Chapter 1

Investment of the Foreign Exchange Reserves[1]

The management of the foreign exchange reserves portfolio, whose average level in 2002 was $ 24 billion, is subject to the Bank of Israel Law 5714–1954 and the relevant legal interpretations which have been added over the years, together with a set of rules which reflect the Bank's responsibility for the reserves.[2] Against the background of the changes in macroeconomic policy and exchange-rate policy, the role played by the reserves has also changed: currently, their main functions are to support financial stability in the economy, to provide a safety net for emergency situations, and to afford the government flexibility in dividing its liabilities between NIS and foreign currency. These aspects of the role of the foreign reserves are similar to those of the reserves of other countries that are comparable to Israel with regard to their macroeconomic policies and their exchange-rate regimes. Studies of the levels of the reserves held by those countries suggest that the level of Israel's reserves is not very different from its expected level.

The holding-period rate of return on the foreign exchange reserves in 2002 was 5.2 percent, down from 6.4 percent in 2001. This reflected the reduction in yield to maturity in capital markets that resulted from the persistent worldwide slowdown in economic activity and the worsening stock market crisis on the one hand, and the low yield to maturity, mainly in the US market, on the other. In NIS terms the holding-period rate of return in 2002 was 17.8 percent, compared to 14.9 percent in 2001, reflecting NIS weakness in these years against the currencies in which the reserves are invested.

The yield on the reserves is greatly affected by the composition of the neutral benchmark, due to the relatively low risk taken in the portfolio, a

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[1] Appendix 1.2 contains a glossary of terms which appear in the Report. More detailed explanations of certain terms and a description of the management of the reserves are given in the Boxes. For a more detailed description of the management of the reserves see various Boxes in Part 1 of the 2000 and 2001 Annual Reports of the Foreign Currency Department, available on the Bank of Israel's website: www.bankisrael.gov.il.

[2] The average level of the reserves in this Report is calculated from the figures of the daily balances of the reserves assessed at their full market value. All the holding-period rates of return in this Report are in terms of the numeraire, unless stated otherwise.

risk that derives from deviations from the benchmark. Much effort has been invested in the last few years in the area of asset allocation (securities not in the benchmark), while on the other hand the scope of positions in the areas of duration and currency management has declined, in accordance with the policy of reducing exposure in these fields. In 2002 the holding-period rate of return was 20 basis points higher than that on the benchmark; this yield differential reflects the contribution of portfolio asset management.

Asset-selection decisions contributed 20 basis points to the yield differential in 2002. This derived from investment in Treasury Inflation-Protected Securities (TIPS) (6 basis points), Eurobonds (6 basis points), mortgage-backed securities issued by the Government National Mortgage Association (GNMAs) (5 basis points), and securities-lending activities (3 basis points). Currency management contributed 3 basis points, while the duration management contribution was a negative 2 basis points.

The exposure of the reserves to the banking system is limited to 25 percent of the value of the portfolio. In 2002 the exposure averaged 20 percent, about half of which was used in securities-lending activities, which have a very short investment horizon. The exposure is managed under a system of quotas and rules which plays a central role in the credit-risk management of the portfolio.

The liquidity of the reserves, that estimates the proportion of the portfolio that can be realized quickly without reducing its value, is very high: 90 percent of the reserves portfolio is invested in very liquid assets, and the rest in assets with lower liquidity. Bearing in mind the high level of the reserves, it seems that the level of liquidity is satisfactory. The high liquidity of the reserves is due on the one hand to the Bank of Israel Law and to the investment policy derived from the spirit of the Law that requires conservative management of financial risks, and on the other hand to considerations of profitability, which in the last few years have led to only partial use of the degrees of freedom to invest in assets with low liquidity.

1. THE RESERVES: THEIR MANAGEMENT, THE PURPOSES OF HOLDING THEM AND THEIR LEVEL

a. The background to the management of the reserves

The management of Israel's foreign exchange reserves is subject to the Bank of Israel Law, 5714–1954 and the relevant legal interpretations which have been added over the years. These define how the Bank may conduct its foreign-currency activities and set limitations on the types of assets it may purchase.

