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INDUSTRY EFFECTS OF MONETARY POLICY IN ISRAEL – A VAR ANALYSIS

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Abstract

This study uses cross-sectional data for the years 1997–2006 to examine the effects of monetary policy on different manufacturing industries. The effects of interest-rate shocks and exchange-rate shocks on the amount produced and the price (to the consumer) in each of 16 industries was studied by means of a system of VAR equations that incorporated five endogenous variables—the Bank of Israel interest rate, the shekel/dollar exchange rate, labor costs per hour, price, and quantity produced. It was found that a rise in the interest rate was generally reflected in a reduction in the amount produced, in conjunction with a fall in price that expressed the effect of demand. An exchange-rate shock was reflected by a price rise in nearly all industries, usually with a cumulative decline in the amount produced. The second part of the study examines the connection between the characteristics of the different industries and their responses to interest-rate and exchange-rate shocks. It was found that the effect on demand of an interest-rate shock was greater in industries that produce consumer durables. It was also found that a price rise in response to an interest-rate increase was smaller in high-tech industries and industries in which production is concentrated in a few companies. In the concentrated industries, a temporary increase in the exchange rate is reflected to a larger extent in a rise in prices.

1. INTRODUCTION

The effect of monetary policy on the Israeli economy has been examined in numerous articles and by various methods. This article examines the effect of policy on prices and activity in the industrial sector. Industry is a major sector in the Israeli economy, and accounts for about one fifth of the business-sector gross product (in 2006). Therefore, even though this is only a partial representation of the overall activity of the business sector, it is important to examine the effect of policy on this sector, and the characteristic responses of different industries to (unexpected) changes in policy. An analysis of this kind could improve our understanding of the behavior of the industrial sector, and contribute to the understanding the transmission mechanisms of monetary policy in the economy as a whole.

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Using industrial data for various sub-sectors (16 two-digits industries), the article examines the connections between the local interest rate, which serves as the policy tool, the exchange rate, labor costs in the industry, prices and industrial production.[1] VAR (Vector Autoregression) analysis does not assume a specific theoretical structure, and permits the empirical results to characterize the economic connections between the variables being examined. With an analysis of this kind, we can examine the transmission mechanisms of monetary policy, and specifically—the extent to which policy affects the activity of the industries, as opposed to its effect on prices. For example: Are different industries, exposed as they are to different degrees to overseas markets, both in their real activity and in their financial connections, affected to different extents by the local interest rate as a result of differences in their ability to raise financing for their activities outside the domestic capital markets, and by differences in the currency composition of their income and their expenditure? By examining the changes in quantity and price in response to shocks in monetary policy, we can identify demand and supply effects: a decrease in quantity and in price supports the existence of a dominant effect of a contractionary policy on the demand for the product, while a reduction in the quantity together with a rise in price supports the existence of effects on the supply side of the firm as well.

In addition to analyzing the effect of a change in monetary policy, we also examine the response of the activity of the various industries—in quantity and in price—to an unexpected shock in the exchange rate.

The study is divided into six sections: Following the introduction, Section 2 presents a short review of the literature; Section 3 presents the major characteristics of the industries during the period researched; Section 4 presents the data, the estimation, and the results of the impulse response function; and Section 5 examines the major characteristics explaining the response of the industries to interest-rate shocks and exchange-rate shocks; Section 6 briefly summarizes the study.

2. REVIEW OF THE LITERATURE

Several recently published articles discuss the differential effect of monetary policy on sectors of the economy and on the various industrial sectors in European and OECD economies. These articles generally consist of two major sections. The first is that of estimating a Vector Autoregression (VAR) system for a group of variables, comprising policy variables, macroeconomic variables and the variable being studied—the economic sector or the industry. Then, after describing the impulse response function of the industry to the policy, an attempt is made, in the second part of the article, to analyze the difference between the responses of the industries according to their characteristics.

The article by Ganley and Salmon (1997) of the Bank of England examines the effects of monetary shocks on sectors of the economy and on industrial sectors using VAR with four variables—nominal interest, real GDP, product prices, and industrial production by

[1] The series of data are defined as the gross product of industry, but they are based to a large extent on data of the sector's output.

sector. The order of the variables assumes that monetary policy does not react immediately to the other variables, while production can (but does not have to) react immediately to policy. The responses in the different sectors are differentiated by their scope and their timing. Generally it was found that the maximal response during the period took place after about 11 quarters, i.e., almost three years. The authors point to the wide response variance between industries, but do not find an unequivocal characteristic causing the effect. They indicate that among the industries that react more are those with smaller firms—which could attest to financing constraints that smaller firms experience. A later article by Dedola and Lippi (2005) examines the transmission mechanisms from monetary policy to industry in five OECD countries (France, Germany, Italy, Great Britain and the United States). They examine 21 industries in each of the countries using VAR estimation for the monthly data of industrial production, the consumer price index, the industrial production index, the interest rate and the quantity of money. For European countries they add the exchange rate. They found significant differences in response between the various industries, as opposed to relatively little variance in response between countries. They succeed in showing that the particular industry's response is dependent on whether it produces durable goods or products for current consumption, on its financing needs and its ability to obtain credit, and the average size of firms in the industry, and indicate that these connections support the role of financial rigidities in the transmission mechanism of monetary policy. Peersman and Smets (2005) adopt a slightly different estimation method for examining the effect of monetary policy on industry in the euro area. They found significant heterogeneity between industries, and also a difference in response between recession and boom periods in economic activity. They estimate a restricted equation for change in production in the industrial sector, an equation dependent on the state of the economy—recession or boom—and monetary policy, and in this equation as well a different state of the economy may produce a different effect. Furthermore, they include a delayed effect on the activity in the sector. They also found that the type of product—durables or consumables—has an effect on the intensity of the industry's response to policy due to the fact that interest-rate changes are likely to have a greater effect on the demand for durables. Similar to the conclusions reached by Dedola and Lippi (2005), they did not find that the extent of openness of the industry (imports and exports relative to production) has a significant effect, nor the extent of investment in the industry. Only in periods of recession do they find the openness of the industry to be significant. They also did not find in their research any effect of indicators from the balance sheet of the firms, indicators that could support the existence of the credit channel in the transmission mechanism. Here too it was found that in periods of recession, the effect of policy is greater if a firm has a weaker balance sheet. The average size of the firms in the sector was not found to have an overall effect, except in periods of recession. Hayo and Uhlenbrock (1999) examined the effect of policy on production and prices in industries in Germany and found considerable variance in the responses of different industries in terms of price and quantity. They found that capital intensity, the rate of exports and the receipt of subsidies could partially explain the response difference between the industries. Barth and Ramey (2000) adopt a similar approach of using VAR to examine the effect of monetary policy on industries in the United States. Their major finding is that monetary policy has significant effect on the supply side. In 10 major industries of the 20

they examined, it was found that the quantity produced decreased, while the price (relative to salaries) increased in response to a positive, unexpected interest-rate shock. The reaction was more intense in an earlier period (1959-1979), and in industries in which the debt-servicing burden was greater. Evidence was found in some of the industries that the effect in the demand channel was stronger than the supply effects. Arnold, Kool and Raabe (2005) examined the transmission mechanism of monetary policy for annual data on the income of the industrial sector in 50 states of the United States. After obtaining, using an impulse response function, the extent of the effect of an unexpected shock in policy on incomes in the state, they explain the variance between the states by the composition variance of their industry by size and capital intensity. They found that the effect of the size of the firm is relatively overshadowed by the direct effect of the sectoral composition in the state, while the effect of capital intensity remains intact even when controlling for sectoral affiliation. They do not include data on industrial prices in their analysis, and thus cannot draw any conclusions about the effect of policy on either the supply or the demand side.

I have not come across research on this subject in the context of the Israeli economy. Several studies deal with industries at the micro level,[2] but I have not encountered any study that links monetary policy to different economic sectors or industries in Israel. Several studies examine related issues. Ber, Blass and Yosha (2001) examine, using data on individual firms, the transmission mechanism of monetary policy, and consider the differences between exporting and non-exporting firms. They found that monetary policy affects the firm's investment, and that exporting firms are less affected by domestic policy. Blass and Yosha (2000) examine, in the context of the reforms in the Israeli financial system, the characteristics of the activities of stock-exchange companies, and particularly their volume of investment in assets, according to their financing sources. Ber and Ribon (2005) examined the connection between the cost of financing of stock-exchange firms, and various variables that characterize the firm and the macroeconomic environment. They found that the rate of interest the firm pays relative to the Bank of Israel interest rate decreased over the years as a result of the opening up of the economy, and that the extent of the improvement was dependent on the characteristics of the firm.

3. CHARACTERISTICS OF THE INDUSTRIAL SECTOR

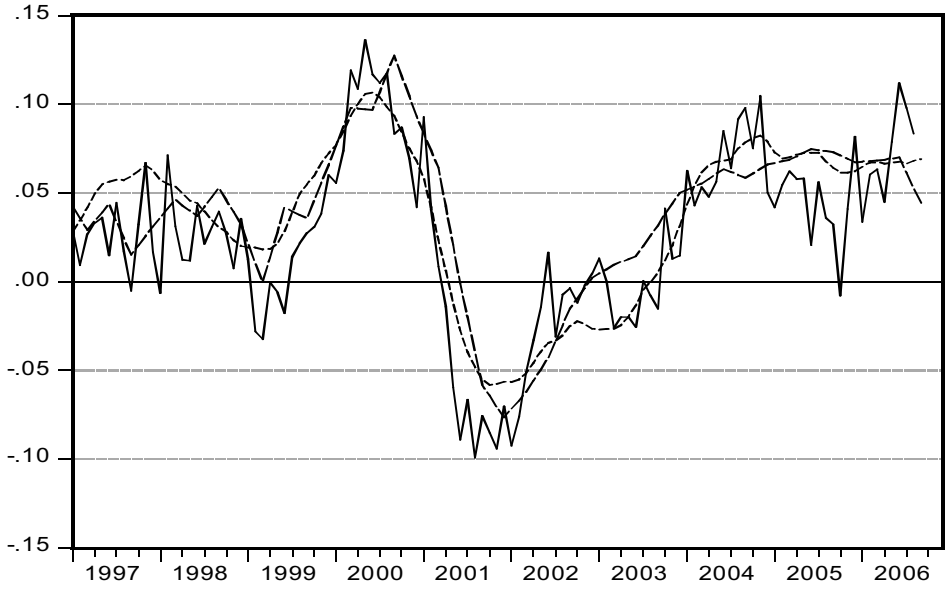
a. Developments during the period

To a great extent developments in the industrial sector reflect the business turnover of the Israeli economy, for this sector is an important component in the activity of the business sector. Figure 1 shows the annual change in the industrial production index, in the composite state-of the-economy index (which includes industrial production), and in the business sector gross product over the past 12 months. The rapid economic growth at the

[2] For example, the studies of Bergman and Marom (1998) that examines industrial productivity, Menashe (1999) that examines investments in industry, and Bar-Eliezer and Bergman (2001) that discusses the spillover effects of R&D in industry (partial list).

end of the 1990s, the sharp recession from the end of 2000 and the emergence from it starting at the end of 2003 are evident in the three indices presented.

