in the uses data and the revisions in the import data.

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Appendix A—Definitions of the variables

Equation	Name of the variable	Source	Units	Characteristics	Notes
Private consumption	**dependent variable:** Private consumption	CBS—National Accounts	NIS at fixed prices, seasonally adjusted	Rate of change (DLOG)	
	The explanatory variables:				
	Durables imports	CBS—Foreign trade	Dollars at fixed prices, seasonally adjusted	Rate of change (DLOG)	
	VAT receipts	Finance Ministry	NIS at fixed prices, seasonally adjusted	Rate of change (DLOG), with a lag of two months	VAT on net domestic production, exclusive of legislative changes
	Consumer Confidence Index	Globes-Smith	Index	Level of the index with a lag of 3 quarters	
	General Stock Index	Tel Aviv Stock Exchange	NIS, adjusted for the CPI	Ratio between the present quarter and the average for the last four quarters	
	Revenue of industry L (health and nursing services revenue)	CBS—productivity indices	Index at fixed prices, seasonally adjusted	Rate of change of first months of the quarter relative to the average for the previous quarter	A lag of a month because the data arrive with a considerable lag
	Raw materials imports	CBS—foreign trade	Dollars at fixed prices, seasonally adjusted	Rate of change (DLOG)	
	The explained variable	CBS—National Accounts	NIS at fixed prices, seasonally adjusted	Rate of change (DLOG), with a lag of a quarter	
Investment in fixed assets	**The explained variable:** Investment in fixed assets	CBS—National Accounts	NIS at fixed prices, seasonally adjusted	Rate of change (DLOG)	
	The explanatory variables:				
	Imports of investment goods	CBS—Foreign trade	Dollars at current prices, seasonally adjusted	Change (D)	
	Inventory investment with a lag	CBS—National Accounts	NIS at fixed prices, seasonally adjusted	Level	The difference between gross domestic investment and investment in fixed assets
	Purchasing Managers Index	Bank Hapoalim	Index	Level of the index	
	Rate of capital utilization	Bank of Israel—Companies Survey	Net balance	Moving average of four quarters with a lag of a quarter	Net balance of capital utilization in manufacturing
	The explained variable with a lag	CBS—National Accounts	NIS at fixed prices, seasonally adjusted	Rate of change (DLOG), with a lag of a quarter	
Inventory investment	**The explained variable:** Inventory investment	CBS—National Accounts	NIS at fixed prices, seasonally adjusted	Change (D)	The difference between gross domestic investment and investment in fixed assets
	The explanatory variables:				
	Inventory at start-up companies	CBS—National Accounts	NIS at fixed prices, seasonally adjusted	Change (D)	
	Exports of goods	CBS—Foreign trade	Dollars at current prices, seasonally adjusted	Rate of change	Net balance
	Level of inventory with a lag	CBS—National Accounts	NIS at fixed prices, seasonally adjusted	Level	
	Average productivity index and index of the traditional industries' production	CBS—revenue and productivity indices	Index	Rate of change of first months of the quarter relative to the average for the previous quarter	
	Second order serial correlation				AR(2)

Appendix A—Definitions of the variables (contd.)

Equation	Name of the variable	Source	Units	Characteristics	Notes
Exports	**The explained variable:** Exports of goods and services	CBS—National Accounts	NIS at fixed prices, seasonally adjusted	Rate of change (DLOG)	
	The explanatory variables:				
	Exports of goods	CBS—Foreign trade	Dollars at current prices, seasonally adjusted	Rate of change (DLOG)	Multiplied by the proportion of goods in total exports
	The US Purchasing Managers Index	ISM	Index	Level	
	Start-up companies' inventory	CBS—National Accounts	NIS at fixed prices, seasonally adjusted	Change (D)	
	First order serial correlation				AR(1)
Imports	**The explained variable:** Imports of goods and services	CBS—National Accounts	NIS at fixed prices, seasonally adjusted	Rate of change (DLOG)	
	The explanatory variables:				
	Imports of goods	CBS—Foreign trade	Dollars at fixed prices, seasonally adjusted	Rate of change (DLOG)	
	Service imports	CBS—National Accounts	Dollars at current prices, seasonally adjusted	Rate of change (DLOG)	
	First order serial correlation				(AR(1)
Gross domestic product	**The explained variable:** Gross domestic product	CBS—National Accounts	NIS at fixed prices, seasonally adjusted	Rate of change (DLOG)	
	The explanatory variables:				
	Estimated product		NIS at fixed prices, seasonally adjusted	Rate of change (DLOG)	Weighted average of estimates of the rate of change in uses and imports
	Indirect tax receipts	Finance Ministry	NIS at fixed prices, seasonally adjusted	Rate of change (DLOG)	Adjusted for legislative changes
	Direct tax receipts	Finance Ministry	NIS at fixed prices, seasonally adjusted	Rate of change (DLOG)	Adjusted for legislative changes
	Tel Aviv Stock Exchange's Trade and Services Index	Tel Aviv Stock Exchange	NIS, adjusted for the CPI	The ratio between the present quarter and the average for the last four quarters with a lag of two quarters	