In areas in which the Bank is not restricted by the wording of the law, it always

The management of Israel's foreign exchange reserves is subject to the Bank of Israel Law, 5714–1954, the relevant legal interpretations, and a set of rules that reflects the Bank's responsibility for the reserves.

tends to follow a conservative policy that derives from the spirit of the law, with its guiding principle being the preservation of the real value of the reserves. To follow this principle and ensure that the management of the reserves is appropriate in a changing financial environment, a set of detailed rules has been developed over the years that reflects the Bank's responsibility for the reserves and imposes limits on the different financial risks to which the reserves portfolio may be exposed. The main risks are credit risk, controlled by a system of rules and quotas; interest-rate risk, controlled mainly by setting a target average duration for each currency portfolio; and currency risk, controlled by defining a neutral, currency-risk-free portfolio composition, called the numeraire, that acts as a yardstick for measuring the performance of the actual portfolio.

b. The purposes of holding the reserves

The purposes for which foreign exchange reserves are held have changed over the years, as macroeconomic policy and the exchange-rate regime changed, and with the effects of the financial crises in the last few years in various countries.[3] In the present situation, with policy based on a declared inflation target and what is effectively a floating-exchange-rate regime, the reserves no longer serve as a source of liquidity for the management of exchange-rate policy, as was true in the past.[4] The reserves currently perform functions in several areas. One is in the area of the economy's financial stability. Here one of the roles of the reserves is to lower the probability of a crisis in the foreign exchange market, as investors consider that large reserves of foreign currency help to prevent crises. Other roles of the reserves in this area are to cope with crises or national emergencies and to make capital markets more accessible to Israel. The importance of the reserves in preventing crises, however, is secondary to that of a responsible and credible macroeconomic policy aimed at achieving economic and financial stability. Another area in which the reserves fulfil a function is the division of government debt into local-currency and foreign-currency debt: the reserves afford the government flexibility in managing this composition of the debt via the law that empowers it to repay external debt by purchasing foreign currency from the Bank of Israel with NIS, and vice versa—to borrow from abroad and to convert the loan into local currency at the Bank of Israel as an alternative to borrowing local currency.

The roles played by Israel's foreign exchange reserves are not significantly different from the role of the reserves in other countries with inflation targets and floating-exchange-rate regimes. Most of those countries want to preserve their ability to intervene in the foreign-currency market. Although most of them do so very rarely, they perceive

In the past the reserves served as a source of liquidity for the management of exchange-rate policy. Currently, with policy based on a declared inflation target and what is effectively a floating-exchange-rate regime, their main functions are to support the economy's financial stability and to afford the government flexibility in managing the composition of its debt between local currency and foreign currency.

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[3] This subject is discussed in greater detail, and comparisons drawn with countries whose economies are similar to Israel's with regard to their macroeconomic policy and exchange-rate regimes, in Section 4a of this chapter.

[4] Since the middle of 1997 (except for a few days around the end of that year) the Bank of Israel has not intervened in the foreign-currency market, and states publicly that it is following a policy of non-intervention in trading within the limits of the exchange-rate band.

The roles played by Israel's foreign exchange reserves are not significantly different from the role of the reserves in a reference group of other countries with macroeconomic policies and exchange-rate regimes similar to Israel's.

their ability to intervene should the need arise in extreme circumstances as contributing to the stability of the market. The countries in this group mentioned other functions fulfilled by the reserves, most of them related to improving financial stability and reducing the probability of a crisis in the foreign-currency market. They include raising the confidence of financial markets, ensuring proper foreign-debt servicing, improving the country's international standing and providing a safety net for emergencies. In Israel the reserves also serve to afford foreign-currency liquidity for the government, and this role was mentioned by some of the other countries too (see Section 4a below).
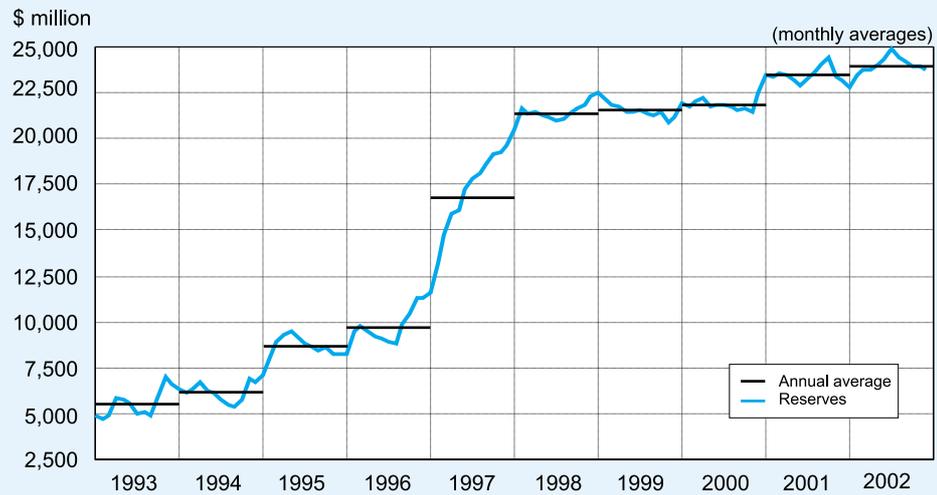
In the light of the changes in the purposes served by the reserves in the last few years, the Bank of Israel is currently reviewing the extent to which its investment policy is appropriate to the reserves' current roles.

c. The actual and desired levels of the reserves

The average level of Israel's foreign exchange reserves in 2002, about $ 24 billion, was slightly higher than their level from 1998 to 2001, and far in excess of their level in any previous year.