Figure 1
The annual rate of change in industrial production, in the composite state-of-the-economy index, and in the business sector gross product

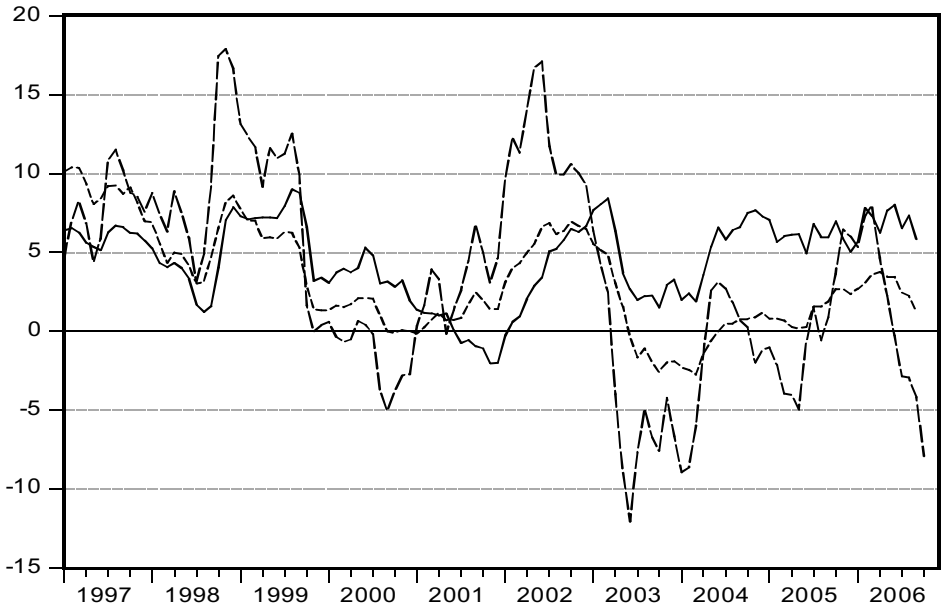


——— Industrial production -------- Composite index – – – – Business sector gross product

Sources: CBS and Bank of Israel computations.

Prices in industry rose at a slightly different rate from the course of development of the consumer price index, particularly toward the end of the period examined. The rate of increase of industrial prices at the end of the 1990s was about 6 percent, following which it declined significantly up to 2001, and in 2002 jumped sharply to around 8 percent—changes that match the course of the consumer price index and which, to a large extent, are the result of developments in the exchange rate at that time. As opposed to this, from the end of 2003, the beginning of the emergence from the recession, industrial prices rose by around 6 percent, a faster rate than that of the overall price index. It therefore appears that even though industry is a tradable sector, the overall index, and particularly its housing component, was more affected by the nominal appreciation in the dollar exchange rate.

Figure 2
The annual rate of change in the industrial price index, the consumer price index and the exchange rate



——— Industrial price index -------- Consumer price index – – – – Rate of change in the dollar exchange rate

Sources: CBS and Bank of Israel computations.

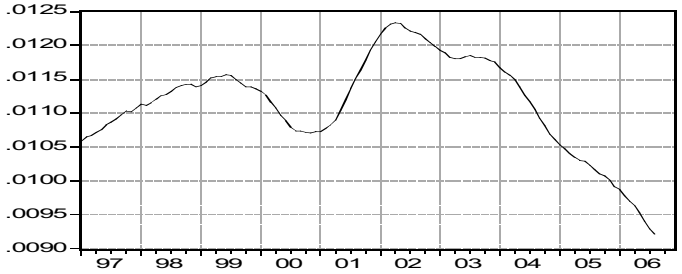
From the start of the present decade the change in the nominal labor cost (per hour of work) has been less than the change in industrial prices, so that throughout this period the real hourly wage per hour declined. An examination of the development of (real) wages per production unit (real unit labor cost) reveals a similar picture, with a strong decreasing trend since the end of 2001. An examination by industrial branches (Table 1) shows that in petroleum and chemicals, plastic and rubber, and electrical and electronic equipment, the labor cost per unit of product declined on average, while in leather, clothing, and non-metallic mineral products this cost rose on average.

Table 1
Rates of change* in quantity, price and labor costs, 1997-2006

		Monthly change							
		In industrial production (seasonally adjusted)		In consumer prices		In nominal labor cost per hour (seasonally adjusted)		In unit labor cost (nominal labor cost) / (price of industrial production)	
		Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.	Average	Std. Dev.
TOT	**Total**	**0.24**	**1.87**	**0.38**	**0.86**	**0.45**	**1.36**	**-0.20**	**2.54**
13	Mining and quarrying	-0.05	5.89	0.42	0.88	0.57	6.45	0.19	9.52
14–16	Food and beverages	0.03	2.47	0.36	0.79	0.41	1.84	0.01	3.15
17	Textiles	-0.04	3.34	0.13	0.86	0.54	2.02	0.44	3.98
18	Clothing	-0.14	5.35	0.06	13.67	0.58	2.59	0.71	14.44
19	Leather	-0.60	5.46	0.14	1.81	0.42	2.95	0.91	6.47
20	Wood	-0.12	4.49	0.20	0.72	0.36	2.94	0.33	5.60
21	Paper	-0.08	2.07	0.39	1.01	0.28	1.90	-0.06	3.03
22	Publishing	-0.02	3.12	0.35	0.84	0.28	1.86	-0.05	3.95
23–24	Petroleum and chemicals	0.76	6.13	0.41	1.06	0.31	3.00	-1.0	6.73
25	Plastic and rubber	0.39	3.94	0.41	1.06	0.45	1.79	-0.37	4.33
26	Non-metallic minerals	-0.61	6.71	0.25	0.53	0.35	2.73	0.70	6.70
27–28	Basic metal and its products	0.15	2.79	0.41	0.94	0.40	4.17	-0.15	4.55
29–30	Machinery and equipment	-0.10	5.22	0.19	0.84	0.37	3.20	0.32	6.78
31–34	Electrical and electronic equipment	0.42	3.24	0.26	0.96	0.42	2.16	-0.28	4.30
35	Transport equipment	0.42	3.38	0.27	0.68	0.56	5.90	-0.13	7.48
36	Furniture	-0.13	3.25	0.41	0.95	0.44	2.43	0.19	4.14
Inter-sector average**		0.02		0.29		0.42		0.11	
Inter-sector standard deviation		0.36		0.12		0.10		0.47	

* Calculated as the difference in the log level of the variable. ** Unweighted.
Source: CBS.

Figure 3
Index of wage to production unit in industry

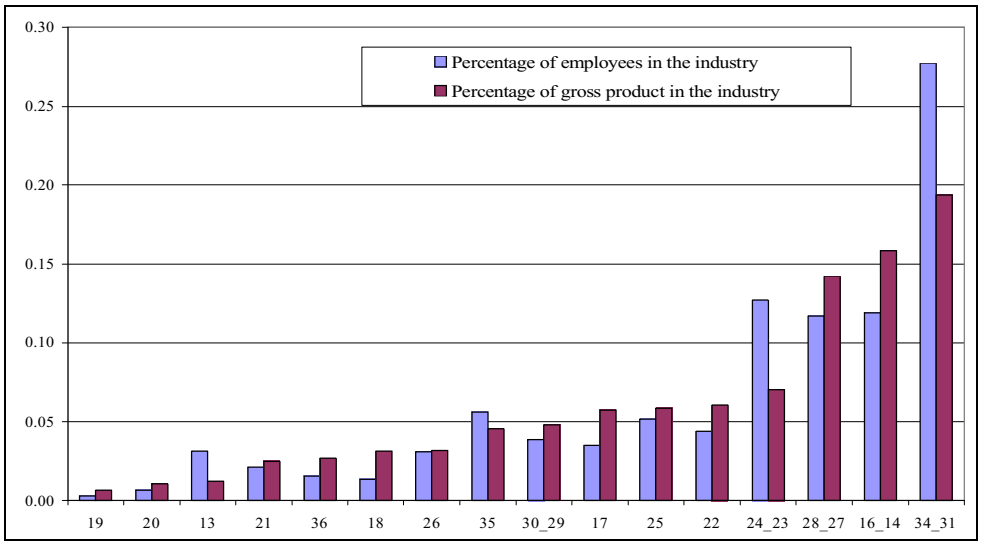


Sources: CBS and Bank of Israel computations.

b. Major characteristics of the industrial sectors

Figure 4 shows the distribution of gross product and employment among the industries.[3] Electrical and electronic equipment employs about a fifth of all employees in industry; food and beverages is the second-largest employer, with 16 percent of employees. Many of the traditional sectors only employ a small percentage, less than 5 percent of all employees. Particularly salient is the high level of gross product per employee in electrical and electronic equipment, and in petroleum and chemicals. The contribution of mining and quarrying and transport equipment to gross product is also greater than their share of employees, even though their weight in the industrial sector is relatively small.

Figure 4
The percentage of employees in the industry and the industry's contribution to gross product (average for 1998 and 2002)



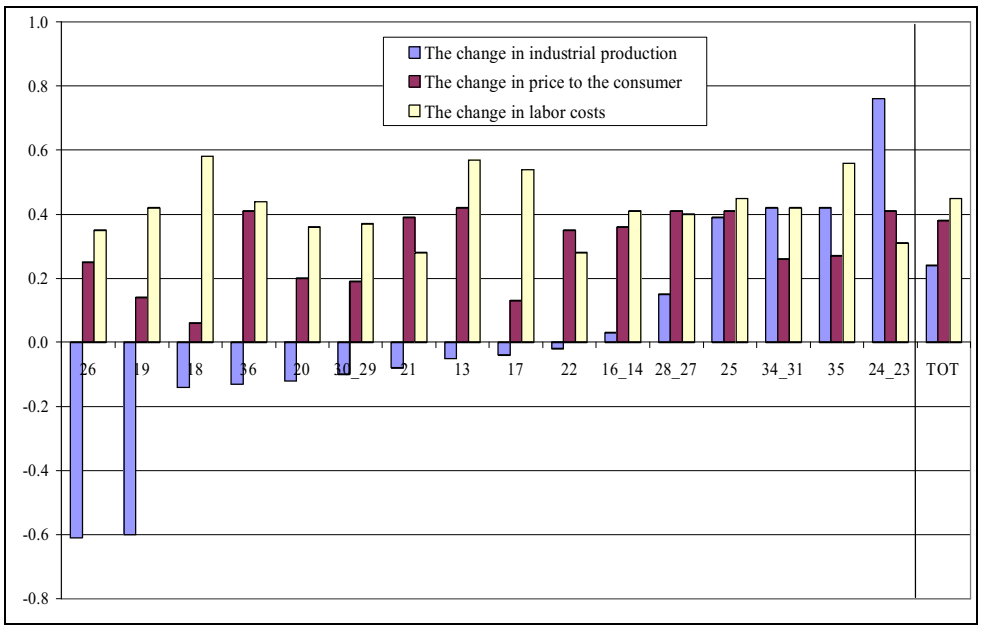
13 – Mining and quarrying; 14-16 – Food and beverages; 17 – Textiles; 18 – Clothing; 19 – Leather; 20 – Wood; 21 – Paper; 22 – Publishing; 23-24 – Petroleum and chemicals; 25 – Plastic and rubber; 26 – Non-metallic minerals; 27-28 – Basic metals and their products; 29-30 – Machinery and equipment; 31-34 – Electrical and electronic equipment; 35 – Transport equipment; 36 – Furniture.
Sources: CBS and Bank of Israel computations.

Figure 5 shows the average monthly change in industrial production, price to the consumer and labor cost (the nominal cost per hour) in each industry and overall. (The data are presented in Table 1.) The data are sorted according to the rate of change in industrial production. We can see variance in the rate of growth between the different industries: while the low-tech industries, such as leather, clothing, and furniture shrank during the

[3] The analysis is based on the averaged industrial-survey data collected by the Central Bureau of Statistics for 1998 and 2002.

period, the advanced industries expanded on average. The difference in the development of prices between the industries is smaller, even though in general the average price rise in the expanding industries is greater. There is no significant change in labor costs (per hour) between industries, despite the change in the composition of employment and the volume of activity in the sector.

Figure 5
The development of production, prices and labor costs – Average 1997-2006



13 – Mining and quarrying; 14-16 – Food and beverages; 17 – Textiles; 18 – Clothing; 19 – Leather; 20 – Wood; 21 – Paper; 22 – Publishing; 23-24 – Petroleum and chemicals; 25 – Plastic and rubber; 26 – Non-metallic minerals; 27-28 – Basic metals and their products; 29-30 – Machinery and equipment; 31-34 – Electrical and electronic equipment; 35 – Transport equipment; 36 – Furniture.
Sours: CBS.

Table 2 indicates various characteristics of industries, including the structure (rate of concentration), extent of openness (exports and imports), and the composition of expenditure (e.g., costs of labor and raw materials). With regard to some of the characteristics, the inter-industry variance is considerable, for example in the rate of sales for exports: about 6 percent in paper products and food, as opposed to about 60 percent in textiles and 70 percent in electrical and electronic equipment. Regarding other characteristics, for example labor costs as a percentage of gross product, and the consumption of raw materials as a percentage of output—the variance between the industries is smaller. I will attempt below to establish a connection between the characteristics of the industry and its response to shocks in the interest rate or the exchange rate.

Table 2
Various characteristics of industrial sub-sectors, average according to the industrial survey, 1998 and 2002

	Percentage of employees in the industry	Percentage of gross product in the industry	Percentage of enterprises with less than 20 employees	Percentage of enterprises with 100 or more employees	Share of imports in total domestic sales*	Share of sales for export out of total output	Labor costs as a percentage of gross product	Financing expenses relative to gross product	Investment relative to gross product	Capital/product ratio (log) **	Consumption of materials as a percentage of output in factors-of-production prices
Total		100	66	6.9	47.3	38.6	64.5	3.5	6.5	7.7	57.8
13	1.2	3.1	47	8.6	87.9	52.7	37.1	4.6	10.9	8.6	44.5
14–16	15.8	11.9	63	10.7	17.8	6.4	63.9	2.3	5.4	7.2	64.1
17	5.7	3.5	58	6.8	60.9	59.2	65.7	3.5	4.6	7.6	60.7
18	3.1	1.4	83	2.3	60.9	35.3	71.1	4.2	2.1	7.7	58.1
19	0.7	0.3	80	4.4	60.9	17.4	73.2	5.7	1.8	7.5	60.0
20	1.0	0.7	77	2.6	40.4	0.9	73.3	5.1	2.4	7.2	62.5
21	2.5	2.1	56	8.6	22.7	5.2	65.0	4.3	6.7	7.8	61.4
22	6.0	4.4	75	3.9	22.7	1.8	67.5	3.8	3.8	8.6	45.8
23–24	7.0	12.7	47	19.3	52.2	46.7	48.8	4.2	6.4	7.9	67.0
25	5.9	5.2	54	10.0	31.3	41.8	55.9	5.8	7.9	8.3	56.6
26	3.2	3.1	73	4.8	25.8	4.0	59.8	3.5	7.7	8.2	62.0
27–28	14.2	11.7	71	3.9	35.4	22.3	62.1	4.5	6.1	7.5	54.1
29–30	4.8	3.9	64	6.7	77.0	33.1	89.9	4.9	4.4	7.3	56.3
31–34	19.4	27.7	49	15.0	61.6	68.1	69.7	2.1	8.7	7.6	51.6
35	4.5	5.6	54	8.6	80.9	65.0	80.9	5.4	3.9	7.1	52.0
36	2.7	1.6	79	2.8	40.4	21.5	73.8	3.4	4.6	7.2	55.0
Average#			64	7.4	49.0	30.1	66.1	4.2	5.5	7.7	57.0
Standard deviation #			12	4.6	22.2	23.5	12.4	1.1	2.5	0.5	6.3

13 – Mining and quarrying; 14-16 – Food and beverages; 17 – Textiles; 18 – Clothing; 19 – Leather; 20 – Wood; 21 – Paper; 22 – Publishing; 23-24 – Petroleum and chemicals; 25 – Plastic and rubber; 26 – Non-metallic minerals; 27-28 – Basic metals and their products; 29-30 – Machinery and equipment; 31-34 – Electrical and electronic equipment; 35 – Transport equipment; 36 – Furniture.
* Average 2001-2005. Aggregate data for industries 17+18+19, 21+22, and 20+36.
** Average for 1997-2006.
# Unweighted according to the size of the industry, 1997-2006.
Sources: CBS and Bank of Israel computations.

4. THE DATA AND THE ESTIMATION

a. The data

Monthly data from 1997 until June 2006—in all 116 periods—were used to examine the connections between monetary policy and industry. I chose to begin in 1997, because at the start of the 1990s many changes took place in the characteristics of monetary policy, and in capital markets and money: from 1997 policy can be characterized as trying to reach an inflation target by means of the interest rate, against the background of a floating exchange rate regime and free capital movements. Data are available on 16 sub-sectors of industry as

well as on the sector as a whole.[4] Similar to many articles that examine the differential effect of monetary policy on various sectors, I used the VAR approach, that is to say, joint estimation of the major endogenous variables that are relevant for examining these connections, without an explicit theoretical model. From the impulse response function that serves as a major analytical tool in this context, we learn, among other things, about the strength of the effect of monetary policy on the various industries. I chose to estimate a system that includes five endogenous variables in the following order: the Bank of Israel interest rate, the log of the exchange rate of the shekel against the dollar,[5] the log of the (nominal) labor cost per hour for an employee in the industry (seasonally adjusted), the log of the price to the consumer in the industry, and the log of industrial production in the industry (seasonally adjusted). In addition, I included five exogenous variables in the estimation: a 3-month moving average of the log of the price of imported raw materials, a 3-month moving average of export prices of the industry in dollars, with a one month lag, a six-month moving average of the industrial production index in the United States, which represents the exogenous business cycle for the Israeli economy,[6] a 3-month moving average over three months of the interest rate on the basket of currencies, and a trend.[7] I examined the degree of integration of the series, and in general it can be said, although not sweepingly about all the series, that the series are, as expected, at a I(1) level of integration. The nominal interest rate, which may be thought of being stationary, behaves as I(1), which is why I preferred to consider it as such.[8] (See the table in Appendix) An examination for the level of integration among the five variables in a formulation parallel to that of the VAR system (four lags and the exogenous variables in the estimation) shows that for all the industries the hypothesis of no cointegration can be rejected at least at the 5 percent level of significance. In some of the sectors 5 cointegration vectors were found, in other words, the variables are stationary (for the formulation of the examination), while in others, between 2 and 4 cointegration connections were found. In order not to lose the long-term connections between the variables, the system was estimated for their levels (logs, except for the interest rate).[9] For all the estimations I included four lags for each of the endogenous variables. The examinations I conducted showed that, generally, few lags are required—two or one—but

[4] The sub-sector "miscellaneous" (39) was excluded from the analysis.

[5] Because raw material prices are measured in dollars, the appropriate exchange rate for translating the cost of raw materials into domestic prices is shekel/dollar. At the same time, the exchange rate against other currencies might also affect the firm's activity. At this stage, the other exchange rates were not included in the estimation.

[6] The correlation between the rate of change of the industrial production index in the United States and the Israeli composite state-of-the-economy index for the past six months is 0.67, and between the former and the half-yearly rate of change of the industrial production index in Israel, the correlation is 0.25.

[7] The trend is included in the estimation, because some of the variables were found to be I(1), when trend is included (see the table in Appendix). Beyond this, a trend such as prices in the clothing industry, which is connected to the exposure process, could be captured by the trend variable without including the exogenous economic variable (decreasing taxation rate).

[8] This result is obtained for the sample in the period 1990-2006, and also in an examination for a partial period—1997-2006.

[9] For a discussion on this, see Hayo and Uhlenbrock (1999), and for estimation at levels, see Ganley and Salmon (1997), Dedola and Lippi (2005), and others.

an examination of lag exclusion for examining the significance of the lags that were already included in the equation, showed that sometimes the fourth lag cannot be omitted. Because the data are monthly, and it is reasonable to assume that the effects of monetary policy can last beyond one or two months, I included four lags. I chose to include the same number of lags in each of the variables and industries in order to preserve symmetry in the analysis. The system was estimated separately for each industry and for the industrial sector as a whole.

In order to identify the shocks, I assumed Cholesky's decomposition, that is to say, a triangular matrix for describing the simultaneous effects of a shock in each of the endogenous variables on the other endogenous variables in the system. This implies that the upper variable in the order of estimation simultaneously affects the variables below it, but is not affected by them. The order of writing here assumes the Bank of Israel interest rate, which appears first in the system, may (but need not necessarily) affect the other prices and quantities simultaneously, but is not affected by them. This is a reasonable assumption, in that the interest rate each month is determined by the central bank a month in advance.[10] The exchange rate, which appears second, can simultaneously be affected by the interest rate and can affect prices and quantities in industry, but is not immediately affected by them. The labor cost could immediately affect the price and the quantity produced, but is not simultaneously affected by them.[11]

The major issue in this study is to examine the different responses of each industry to shocks in policy and in the exchange rate, but we can, using the equation that describes the industrial sector as a whole, examine the Bank's impulse response function and derive the Bank's response to the exchange rate, as well as the exchange rate's response to changes in the interest rate. We discuss this in Section D of this section. In Section E we briefly describe the effects of the exogenous variables on the system.

b. Results of the estimation

The estimated VAR system enables us to build an impulse response function for each of the endogenous variables to a shock in one of the other variables. I have chosen to focus on the system's response to two variables: the first, and most important, is a change in the Bank of Israel interest rate, that is to say, an unexpected shock to monetary policy; the second is a shock to the dollar exchange rate. Admittedly, changes in the exchange rate are dependent to a large extent on interest-rate changes, but it is possible that factors external to our system, such as long-term capital movements or changes in the state of the current account, will exogenously (relative to the model) affect the exchange rate. In analyzing the effects, we will concentrate on examining the response of the output of the industries and its price

[10] At the same time it can be claimed that in the process of determining the interest rate, the central bank relies on assessments and forecasts of the values of the variables in the coming months. In any event, because the frequency of the analysis is monthly, the order of the variables does not seem to be significant. (See also the following footnote, and footnote 13).

[11] A change in the order of the matrix so that labor cost appears last, that is to say, does not have an immediate effect, but is affected by all the other variables, does not change the results of the impulse response function.

to changes in the interest rate and the exchange rate. The technique of creating a random shock and examining the impulse response function allows us to examine the dynamic connections between the endogenous variables, given the policy, and to assess the overall effect of the policy on the other variables, taking into consideration the responses of all the variables in the system.