At the end of 2002 Israel's foreign exchange reserves stood at $ 23,664 million, a rise of $ 483 million from their level at the end of 2001 (for the reasons for the change see Box 1.1). Their average level in 2002 was about $ 24 billion, slightly higher than their level from 1998 to 2001, and far in excess of their level in any previous year (Figure 1.1). The steep rise in the reserves, mainly in 1995–97, also increased them relative to other economic aggregates which are usually used in assessing the level of the reserves: imports, the external debt, local-currency assets in the hand of the public, and the money supply (Table 1.1).

Figure 1.1
Gross Foreign Exchange Reserves, 1993–2002

$ million
(monthly averages)

SOURCE: Bank of Israel.

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Table 1.1
The Level of the Reserves Relative to Other Aggregates, 1991–2002

(percent)

	Average level of reserves[a]	Imports (months)	Gross external debt[b]	Short-term external debt		Unindexed local-currency assets	Monetary base	Local-currency liabilities in Bank of Israel balance sheet[c]
				excluding suppliers' credit	including suppliers' credit			
1991	6,985	3.2	21	59	–	70	328	–
1992	6,279	2.7	18	55	–	58	283	–
1993	5,510	2.2	15	44	–	45	219	–
1994	6,151	2.2	15	43	–	35	208	–
1995	8,594	2.6	19	50	–	37	295	139
1996	9,665	2.7	21	49	–	35	288	107
1997	16,797	4.7	31	84	69	52	466	110
1998	21,392	6.1	37	108	92	61	520	111
1999	21,569	5.3	35	102	86	55	503	105
2000	21,843	4.5	35	–	81	46	442	97
2001	23,495	5.5	37	–	86	43	421	99
2002	23,948	5.8	36	–	85	48	430	117

[a] Based on estimated daily valuations.
[b] From 1997 this includes suppliers' credit. In 1997 this inclusion reduced the ratio of the reserves to the gross external debt by 2 percentage points.
[c] These liabilities include the monetary base, interest-bearing deposits of the banks, and the Treasury bills deposit.
SOURCE: Bank of Israel, The Central Bureau of Statistics, and returns from the banks.

Box 1.1: The Changes in the Foreign Exchange Reserves and their Causes

The changes in the reserves shown in the following table occurred for several reasons:

• The government receives money in foreign currency from financial aid from the US government and from borrowing. It also incurs expenditure in foreign currency—the repayment of debts and financing other needs abroad. The government's contribution to the reserves may thus be either positive or negative. In 2002 the government's foreign-currency payments offset its receipts, and in total it made a negative contribution (–$ 244 million) to the reserves.

• The Bank of Israel invests the reserves, and positive income on this investment increases them. The Bank of Israel's effect on the reserves, measured in dollars, includes exchange-rate differentials between the currencies included in the reserves portfolio and the dollar. The actual currency composition of the portfolio is determined by a neutral composition

known as the currency numeraire, used by the Bank of Israel as a currency-risk-free composition that serves as a benchmark for assessing the performance of the reserves portfolio.[1] The numeraire contains various currencies, including the dollar; thus when the dollar strengthens against the other currencies in the numeraire, there will be negative exchange-rate differentials, in dollar terms, on the share of the reserves invested in those non-dollar currencies. When the dollar weakens against the other currencies, the exchange-rate differentials will be positive, in dollar terms. In 1999–2001 the dollar strengthened against the other currencies, particularly the euro. In that period the negative exchange-rate differentials offset some of the positive effect of the return on the investment of the reserves. In 2002 the dollar weakened, so that the exchange-rate differentials acted together with the return on the investment to increase the reserves by some $ 2,035 million.

• The domestic commercial banks hold foreign-currency deposits at the Bank of Israel. Some serve to meet the foreign-currency reserve requirement, and the rest are unrestricted deposits. An increase in these deposits raises the foreign exchange reserves, and vice versa. In 2002 the balance of these deposits fell by $ 1,308 million. Most of this decrease, $ 1,115 million, was due to the reduction in the reserve-requirement deposits. These declined mainly due to the gradual reduction in the secondary reserve requirement, a process which started in July 2002 and which is due to be completed in April 2003 when the requirement reaches zero percent.