1. The effect of raising interest[12]

The effect on quantities: Generally, raising interest tends to reduce the quantity produced by the various industries (Figure 6a and Table 3a). In observing the industrial sector as a whole, a certain decline is already evident after one month; this decline continues for several months, and converges to the basic situation after less than eighteen months, accompanied by a gross-product loss over the period. While the initial direction, the depth and duration of the response differ from industry to industry, after 6 months most industries (11 out of the 16) accumulate a gross-product loss. Particularly salient are wood (20), clothing (18) and electronic and electrical equipment (31-34). Some industries produce a volatile response to an increase in interest, and others—even a certain increase in quantity. The textile industry (17) shows a continuous increase in production as a result of an increase in the interest rate, with a slow convergence to the initial situation. There may be a problem in formulating the equation in this industry, because of the significant structural changes that the industry has been undergoing in the past decade. It should be recalled that as a response to the increase in interest, the other endogenous variables in the system also change—particularly the exchange rate and prices—and therefore, the overall effect of the interest rate may ultimately be smaller than its marginal effect (that is to say, its effect when the other factors are constant).

Table 3A presents the maximal response in quantity and in price in each industry and within what period it took place following the shock, the cumulative change in quantity, and the average change in price in response to the interest-rate shock. The bold digits indicate a response greater than one standard deviation, and a gray cell—a maximal response greater than two standard deviations. In all industries the maximal response in quantity, which is generally negative, is greater than one standard deviation, and in the equation that describes the industrial sector as a whole, it is greater than two standard deviations, which, in general, implies that an interest-rate shock has a real negative effect on the amount produced. An interest-rate increase of one percentage point is expressed in the industry as a whole in a maximal decline of about one percent in the quantity produced in the second period after the shock, and in a cumulative loss of about 4 percent in the quantity produced over two years.

[12] By one percentage point.

Table 3a
The effect of a one-percent shock in the interest rate

	Maximal response (the absolute value) of **quantity** (percentages)		Overall change in quantity (24 periods)	Maximal response (the absolute value) of **price** (percentages)		**Average** change in price (24 periods)
	The size	The period*		The size	The period*	
TOTAL	**-**1.04	2	**-**4.2	**-0.41**	3	**-**0.01
13	**2.49**	1	1.1	0.58	1	0.10
14–16	**-0.72**	3	**-**0.0	0.64	1	**-**0.02
17	**1.44**	5	16.9	0.72	0	0.04
18	**-1.67**	2	**-**10.8	0.31	1	0.09
19	**1.67**	1	3.2	**0.60**	1	**-**0.00
20	**-2.37**	5	-14.0	0.76	0	0.05
21	**-0.47**	0	1.0	0.56	0	**-**0.10
22	**-0.96**	0	1.9	**-0.37**	2	**-**0.04
23–24	**-2.70**	1	**-**0.3	**-0.11**	3	**-**0.25
25	**-1.05**	6	-5.7	-0.13	4	-0.13
26	**2.51**	1	1.7	**0.38**	2	**-**0.09
27–28	**-1.17**	3	**-**2.9	**-**0.14	4	**-**0.19
29–30	**-3.30**	3	**-**4.9	**-**0.66	3	**-**0.20
31–34	**-1.77**	3	**-**7.9	**-**0.12	2	**-**0.27
35	**-0.95**	4	-0.0	**-0.26**	3	-0.00
36	**-0.77**	0	1.3	0.76	1	-0.03

*The period in which the shock took place is defined as period zero. The following period is called period 1.
Bold digits indicate a response greater than one standard deviation. A gray cell indicates a response of about 2 or more standard deviations.
13 – Mining and quarrying; 14-16 – Food and beverages; 17 – Textiles; 18 – Clothing; 19 – Leather; 20 – Wood; 21 – Paper; 22 – Publishing; 23-24 – Petroleum and chemicals; 25 – Plastic and rubber; 26 – Non-metallic minerals; 27-28 – Basic metals and their products; 29-30 – Machinery and equipment; 31-34 – Electrical and electronic equipment; 35 – Transport equipment; 36 – Furniture.

The effect of the interest rate on prices in the industries (Figure 6b and Table 3a): A contractionary monetary policy could affect prices in two directions, according to its effect on the industry's supply and demand. Raising interest could reduce private consumption, and therefore the demand for products. In this case the reduction in the amount will lead to a decrease in price. On the other hand, if the effect of the interest rate on the supply side is stronger by making the financing sources more expensive, reducing credit to the firm and adversely affecting production capability, we would expect to see a reduction in quantity in conjunction with increasing prices. A decrease in prices attests to the fact that the transmission mechanism of monetary policy acts mainly on the demand side, while a rise in prices supports the existence of a significant effect on the supply side. Regarding the effect on the supply, we are unable to differentiate between two channels of influence—the effect on the firm's balance sheet, and the effect on the banks' lending. The first channel reduces the credit that the firms apply for, because the higher interest rate adversely affects the value of the firms and the collateral at their disposal for obtaining credit; the second channel makes the banks' resources for giving credit more expensive. The reduction in the quantity the firm produces, in conjunction with price increases because of higher interest rates, does not allow us to differentiate between these two channels of influence.

The results obtained indicate an immediate increase in prices in most industries and in the industrial sector as a whole in response to an interest-rate increase; however, 3 months later a decrease in prices is already evident in some industries, and after 6 months, prices fall in almost all industries. In most industries, prices return to their original level after two years or even less, and in a few industries the convergence continues over a longer period. It appears therefore that the demand side is more dominant in the industries' responses to interest-rate increases. A short-term price increase in response to an (unexpected) tight monetary policy was also found in some research studies (e.g., Barth and Ramey, 2000, and to a certain extent Dedola and Lippi, 2005) and is connected to the discussion on the existence of a "price puzzle"—a price increase in response to an interest-rate increase—found by Sims (1992). Because price increases are temporary and take place immediately following the shock, it is difficult to say that they express the effect on supply, because it is reasonable to assume that interest-rate changes affect the firm's supply only in the course of time, and not immediately.

Table 3a shows that the maximal response of prices to an interest-rate shock is almost always greater than one standard deviation, and in a third of the industries it is greater than two standard deviations. The maximal response in the traditional industries tends to be a price rise, which implies a greater effect on supply (in the short term), while in the advanced industries the maximal response is usually a price decrease. Raising interest by one percentage point is reflected in a decrease of 0.4 percent in price in the industrial sector as a whole. In some of the industries the response obtained ranges between a maximal decrease of up to about 0.6 percent and an increase of about 0.8 percent. In most industries, a slight decrease in price was recorded on average over 24 months (even if the maximal response was in the direction of a price rise).

Sensitivity of the results to identifying assumptions: As described above, in order to identify the structural shocks, it is necessary to assume the order of the effect of the shocks in the estimated system. In the structure we assumed, the interest rate does not respond simultaneously to prices. Alternatively, we may assume that the interest rate can respond simultaneously to changes in prices (that is to say, to changes in the decision-makers predictions at the time of determining the interest).[13] As part of an identification of this kind a restriction is imposed: the simultaneous response of prices to interest has to be zero. The course of prices obtained in response to an interest-rate shock shows lower price rises in the initial periods following the shock, and particularly in the equation that describes the industrial sector as a whole—further support for the finding that the major effect is on the demand side, and is reflected in price decreases in response to an increase in interest.

A claim that could arise in the context of price increases in response to an increase in interest is that the increase expresses the central bank's expectations of future price rises, an expectation that motivates it to raise the interest rate—in other words, inverse causation. The alternative identifying assumptions, which were discussed above, weaken this claim.

[13] As part of the Cholesky decomposition, the alternative arrangement of the variables that was examined is gross product, labor cost, prices, Bank of Israel interest, and the exchange rate. The implication is that the gross product is not temporarily affected by any of the variables, and that the exchange rate could be affected simultaneously by all the other variables.

Moreover, the central bank examines mainly the development of the consumer price index, because its policy aim is defined as maintaining the inflation target in terms of the consumer price index; the correlation between the consumer price index and the industrial price indices (Figure 2), and even more, the correlation with the price indices of the individual industries, is not complete. The system of equations estimated as part of VAR enables us to examine also the response of the interest rate as a shock to each of the prices in the various industries. With regard to industrial prices as a whole, we see that the Bank of Israel interest increases within a short period by about 0.2 percentage points in response to a shock in prices.[14]

2. The effect of a random shock in the exchange rate of the shekel against the dollar

The effect on quantities: (Figure 6c and Table 3b). The effect of the exchange rate on the quantity produced is relatively volatile, and in the immediate term an increase in the exchange rate clearly causes a growth in quantity in a large proportion of the industries.[15] From 6 months to two years later there is a decrease in the quantity produced and a cumulative loss of gross product in more than half the industries, most of them traditional. In the other industries the gross product grew as a result of the increase in the exchange rate (Table 3b). The exchange rate affects both the costs of production (raw materials) and the return obtained for exported goods, or goods that serve as income substitutes in the domestic market. When the effect on the return is greater than that on the costs, we expect to see an expansion of activity. After two years, the activity in all industries, except textiles, returned to its base level. Table 3b also shows that the maximal response in a large proportion of the industries is positive and significant (at least with one standard deviation); however, for the industrial sector as a whole an increase in the exchange rate causes a cumulative product loss of about 1.5 percent in 24 months.

The effect on prices: (Figure 6d and Table 3b). Prices immediately and clearly rise in response to an increase in the exchange rate. In most industries the response is immediate and sharp, dissipating after about a year, generally without significant undershooting of prices in the convergence process. An exception is the leather industry in which no clear price rises were recorded. In the clothing industry a volatile response was obtained—apparently because of the problems connected to the strong seasonality of prices in this industry. Table 3b presents the significant positive response in all the industries (except for clothing and leather).

[14] In the alternative formulation of the constraints presented above (footnote 13), the interest rate reacts immediately, and up to about 0.5 percentage points within 3 months.

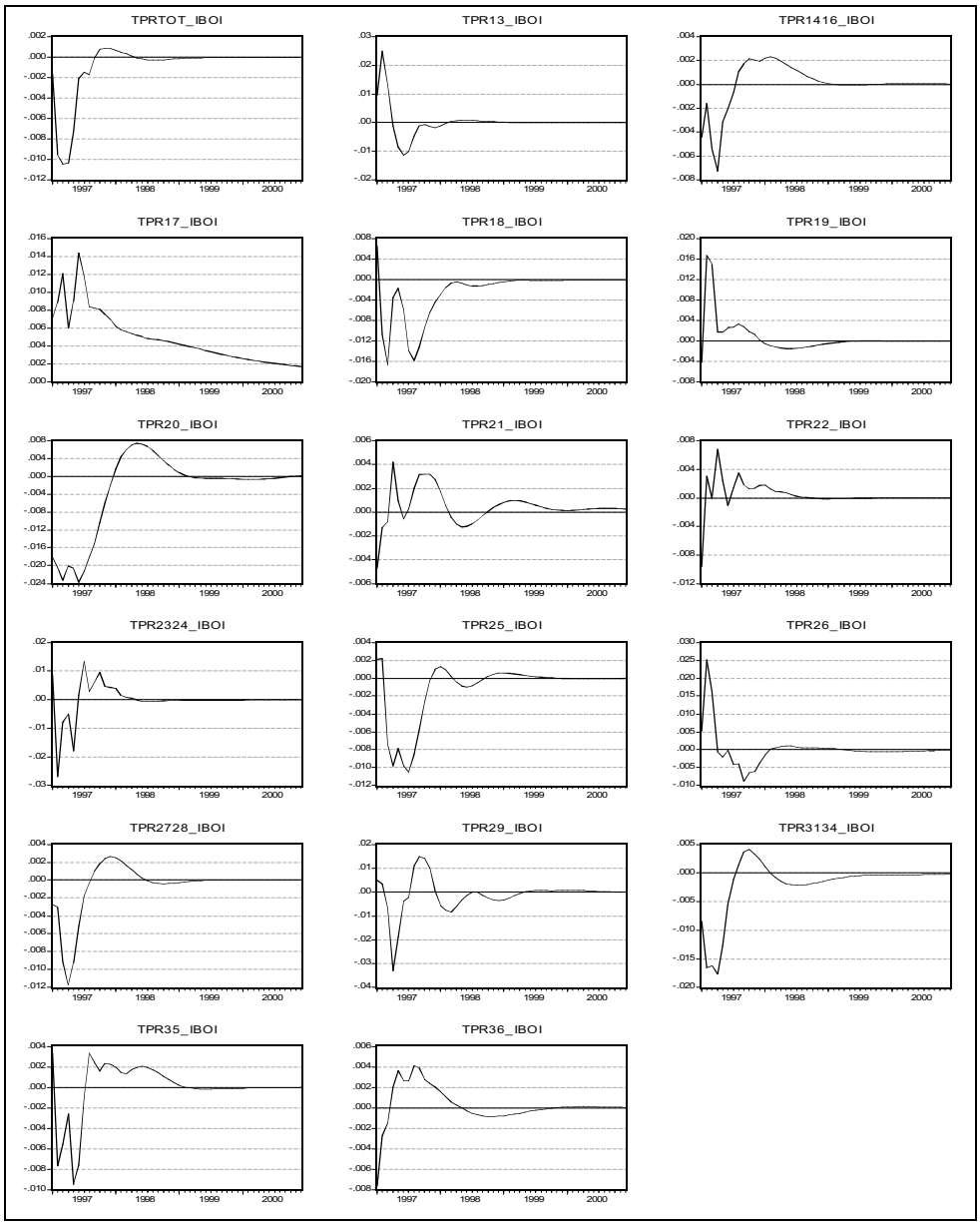
[15] The alternative formulation of the constraints, in which we assume that prices and quantities do not respond simultaneously to an exchange-rate shock, does not change the general picture, but does weaken this effect.

Table 3b
The effect of a one-percent shock in the exchange rate

	Maximal response (the absolute value) of **quantity** (percentages)		Overall change in quantity (24 periods)	Maximal response (the absolute value) of **price** (percentages)		**Average** change in price (24 periods)
	The Size	The Period*		The Size	The Period*	
TOT	-0.23	4	-1.52	0.38	1	0.05
13	-0.18	7	-1.33	0.26	2	0.09
14–16	**-0.24**	1	-1.93	0.36	4	0.09
17	0.59	3	8.53	0.21	1	0.01
18	**-0.40**	2	-2.92	-0.90	4	-0.04
19	0.77	1	11.10	-0.21	0	-0.02
20	**0.40**	0	-1.36	0.35	1	0.06
21	0.30	1	0.16	0.38	2	0.00
22	0.31	0	-1.41	0.21	1	0.00
23–24	0.82	3	4.47	0.54	1	0.30
25	0.64	1	1.30	0.42	2	0.08
26	-0.07	0	-0.80	0.14	2	0.05
27–28	0.14	2	-0.77	0.21	1	0.01
29–30	**-0.60**	3	2.10	0.39	1	0.10
31–34	**-0.29**	4	-2.02	0.38	1	0.06
35	-0.57	6	-3.48	0.12	1	0.00
36	0.05	0	0.91	0.51	2	0.08

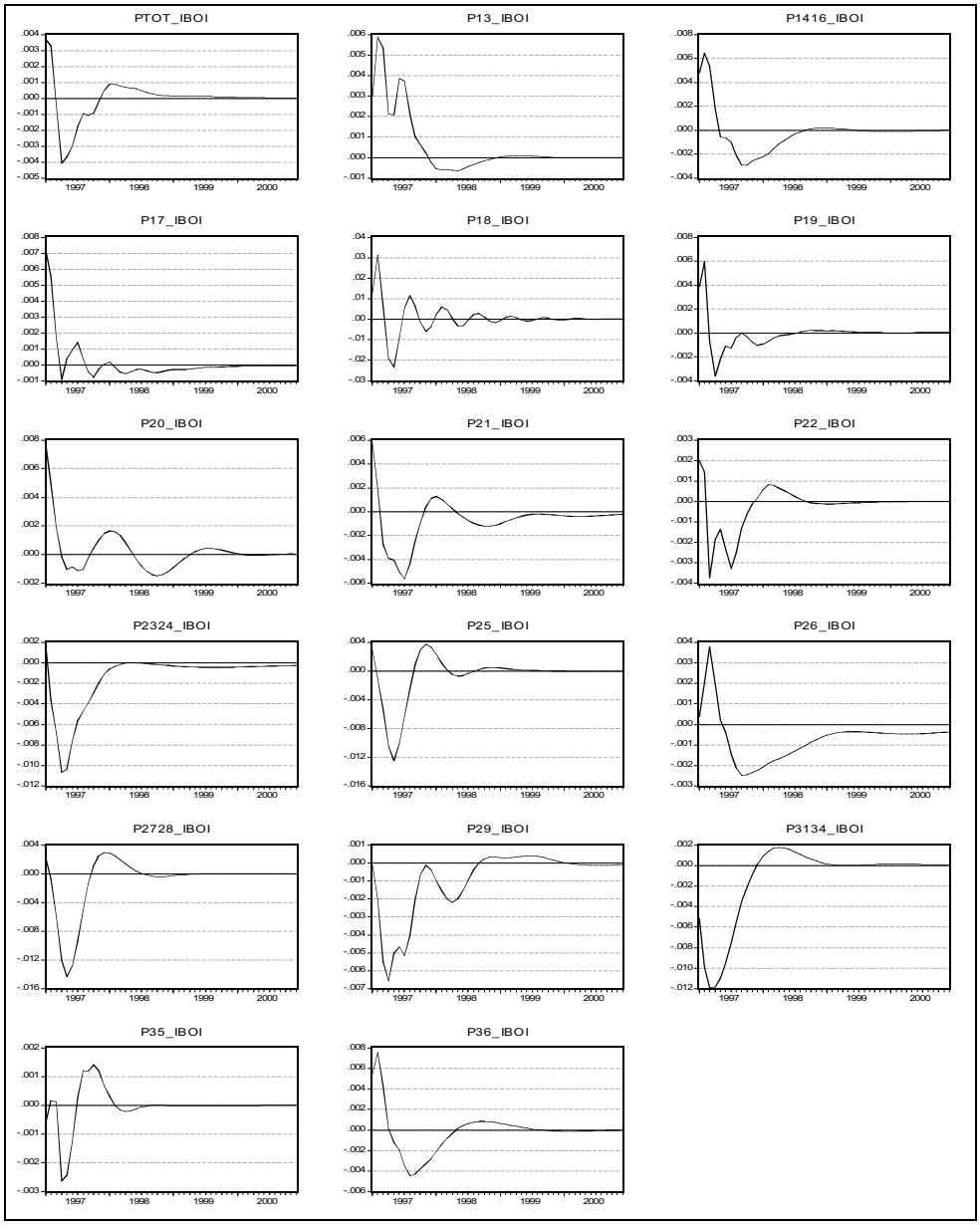
***** The period in which the shock took place is defined as period zero. The following period is called period 1.
Bold digits indicate a response greater than one standard deviation. A gray cell indicates a response of about 2 or more standard deviations.
13 – Mining and quarrying; 14-16 – Food and beverages; 17 – Textiles; 18 – Clothing; 19 – Leather; 20 – Wood; 21 – Paper; 22 – Publishing; 23-24 – Petroleum and chemicals; 25 – Plastic and rubber; 26 – Non-metallic minerals; 27-28 – Basic metals and their products; 29-30 – Machinery and equipment; 31-34 – Electrical and electronic equipment; 35 – Transport equipment; 36 – Furniture.

Figure 6a
The effect of an interest-rate shock on the quantity produced



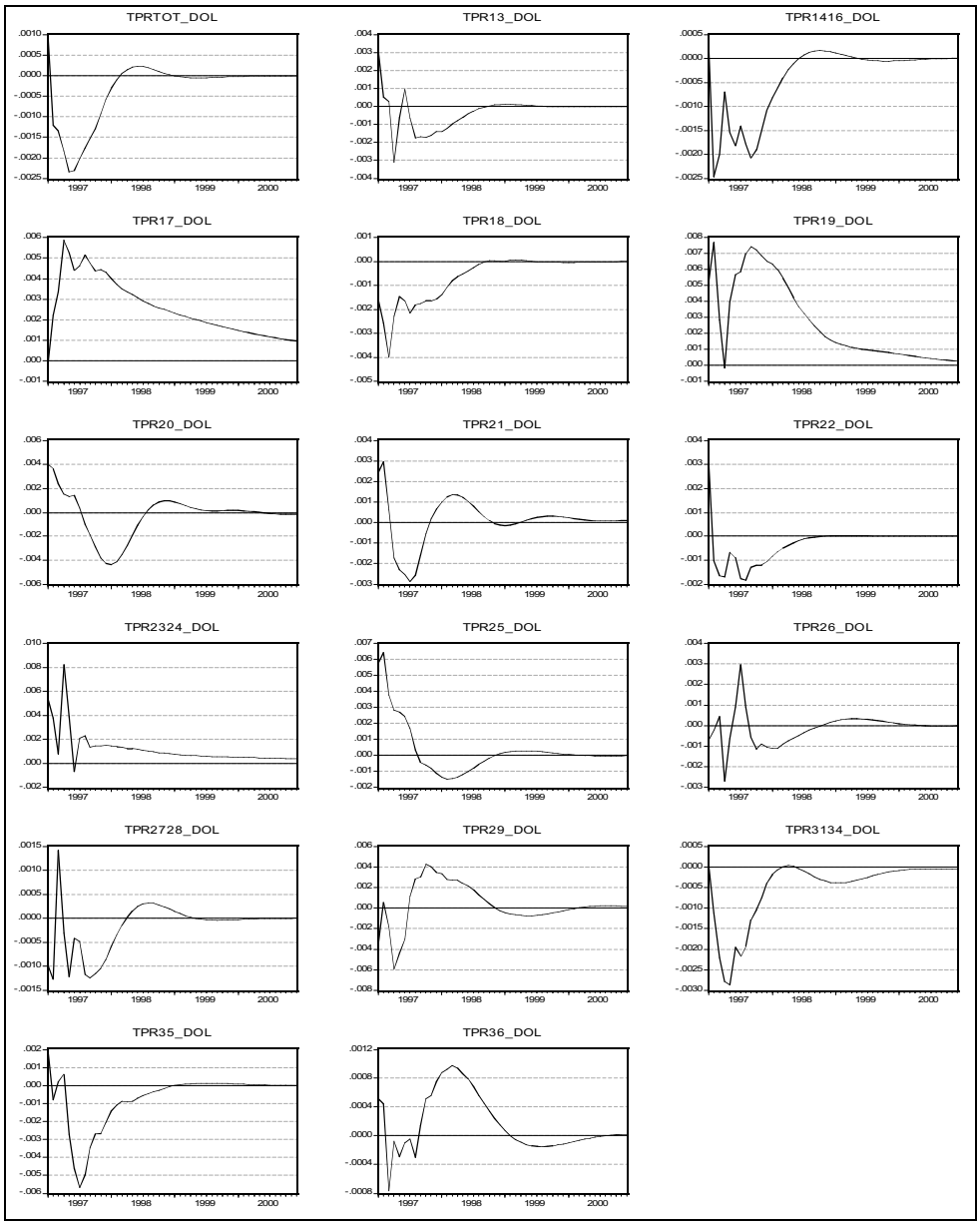
13 – Mining and quarrying; 14-16 – Food and beverages; 17 – Textiles; 18 – Clothing; 19 – Leather; 20 – Wood; 21 – Paper; 22 – Publishing; 23-24 – Petroleum and chemicals; 25 – Plastic and rubber; 26 – Non-metallic minerals; 27-28 – Basic metals and their products; 29-30 – Machinery and equipment; 31-34 – Electrical and electronic equipment; 35 – Transport equipment; 36 – Furniture.