• Since the middle of 1997, with the exception of a few days around the end of that year, the Bank of Israel has not intervened in the foreign-currency market, i.e., it does not sell the domestic banks foreign currency in exchange for NIS, and does not buy foreign currency from them. Hence trading in the foreign-currency market takes place between active private-sector participants in the market, and does not cause a change in the reserves. The balance between the quantities demanded and supplied—including those related to imports and exports of goods and services and those related to changes in the composition of the assets and liabilities portfolios of domestic and foreign participants in the market—is achieved in the foreign-currency market by changes in the price of the foreign currency, with the domestic commercial banks acting as market makers.

The non-intervention in the market is shown in the table under the item 'Sales of foreign currency by the banks to the Bank of Israel,' the figures for which are zero for the years 1999 to 2002. The amount shown for 1998 represents the Bank's intervention on a few days at the beginning of that year, referred to above.

[1] For a description of the numeraire see Box 1.1 in the 2001 Annual Report of the Foreign Currency Department.

Changes in the Reserves and Their Causes, 1998–2002

($ million)

	1998	1999	2000	2001	2002	1998–2002
Total change in foreign-exchange reserves	**2,342**	**–159**	**649**	**17**	**483**	**3,332**
Causes of the change (1)+(2)+(3)						
1. The government (including the Jewish Agency)	**804**	**–608**	**70**	**–945**	**–244**	**–923**
2. Bank of Israel	**1,595**	**–199**	**971**	**1,067**	**2,035**	**5,469**
Interest on capital gains	1,205	645	1,451	1,347	977	5,625
Exchange-rate differentials	390	–844	–480	–280	1,058	–156
3. The private sector	**–57**	**647**	**–392**	**–106**	**–1,308**	**–1,216**
Change in the banks' nondirected deposits	–35	485	–493	259	133	349
Change in foreign-currency reserve-requirement deposit	–334	101	31	–168	–1,115	–1,485
Banks' sale of foreign currency to the Bank of Israel	492	0	0	0	0	492
Statistical adjustments	–180	62	70	–196	–326	–570
Total reserves (end of period)	**22,674**	**22,515**	**23,164**	**23,181**	**23,664**	

SOURCE: Bank of Israel.

Holding the reserves incurs a cost, as the yield on them is generally lower than the cost to the country of borrowing in Israel or abroad. The increase in the size of the reserves thus raises the question of what is their appropriate level, i.e. that would enable the Bank to achieve the purposes for which the reserves are held.

The level of Israel's reserves may be assessed by means of a comparison with the level of reserves in other countries which have similar macroeconomic policies and exchange-rate regimes to Israel's. Figure 1.2 shows the level of the reserves relative to certain debt and asset aggregates in Israel and in a selection of similar countries, i.e., countries which have inflation-target policies and floating-exchange-rate regimes, with either a completely free float, or a float within a wide band.[5] It can be seen from the figure that each of the variables differs widely from country to country, and the level of Israel's reserves relative to each variable is well within the range. With regard to the size of the reserves relative to the external debt Israel is quite high on the list of countries: only two other countries have significantly higher reserves relative to their external debt, and more than half of the countries have lower levels. In the ratings according to the ratio of the reserves to the short-term external debt (for repayment within a year) and their ratio to the government's external debt Israel is in a lower position than most of the other countries. In the ratio of the reserves to total government debt and to the wider money supply (M2), Israel is close to the median position.
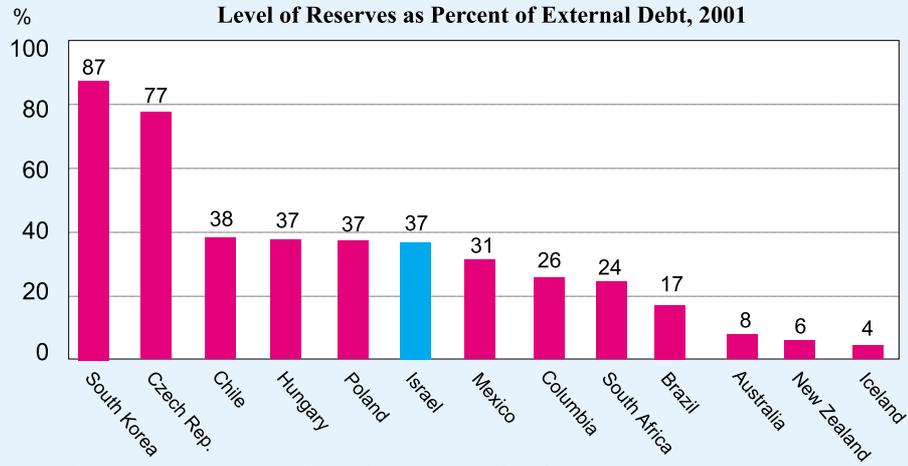
In international discussions in the last few years it has been suggested that a rule should be introduced determining that the level of the foreign exchange reserves should be similar to that of the short-term external debt, as this would help engender a feeling of security among foreign investors, and hence contribute to economic stability. Several countries, some of them included in the reference group, have in fact adopted this rule, and in practice the reserves in more than half of the countries in the group are higher

The question arises of what is the appropriate level of the reserves that would enable the Bank to achieve the purposes for which they are held.
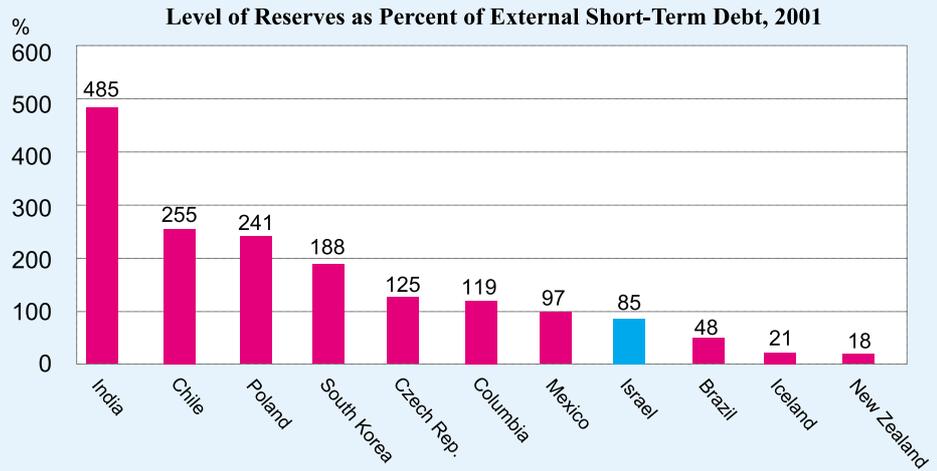
A comparison of the level of the reserves relative to certain debt and asset aggregates in Israel with those levels in a reference group of other countries shows that each of the variables differs widely from country to country, and the level of Israel's reserves relative to each variable is well within the range.

[5] For details of the countries included see Section 4a below. The grading of the countries by each of the variables in Figure 1.2 is in some instances based on data relating to only some of the countries.
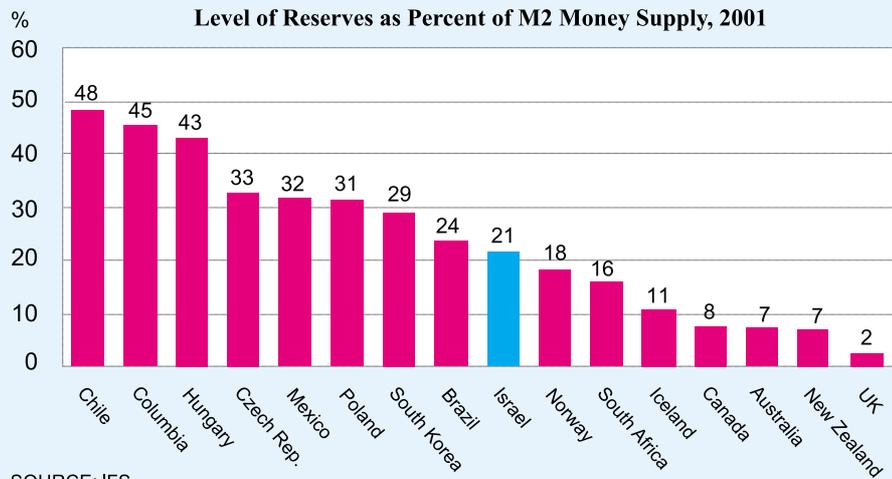
Figure 1.2
The Level of the Reserves Relative to Various Aggregates, 1999–2001

Level of Reserves as Percent of External Debt, 2001

%

87 — South Korea
77 — Czech Rep.
38 — Chile
37 — Hungary
37 — Poland
37 — Israel
31 — Mexico
26 — Columbia
24 — South Africa
17 — Brazil
8 — Australia
6 — New Zealand
4 — Iceland

SOURCE: Moody's, internet sites of central banks, Bank of Israel.