Figure 6b
The effect of an interest-rate shock on the price



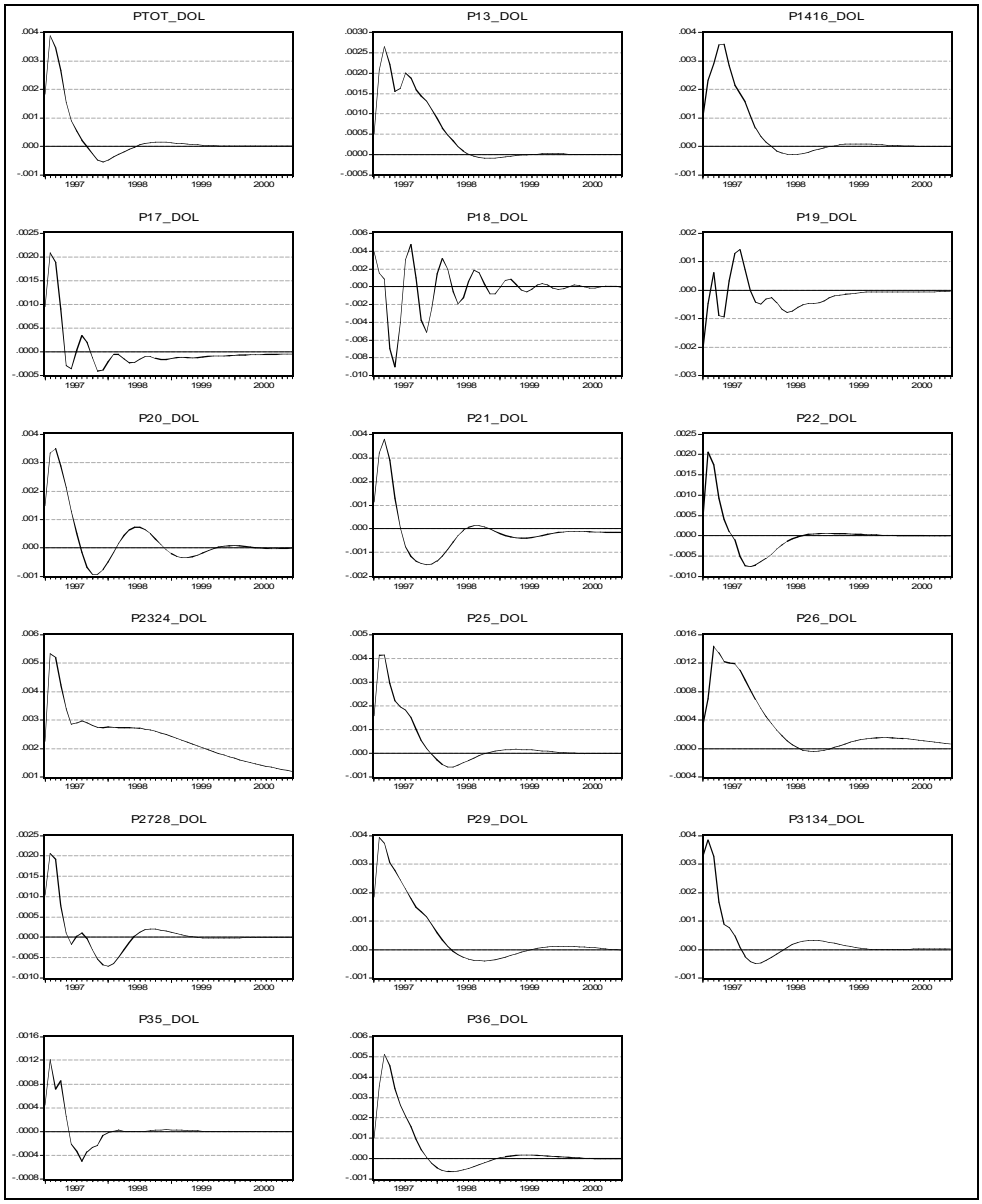
13 – Mining and quarrying; 14-16 – Food and beverages; 17 – Textiles; 18 – Clothing; 19 – Leather; 20 – Wood; 21 – Paper; 22 – Publishing; 23-24 – Petroleum and chemicals; 25 – Plastic and rubber; 26 – Non-metallic minerals; 27-28 – Basic metals and their products; 29-30 – Machinery and equipment; 31-34 – Electrical and electronic equipment; 35 – Transport equipment; 36 – Furniture.

Figure 6c
The effect of an exchange-rate shock on the quantities produced



13 – Mining and quarrying; 14-16 – Food and beverages; 17 – Textiles; 18 – Clothing; 19 – Leather; 20 – Wood; 21 – Paper; 22 – Publishing; 23-24 – Petroleum and chemicals; 25 – Plastic and rubber; 26 – Non-metallic minerals; 27-28 – Basic metals and their products; 29-30 – Machinery and equipment; 31-34 – Electrical and electronic equipment; 35 – Transport equipment; 36 – Furniture.

Figure 6d
The effect of an exchange-rate shock on the price



13 – Mining and quarrying; 14-16 – Food and beverages; 17 – Textiles; 18 – Clothing; 19 – Leather; 20 – Wood; 21 – Paper; 22 – Publishing; 23-24 – Petroleum and chemicals; 25 – Plastic and rubber; 26 – Non-metallic minerals; 27-28 – Basic metals and their products; 29-30 – Machinery and equipment; 31-34 – Electrical and electronic equipment; 35 – Transport equipment; 36 – Furniture.

c. Variance decomposition

By using the impulse response function of the variables on any shock, we can allocate weights to the effect of each of the endogenous variables on the variance of the forecast of these variables. This can be done for each of the 16 industries separately and for the industrial sector as a whole. Table 4a presents the decomposition of the variance of each of the five variables at the time of the shock, and for 1, 5 and 10 periods for the industrial sector as a whole. Table 4b presents the variance decomposition of the forecast for price and quantity in the long term (after 10 periods) for each of the 16 industrial sectors.

Table 4a
Variance decomposition for the industrial sector as a whole

			Rate of variance in the forecast resulting from:				
	The period	Standard deviation of the equation	Bank of Israel interest	Exchange rate	Labor cost	Price	Amount produced
Bank of Israel interest	0	0.36	100	0.0	0.0	0.0	0.0
	1	0.58	82.0	17.0	0.1	0.5	0.5
	5	1.20	27.1	65.9	0.4	2.0	4.6
	10	1.42	19.3	67.2	0.3	1.5	11.7
Exchange rate (log)	0	0.015	6.31	93.7	0.0	0.0	0.0
	1	0.022	6.66	91.3	1.8	0.2	0.1
	5	0.027	9.77	77.0	2.5	7.5	3.1
	10	0.027	9.77	76.6	2.6	7.4	3.6
Labor cost (log)	0	0.010	2.3	0.4	97.3	0.0	0.0
	1	0.011	4.4	0.8	94.2	0.4	0.1
	5	0.013	7.9	4.5	77.8	1.0	8.8
	10	0.014	10.3	5.1	67.2	3.7	13.7
Price (log)	0	0.006	4.4	18.5	0.7	76.4	0.0
	1	0.010	3.1	40.3	1.4	55.1	0.1
	5	0.013	4.8	52.6	3.7	37.7	1.1
	10	0.014	5.0	50.6	4.8	36.1	3.4
Quantity (log)	0	0.015	0.2	0.9	0.2	0.1	98.6
	1	0.016	4.9	2.1	1.0	0.3	91.6
	5	0.020	12.6	10.7	4.0	7.8	64.9
	10	0.021	11.8	16.3	3.8	7.5	60.6

We see from the table that the Cholesky decomposition we assumed is reflected in a contribution of zero variance in the shock period for some of the variables, according to the structure we chose. In other words: Bank of Israel interest is not immediately affected by the other variables, while the amount produced is. A salient result is that the variance of the forecast of Bank of Israel interest is mainly a result of variance in the exchange rate, and is almost unaffected by the other variables. About half the variance of the price forecast is affected by the variance in the exchange rate, and is virtually independent of the volatility of the amount produced. The variance of quantity is more moderately affected—slightly more than 10 percent—by variance in Bank of Israel interest, and to a similar degree by variance in the exchange rate. Price fluctuations only slightly affect the fluctuations in quantity.

Table 4b
Decomposition of the forecast variances into price and quantity, by industry, after 10 periods

	Share of variance in forecast for **price** resulting from:					Share of variance in forecast for **quantity** resulting from:				
	Bank of Israel interest	Exchange rate	Labor cost	Price	Quantity produced	Bank of Israel interest	Exchange rate	Labor cost	Price	Quantity produced
TOT	5.0	50.6	4.8	36.1	3.4	11.8	16.3	3.8	7.5	60.6
13	7.2	40.0	2.9	49.2	0.8	5.6	2.7	4.6	14.9	72.2
14–16	5.6	51.4	9.2	33.3	0.5	2.9	13.2	7.7	3.5	72.8
17	8.2	15.9	7.1	66.4	2.4	5.4	19.4	1.5	2.0	71.6
18	1.7	2.8	0.3	93.5	1.8	5.1	3.7	10.9	2.8	77.5
19	2.3	5.3	9.2	75.9	7.2	1.8	17.9	7.0	2.9	70.4
20	4.7	38.7	0.8	51.5	4.4	9.3	2.9	9.6	0.7	77.5
21	6.9	32.8	7.5	50.4	2.3	1.5	15.1	5.8	32.9	44.8
22	2.6	9.2	1.5	85.1	1.5	2.6	6.9	15.5	14.6	60.4
23–24	5.9	34.4	4.7	26.8	28.2	4.2	6.9	2.9	10.3	75.6
25	10.4	24.2	5.5	41.3	18.6	4.1	15.4	2.1	3.0	75.4
26	3.5	17.6	1.6	76.9	0.4	3.4	1.2	12.6	7.3	75.4
27–28	21.5	5.1	9.3	56.4	7.6	7.5	3.9	12.8	8.9	66.9
29–30	5.0	33.2	0.4	54.4	7.1	7.7	7.8	12.4	2.0	70.1
31–34	24.2	21.9	2.9	45.3	5.6	7.8	4.1	3.6	9.0	75.5
35	3.2	9.5	9.6	75.4	2.3	2.9	21.3	4.2	6.6	65.1
36	3.0	26.4	3.4	59.7	7.5	2.1	0.5	3.3	5.7	88.4

13 – Mining and quarrying; 14-16 – Food and beverages; 17 – Textiles; 18 – Clothing; 19 – Leather; 20 – Wood; 21 – Paper; 22 – Publishing; 23-24 – Petroleum and chemicals; 25 – Plastic and rubber; 26 – Non-metallic minerals; 27-28 – Basic metals and their products; 29-30 – Machinery and equipment; 31-34 – Electrical and electronic equipment; 35 – Transport equipment; 36 – Furniture.