Level of Reserves as Percent of External Short-Term Debt, 2001

%

485 — India
255 — Chile
241 — Poland
188 — South Korea
125 — Czech Rep.
119 — Columbia
97 — Mexico
85 — Israel
48 — Brazil
21 — Iceland
18 — New Zealand

SOURCE: Moody's, internet sites of central banks, Bank of Israel.

Level of Reserves as Percent of M2 Money Supply, 2001

%

48 — Chile
45 — Columbia
43 — Hungary
33 — Czech Rep.
32 — Mexico
31 — Poland
29 — South Korea
24 — Brazil
21 — Israel
18 — Norway
16 — South Africa
11 — Iceland
8 — Canada
7 — Australia
7 — New Zealand
2 — UK

SOURCE: IFS.

Figure 1.2 (continued)

Level of Reserves as Percent of Total Government Debt, 1999

%

Czech Rep.	204
Chile	154
Poland	41
Hungary	40
Australia	35
Mexico	26
New Zealand	23
Israel	21
Iceland	19
Sweden	13
South Africa	12
UK	7
Canada	7

SOURCE: IFS.

Level of Reserves as Percent of Government External Debt, 2000

%

Czech Rep.	1667
Chile	583
South Korea	516
Hungary	295
South Africa	187
Canada	143
New Zealand	98
Israel	86
Poland	83
Mexico	57
Sweden	38
Iceland	27

SOURCE: IFS.

than the short-term external debt. The Bank of Israel has not adopted this rule regarding the desired level of the reserves, and the fact that Israel's reserves are close to the level of its short-term external debt is not the result of a policy decision.

Various studies and statistical analyses that show a connection between the level of the reserves and various economic variables provide other yardsticks for assessing the level of the reserves:

A group of researchers in the Inter-American Development Bank[6] examined the connection between the level of the reserves on the one hand and the passthrough coefficient from the exchange rate to inflation and the degree of currency exposure of the business sector on the other. Applying this approach to the reference group of countries yields the result that the level of the reserves in Israel is not different from the level expected from the behavior of those countries (see Section 4a below).

[6] R. Hausmann, U. Panizza and E. Stein, "*Why Do Countries Float The Way They Float?*" IADB Research Department Working Paper 418, May 2000.

Studies that estimate the desired level of reserves in countries comparable to Israel—based on the coefficient of the passthrough from the exchange rate to inflation and the currency exposure of the business sector and on the size of the economy and degree of geographical diversification of capital—show that the level of reserves in Israel is not very different from the desired level.

A study by the Foreign Currency Department of the Bank of Israel explains the level of a country's reserves by the size of the economy and the geographical diversification of capital. Israel's level is within the range estimated by this model. Another finding was that the risk of a major crisis in the foreign-currency market is highest when the size of the reserves is significantly out of line with the size of the economy (see Section 4b below).

The question of the desired level of the reserves requires further study, but based on the various comparisons and research described above, their level in Israel appears to be close to the desired level, using accepted yardsticks.

2. YIELD AND RISK IN MANAGING THE RESERVES

a. The return on the reserves portfolio

The holding-period rate of return was 5.2 percent in 2002, down from 6.4 percent in 2001, and below the average of 5.5 percent in the years 1993–2002. In NIS terms the return was 17.8 percent in 2002, reflecting the weakening of the NIS against the currencies in which the reserves are invested.
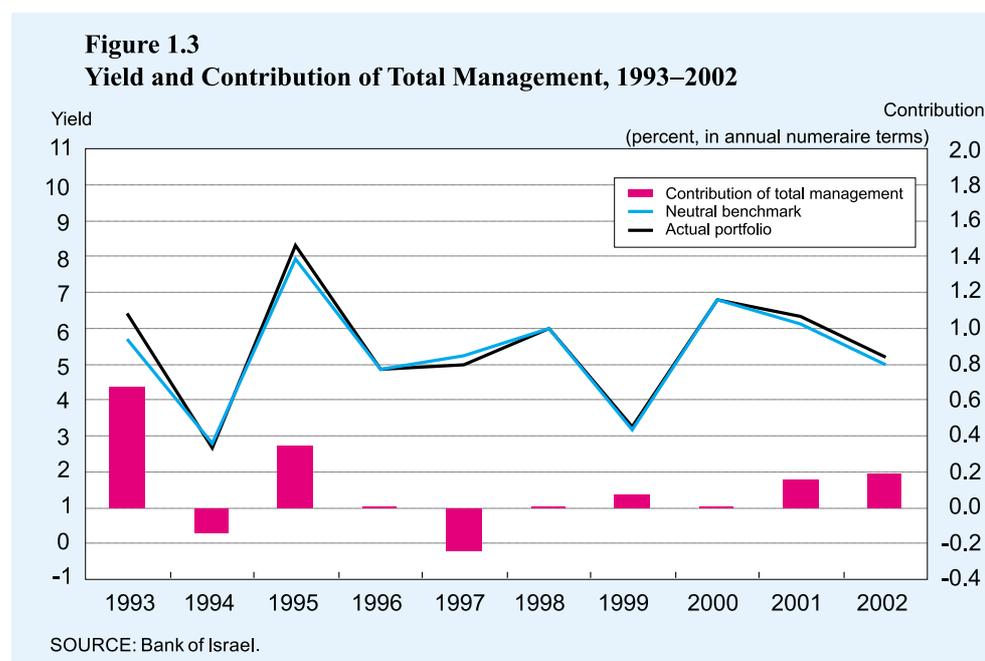
The holding-period rate of return on the foreign exchange reserves is generally assessed by the Bank of Israel in terms of a basket of currencies, the numeraire, which reflects the composition of imports and debt repayments. The total holding-period rate of return in terms of the numeraire was 5.2 percent in 2002, down from 6.4 percent in 2001, and below the average of 5.5 percent in the years 1993–2002 (Table 1.2 and Figure 1.3). In NIS terms the return was 17.8 percent in 2002, compared with 14.9 percent in 2001 and 1.8 percent in 2000. The local-currency rates of return in 2001 and 2002 reflect the weakening of the NIS against the currencies in which the reserves are invested, in

Figure 1.3
Yield and Contribution of Total Management, 1993–2002

SOURCE: Bank of Israel.

Table 1.2
The Performance of the Actual Portfolio vis-à-vis the Neutral Benchmark Portfolio, 1992-2002

(percent, in annual terms)

| | Portfolio performance | | Incremental yield | | Asset and duration management | | | Asset and dispersion management | | |
	Actual portfolio	Neutral benchmark	Total	Currency management	Total	Decision to invest in GNMA	Duration management	Total	Asset management	Dispersion management
1992	7.40	6.90	0.45	0.12	0.33	–	–	–	–	–
Standard deviation	1.07	0.76	0.51	0.29	0.50					
1993	6.42	5.70	0.68	0.04	0.64	–	0.26	0.38	–	–
Standard deviation	0.89	0.55	0.42	0.21	0.43					
1994	2.68	2.81	–0.13	–0.01	–0.12	0.27	0.19	–0.57	–	–
Standard deviation	0.75	0.62	0.32	0.07	0.33					
1995	8.31	7.94	0.35	0.35	0.00	–0.10	0.26	–0.16	–	–
Standard deviation	0.56	0.56	0.24	0.10	0.21	0.05	0.19	0.10	–	–
1996	4.87	4.86	0.01	–0.01	0.02	0.03	–0.11	0.11	0.20	–0.09
Standard deviation	0.70	0.59	0.23	0.10	0.17	0.05	0.16	0.06	0.08	0.03
1997	4.99	5.24	–0.24	–0.26	0.02	0.03	–0.17	0.17	0.18	–0.01
Standard deviation	0.44	0.49	0.16	0.08	0.12	0.02	0.09	0.06	0.07	0.02
1998	6.00	5.99	0.01	0.00	0.01	–0.03	0.01	0.04	0.10	–0.07
Standard deviation	0.63	0.69	0.08	0.03	0.08	0.06	0.02	0.05	0.05	0.02
1999	3.26	3.17	0.08	0.02	0.06	0.03	–0.06	0.10	0.05	0.05
Standard deviation	0.66	0.60	0.13	0.02	0.13	0.05	0.08	0.07	–	–
2000	6.79	6.78	0.01	–0.15	0.16	–0.04	0.00	0.20	0.19	0.01
Standard deviation	0.89	0.86	0.11	0.06	0.10	0.03	0.02	0.10	–	–
2001	6.35	6.13	0.17	0.00	0.16	–0.05	–0.01	0.22	0.23	–0.01
Standard deviation	1.44	1.36	0.20	0.03	0.10	0.04	0.04	0.08	0.09	0.00
2002	5.18	4.98	0.20	0.03	0.17	0.00	–0.02	0.19	0.20	–0.01
Standard deviation	1.32	1.41	0.17	0.04	0.16		0.05	0.09		
1992–2001	5.65	5.44	0.05	0.01	0.12	–	–	–	–	–
1993–2001	5.47	5.35	0.11	0.00	0.11	0.01	0.03	0.07	–	–