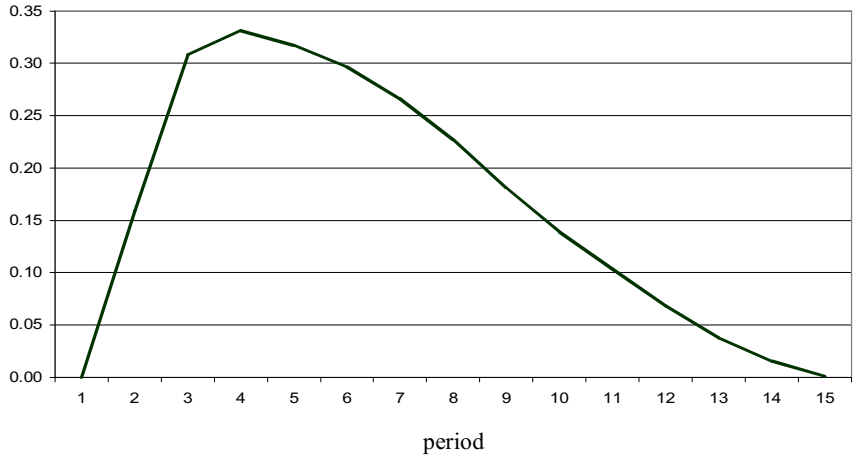
An examination of the weight of the effect of fluctuations in the exchange rate on variance in the long-term price forecast in each of the industries reveals significant differences between the industries. While the weight of the exchange rate is small in textiles, clothing, and basic metals—about 5 percent—in mining and quarrying, food and beverages, and wood products, the weight reaches from about 40 to 50 percent. An examination of the correlation between characteristics of the sector and the weight of volatility in the exchange rate as an explanation for volatility in price does not produce clear results.[16] Fluctuations in the exchange rate also carry some weight in explaining the variance in the forecast of the quantity produced, but not more than 15 to 20 percent. Variance in labor cost has a weight of about 5 to 10 percent in most industrial sectors, while the weight of the variance in the quantity itself is dominant in explaining the overall variance of the forecast.

[16] The exchange rate will have a greater effect on volatility in those industries that produce durable goods and that have a larger concentration of domestic production, or that have a greater rate of investment in them.

d. The response of the interest rate to a shock in the exchange rate

The equations, and particularly the system relating to the industrial sector as a whole, enable us, as we have said, to examine the impulse response function of the interest rate and the exchange rate. Admittedly we are dealing here with a very partial portion of total activity—industry only—but as mentioned, changes in industry correlate to a large extent with the general business cycle.[17] According to the equation for the Bank of Israel interest, which is included in the system of the equations, the interest rate increases, significantly, in response to an increase in the exchange rate of the shekel against the dollar, and in response to an increase in industrial prices. The effect of the volume of production on the interest is not significant, and the labor cost obtains a negative sign (contrary to expectation). It was also found that the current interest-rate level is dependent on its level in the previous period, in other words, there is interest smoothing. Figure 7 presents the impulse response function of Bank of Israel interest to a shock of one percent in the rate of the dollar against the shekel.[18] We see that the Bank of Israel's response is relatively rapid and strong, while the return to the base situation is more gradual. According to the impulse response function obtained, the Bank of Israel does not respond significantly to shocks in labor costs in industry and to shocks in industrial prices. In response to a shock in industrial production, the interest rate is lowered moderately, but the significance of this response is rather weak.

Figure 7
Response of Bank of Israel interest to a one-percent shock in the exchange rate (± a standard deviation)



[17] A correlation of 0.68 was found between the change during the past 12 months in the industrial production index and the change during the past 12 months in the Bank of Israel's composite index, which includes industrial production.

[18] Bear in mind that the impulse response function reflects the interest-rate response over time, taking into consideration the responses of the other endogenous variables in the system (the implication being that not all the other factors are constant).

It is also possible, using the system, to examine the response of the exchange rate to changes in interest. Ostensibly, an interest-rate change, which affects interest-rate differentials between Israel and abroad, should affect the demand for foreign currency: a higher interest rate will tend to reduce the demand and act in the direction of lowering the exchange rate. However, the impulse response function of the exchange rate to the interest rate rises because the response is not significant, except for the first period where it is marginally significant, and its scale is relatively small.

e. The effect of the exogenous variables on activity in the industrial sector

In addition to the endogenous variables in the system, which appear in all the equations, we added, as described above, several variables that contribute to explaining the development of the estimated variables: import prices of the raw materials (in dollars), export prices of each sector (in dollars), the industrial production index in the United Sates, and the Libid interest rate, weighted according to the weights of the currency basket. The effect of import prices of raw materials on the domestic price is not significant for the industrial sector as a whole and for most of the industries. However, the effect of import prices of raw materials on the quantity produced is generally positive and significant for the industrial sector as a whole. It seems that the significant increasing trend of import prices since the beginning of 2002 matches the expansion of activity in the sector since then, but does not necessarily explain the expansion. We did not find a significant effect of import prices on price and quantity in the industrial sector as a whole. A positive effect on the price was found in only a few industries. Activity in the United States, as expected, has a significant positive effect, both on the quantity and on the price of aggregate industrial activity. A growth in demand for industrial goods is expected to increase the quantity in conjunction with a price rise. In some of the industries a positive effect was also obtained on quantity and price. The Libid interest rate did not significantly affect quantity and price in the industrial sector as a whole or in most of the industries (it did have some effect on the development of the exchange rate and the interest rate).

5. THE FACTORS EXPLAINING THE INDUSTRIES' RESPONSE

In an attempt to better understand the different behavior of each of the industries, we examine the correlation between various characteristics of the industry and the response of the quantities and the prices to an interest-rate or an exchange-rate shock. We examined the **cumulative** change in quantity for different periods following the shock—immediately and up to two years—and the change in price **after** periods of the same length. The results are presented in Tables 6a to 6d. Because of the small number of observations—only 16 industrial sectors—it is difficult to conduct more complex statistical examinations. Even though the correlation measured is not independent of other factors and there is also a high correlation between some of the characteristics of each industry (Table 5), it is still possible to obtain an initial impression about the factors that are likely to affect the response of the industry to shocks in the interest rate and the exchange rate.

Table 5
The correlation between various characteristics of the industry

	Durables	Proportion of enterprises with 100 or more employees	Proportion of imports in sales to the domestic market	Proportion of raw-material expenses in the output	Labor costs as a proportion of gross product	Percentage of exports	Financing expenses as a proportion of gross product	Rate of investment relative to gross product	Capital/ product ratio
Technological level[1]	0.63	0.45	0.51	-0.30	0.12	0.60	0.10	0.43	-0.04
Durables		-0.10	0.25	-0.37	0.08	0.21	0.18	0.38	-0.09
Proportion of enterprises with 100 or more employees			0.13	0.19	-0.38	0.51	-0.24	0.53	0.11
Proportion of imports in sales to the domestic market				-0.36	0.11	0.74	0.30	0.03	-0.13
Proportion of raw-material expenses in the output					0.07	-0.29	-0.05	-0.28	-0.39
Labor costs as a proportion of gross product						-0.10	0.08	-0.69	-0.69
Percentage of exports							0.02	0.33	-0.03
Financing expenses as a proportion of gross product								-0.25	0.05
Rate of investment relative to gross product									0.53

[1] According to the Central Bureau of Statistics Classification, and given the limitations of the division into sectors at a level of up to two digits, we have assigned to the high-tech and the mixed high-tech (unified) sectors, machinery and equipment (29-30), electrical and electronic equipment (31-34), and transport equipment (35). We have included in the mixed-traditional technological sectors, mining and quarrying (13), petroleum and chemicals (23-24), plastic and rubber (25), non-metallic mineral products (26) and basic metals and their products. The traditional-technological sectors are food and beverages (14-16), textiles (17), clothing (18), leather (19), wood (20), paper (21), publishing (22), and furniture (36).

The effect of an interest-rate shock on quantity (Table 6a): We found a positive correlation between the technological level,[19] the extent of local concentration in the industry (the share of large enterprises), the extent of the industry's openness (a high rate of

[19] See the comment to Table 5.

production for export, and a high rate of imports in domestic sales), and the immediate change in the quantity produced in response to a rise in the interest rate. In other words: the more concentrated the structure of the industry, the more advanced it is and the more open it is to overseas—characteristics that are correlated between them to a large extent—the smaller will be the adverse effects of an interest-rate increase on the quantity produced. This behavior could reflect a lower elasticity of demand for the products of more tradable industries, and especially in the industries that export more, relative to the domestic interest rate. This result could reflect also the more moderate effect of credit restrictions on firms in these industries. The larger the firm, the less likely that it will face financing restrictions; therefore the harm caused to its financing ability when the interest rate rises is more moderate, as is the harm caused to the quantity produced (Ribon, 2006). However, because the positive correlation was found for the immediate response, in the first month, it is difficult to connect it to financing difficulties, because these generally develop over time. A further characteristic that emerges from the correlations, and that was found in other research studies,[20] is the dependence on the nature of the product produced.

Table 6a
The correlation between the effect of the interest rate on quantity, and the various characteristics of the industry

	Period 0	In 3 months	In 6 months	In 9 months	In 12 months	In 24 months
Technological level[1]	0.33	-0.02	-0.29	-0.15	-0.08	-0.22
Durables	-0.07	-0.05	-0.33	-0.37	-0.36	-0.38
Proportion of enterprises with 100 or more employees	0.29	-0.15	-0.17	0.01	0.10	0.05
Proportion of imports in sales to the domestic market	0.48	0.20	0.00	0.05	0.08	0.02
Proportion of raw-material expenses in the output	0.02	-0.18	-0.10	-0.08	-0.07	-0.07
Labor costs as a proportion of gross product	-0.35	-0.33	-0.29	-0.18	-0.13	-0.19
Percentage of exports	0.53	0.05	-0.00	0.10	0.16	0.13
Financing expenses as a proportion of gross product	0.16	0.13	-0.05	-0.13	-0.15	-0.16
Rate of investment relative to gross product	0.32	0.31	0.15	0.15	0.15	0.09
Capital/product ratio	0.29	0.44	0.39	0.25	0.18	0.14

[1] See the comment to Table 5.

Industries producing durable products are negatively affected more, in the long term, by interest-rate increases. The explanation given for this is that the demand for durables is more sensitive to the interest rate, and therefore an increase in the interest rate will be

[20] For example Ganley and Salmon (1997) and Dedola and Lippi (2005).

reflected in a greater reduction of demand in these industries. This connection was evident in the declining quantity produced cumulatively in the period from six months to two years. One could assume that in response to an interest rate increase, the purchase of durables does not necessarily decline, but rather is postponed. From an examination of the impulse response function on the various industries, it is difficult to differentiate the duration of the response between durables and other products, and possibly the duration of the demand response to other products is also longer. Also, it is not possible in this framework to differentiate between a real reduction in the purchase of products and a postponement (for a considerable time). Interestingly, industries in which the rate of investment and the capital/product ratio are higher, make smaller reductions in the quantity produced in response to an interest-rate increase—contrary to expectations.

The effect of an interest-rate shock on price (Table 6b): In general we would expect to find that an increase in interest in conjunction with a decrease in price mainly reflects a negative impact on demand, while a reduction in quantity in conjunction with a price rise reflects a negative impact on the supply side.

Table 6b
The correlation between the effect of the interest rate on price and various characteristics of the industry

	Period 0	After 3 months	After 6 months	After 9 months	After 12 months	After 24 months
Technological level[1]	-0.78	-0.53	-0.27	-0.13	0.27	0.38
Durables	-0.46	-0.13	-0.07	-0.11	0.34	0.33
Proportion of enterprises with 100 or more employees	-0.52	-0.52	-0.21	-0.40	0.09	0.30
Proportion of imports in sales to the domestic market	-0.15	0.01	0.19	0.36	-0.09	0.13
Proportion of raw-material expenses in the output	0.31	0.10	-0.07	-0.19	-0.21	-0.30
Labor costs as a proportion of gross product	-0.01	-0.10	-0.07	0.02	-0.10	0.03
Percentage of exports	-0.32	-0.28	-0.14	0.18	0.11	0.28
Financing expenses as a proportion of gross product	0.14	-0.01	-0.02	0.46	0.46	-0.07
Rate of investment relative to gross product	-0.50	-0.23	-0.04	-0.32	0.24	0.29
Capital/product ratio	-0.09	-0.06	0.05	0.14	0.12	-0.06

[1] See the comment to Table 5.

We find that industries characterized by greater concentration and a higher technological level respond with a smaller price rise (or a greater decline) in the short term. This implies that the effect on the supply side in these industries is smaller than the effect on the demand for their products. In industries producing durables, a greater price decline is

evident in the short term as a consequence of an increase in interest, as would be expected. The higher the rate of expenditure on financing, the higher the price rise is expected to be in the medium term (after 9 and 12 months), in accordance with the more significant effect on the supply side. In industries with a high rate of investment, a decrease in price is actually obtained in the immediate term. In the long term, the correlation of the different characteristics with the change in price is in the opposite direction, because of the convergence back to the basic equilibrium.

The effect of an exchange-rate shock on quantity (Table 6c): The table shows a positive correlation between the rate of expenditure on financing as part of the gross product, and the effect of the exchange rate on the quantity. A higher rate of expenditure on raw materials in output also has an effect in the same direction, contrary to expectations. The export rate of the industry and the import rate in total sales in the industry do not have a differential effect on the quantity. A change in the exchange rate is not expected in the short term to change the dollar price of the product and the demand for the product abroad, and therefore no immediate change is expected in the quantity exported.

Table 6c
The correlation between the effect of the exchange rate on quantity and various characteristics of the industry

	Period 0	In 3 months	In 6 months	In 9 months	In 12 months	In 24 months
Technological level[1]	-0.22	-0.20	-0.33	-0.32	-0.27	-0.26
Durables	-0.18	-0.08	-0.22	-0.27	-0.32	-0.40
Proportion of enterprises with 100 or more employees	0.29	0.16	0.15	0.09	0.08	0.06
Proportion of imports in sales to the domestic market	-0.13	-0.07	-0.09	-0.01	0.07	0.14
Proportion of raw-material expenses in the output	0.06	0.24	0.35	0.40	0.39	0.37
Labor costs as a proportion of gross product	-0.45	-0.31	-0.37	-0.25	-0.12	0.00
Percentage of exports	-0.05	-0.03	0.04	0.02	0.05	0.08
Financing expenses as a proportion of gross product	0.44	0.60	0.42	0.37	0.33	0.24
Rate of investment relative to gross product	0.07	0.02	-0.06	-0.13	-0.17	-0.23
Capital/product ratio	0.34	0.19	0.16	0.10	0.03	-0.07

[1] See the comment to Table 5.

In the longer term there may well be an effect on the quantity offered. In industries producing durable goods a rise in the exchange rate tends to reduce the amount produced, possibly because the exchange rate affects costs (raw materials) more than the receipts in these industries.[21] At the same time, we also found a negative connection between the technological level of the industry and the response of the quantity. Industries at a higher

[21] This hypothesis is weakened by the positive correlation between the rate of expenditure on raw materials and the response in the quantity produced.

technological level tend to increase their output less over time as a result of a positive shock in the exchange rate. Possibly in these industries it is the expenditure side that is more affected by changes in the exchange rate than the income side.

The effect of an exchange-rate shock on price (Table 6d): It appears that in more concentrated industries, a temporary increase in the exchange rate is reflected to a greater degree in a price rise. A concentrated industry benefits from a more rigid demand, and can therefore raise its price without significantly jeopardizing quantity.

Table 6d
The correlation between the effect of the exchange rate on price and various characteristics of the industry

	Period 0	After 3 months	After 6 months	After 9 months	After 12 months	After 24 months
Technological level[1]	0.21	0.03	0.20	0.16	0.42	0.22
Durables	0.07	0.18	0.30	-0.04	0.16	-0.11
Proportion of enterprises with 100 or more employees	0.29	0.44	0.42	0.40	0.63	0.75
Proportion of imports in sales to the domestic market	0.06	-0.21	-0.15	0.25	0.21	-0.07
Proportion of raw-material expenses in the output	0.08	0.22	0.15	0.25	0.13	0.30
Labor costs as a proportion of gross product	0.03	-0.19	-0.19	-0.38	-0.40	-0.43
Percentage of exports	0.32	-0.02	-0.10	0.23	0.24	0.20
Financing expenses as a proportion of gross product	-0.34	-0.15	-0.11	-0.03	-0.00	-0.09
Rate of investment relative to gross product	0.12	0.33	0.39	0.22	0.44	0.29
Capital/product ratio	-0.05	-0.04	-0.05	0.10	0.16	0.14

[1] See the comment to Table 5.

All the industries are tradable to some extent, but the extent to which changes in the exchange rate affect the price is dependent on the extent of tradability of the industry—the export rate of domestic industry and/or the existence and scale of import substitutes, and the industry's rate of dependence on imported raw materials. The greater the export rate, or the greater the import of substitute products in the industry, the greater the possibility of matching the domestic price of the product to change resulting from changes in the exchange rate. The greater the rate of imported raw materials in the output, the more the production cost will be affected by changes in the exchange rate, and therefore—also the tendency to change the price of the product in response to an exchange-rate shock. The results obtained show, as expected, that industries with a higher rate of exports have a stronger price response. Furthermore, the greater the rate of expenditure on raw materials in the output, the stronger the price response—also a reasonable result. A positive, albeit weak, correlation was found between the technological level of the industry and the extent of price increases as a result of a positive shock in the exchange rate. Firms with a high rate

of investment, and matched to the rate of exports, will tend to respond more by means of price to an exchange-rate shock.

6. CONCLUSION

The study used data on industrial sectors to examine the transmission mechanism of monetary policy. Applying the VAR technique, we examined the effect of an (unexpected) change in the Bank of Israel interest rate or the exchange rate on prices and quantities in each of 16 industries. We found that raising interest generally leads to a reduction in the quantity produced, combined with a reduction in the price, reflecting the effect on demand. At the same time in some of the industries, and with certain identification restrictions, a rise in prices was recorded at the start of the process. This was also documented in other countries. An exchange-rate shock (depreciation) is clearly reflected in a rise in price in almost all the industries, usually combined with a growth in the quantity. Decomposition of the variance shows that volatility in the exchange rate plays a significant part in explaining an error in forecasting price in the industrial sector as a whole and in the individual industries.

From the estimated system of equations we can also learn about the Bank of Israel's impulse response function. According to the estimation, the central bank responds significantly to exchange-rate shocks, while its response to shocks in quantity and price in industry is not significant. One possible reason for this result is that these variables do not fully represent the macroeconomic developments that the bank examines when it determines the interest rate.

In the second part of the study we examined the connection between the characteristics of the industries and the quantity and price response to changes in interest and in the exchange rate. In general, the paucity of observations does not permit a detailed analysis, and the results, by and large are not clear-cut.

In industries producing durable goods, we found a greater reduction in quantity in response to an interest-rate increase, together with a greater decrease in price—in other words, a more significant effect on the demand for the products produced by the industry—as expected. Industries at a higher technological level and more concentrated in production respond to the interest-rate shock by a smaller increase in prices, from which we can conclude that in these industries the effect on the supply side is smaller than that on the demand side for their products.

We also found that in more concentrated industries a temporary increase in the exchange rate is reflected to a greater extent in prices increases. This is because a concentrated industry benefits from a relatively inelastic demand, and can thus raise prices without significantly jeopardizing quantity.

Appendix
Tests for the existence of a root of unity, 1997-2006

		Industrial production (deducting seasonality)		Prices to the consumer		Labor costs per hour for employees (deducting seasonality)		Export Prices In dollar	
		No. of lags*	P-value**	No. of lags*	P-value**	No. of lags*	P-value**	No. of lags*	P-value**
TOT	Total	2	0.97	2	0.97	2	0.13t	7	0.89
13	Mining & quarrying	1	t 0.13	0	0.89	2	0.78	10	0.81
14–16	Food & beverages	2	0.21	0	0.50	1	0.24 t	4	0.81
17	Textiles	2	0.75	3	0.07	1	0.59	10	0.96
18	Clothing	1	0.44	11	0.24	0	0.68	7	0.97
19	Leather	4	t 0.90	6	0.16	1	0.22 t	10	0.99
20	Wood	0	t 0.15	1	0.65	1	0.27	10	0.15
21	Paper	0	t 0.04	1	0.26	1	0.09 t	4	0.02
22	Publishing	2	0.41	0	0.57t	2	0.72	4	0.69
23–24	Petroleum & chemicals	2	0.99	2	0.91	1	0.15t	7	0.19
25	Plastic & rubber	2	0.97	2	0.96	1	0.00t[1]	4	0.57
26	Non-metallic minerals	3	0.08	0	1.00	2	0.97 t	10	0.96
27–28	Basic metals & their products	2	0.88	3	0.99	2	0.94t	4	0.96
29–30	Machinery & equipment	1	0.20	1	0.15	4	0.95t	7	0.37
31–34	Electrical & electronic equipment	0	0.45	1	0.89	2	0.99t	4	0.90
35	Transport equipment	1	0.63	0	0.27t	2	0.32	7	0.45
36	Furniture	2	0.30	1	0.41	2	0.17	7	0.56
Bank of Israel interest		1	0.34						
Log of exchange-rate level		2	0.09						
Log of prices of importing raw materials (in dollars)		3	0.99						
Log of United States industrial production		3	0.42						

* According to the Schwartz Test. ** *t* indicates inclusion of the trend in the test (without the trend, the variable is obtained as I(0).
** The results of the root of unity examination starting in 1990 show that the existence of a root of unity with a p-value of 0.98 cannot be rejected.

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