SOURCE: Bank of Israel.

contrast to its strengthening in 2000. Over the last ten years the holding-period rate of return in local-currency terms came to 11.0 percent a year, or, after deducting domestic price rises, to a real return of 4.0 percent a year over that period.

b. Factors affecting the holding-period rate of return

Three main factors affect the holding-period rate of return on the foreign exchange reserves: (i) developments in the financial markets; (ii) long-term investment decisions

relating to the currency composition, duration, asset composition of the investment and the dispersion along the yield curve—these decisions are expressed in the composition of the neutral benchmark of the portfolio;[7] and (iii) decisions on deviations from the neutral benchmark (day-to-day portfolio management).

(i) Market developments

The holding-period rate of return reflects the decline in 2002 in yields to maturity in the capital market that derived from the persistent economic slowdown and the deepening crisis in stock markets, and the low level of yields to maturity, particularly in the US market.

In the US and European financial markets yields to maturity declined in 2002, continuing the downward paths followed in 2001. Yields to maturity in the long-term parts of the yield curves declined more than in their short ends; thus the curves flattened in 2002. The changes in yields to maturity reflected the persistent global slowdown and the crisis in stock markets that caused investors to switch to safer assets. The slow growth in 2002 had not been forecast, so that central banks, having pursued very expansionary policies in 2001, rejected further expansionary measures in 2002. Such measures were adopted only towards the end of the year—in November in the US, and in December in Europe. The reduction in the yields to maturity was expressed in a rise in bond prices and made a positive contribution to the holding-period yield. The holding-period rate of return is affected not only by changes in the yields to maturity but also by the level of the yields. The expansionary monetary policy pursued by the US in 2002 led to a slump in yields to maturity in the US market to levels not seen in the last forty years (see Figure 1.20). The low yields to maturity depress the current income component (the carry) of the holding-period rate of return, thereby reducing the return on the reserves (for details of developments in the markets see Appendix 1.1).

The spreads between the yields to maturity on Treasuries and the yields on spread assets, which affect the performance of the spread assets included in the portfolio, continued to contract in 2002, following the trend that started at end-2000. The main reasons were the switch in the US budget from surplus to deficit, and the shortening of time to maturity of issues of US Treasuries.

The differentials between the yields to maturity on Treasuries and the yields on spread assets affects the performance of the spread assets included in the portfolio. These differentials continued to shrink in the first half of 2002, continuing the trend that had started in the last few months of 2000. In the middle of 2002 the differentials widened, and narrowed again in the last few months of the year, reverting to the mid-year level (Figures A.1.1–1.4). This latter trend, very notable in the US market, had two main causes: the change in the US budget from a surplus to a deficit, and a change in the issuance policy of the US Treasury in favor of issues with short-term maturities, a change which led to a reduction in the differentials at the short-term end of the yield curve. The widening of the differentials mid-year reflected a rise in the risk of spread assets that accompanied the revelation of improper accounting by several leading US companies and a number of bankruptcies.

(ii) The benchmark

The benchmark is the decisive factor in determining the holding-period rate of return of the portfolio. In 2002 the holding-period rate of return of the benchmark was 5.0 percent, and its volatility, 1.4 percent.

(a) *The yield and risk of the benchmark*: With given market developments, the benchmark is the decisive factor in determining the holding-period rate of return of the portfolio, because of the relatively low risk added by the active management of the portfolio, risk that arises from deviations of the actual portfolio from the benchmark. In 2002 the holding-period rate of return of the benchmark was 5.0 percent, and its volatility, 1.4 percent.

[7] See Box 1.2 in the 2001 Annual Report of the Foreign Exchange Department.

Figure 1.4
Distribution of Yields of the Portfolio and the Benchmark, 1993−2002

Yield (Percent, in annual numeraire terms)

Years ranked by yield on actual portfolio				
Benchmark		Portfolio		
Standard deviation	Yield	Standard deviation	Yield	
0.6	7.9	0.6	8.3	1995
0.9	6.8	0.9	6.8	2000
0.5	5.7	0.9	6.4	1993
1.4	6.1	1.4	6.3	2001
0.7	6.0	0.6	6.0	1998
1.4	5.0	1.3	5.2	2002
0.5	5.2	0.4	5.0	1997
0.6	4.9	0.7	4.9	1996
0.6	3.2	0.7	3.3	1999
0.6	2.8	0.7	2.7	1994

SOURCE: Bank of Israel.
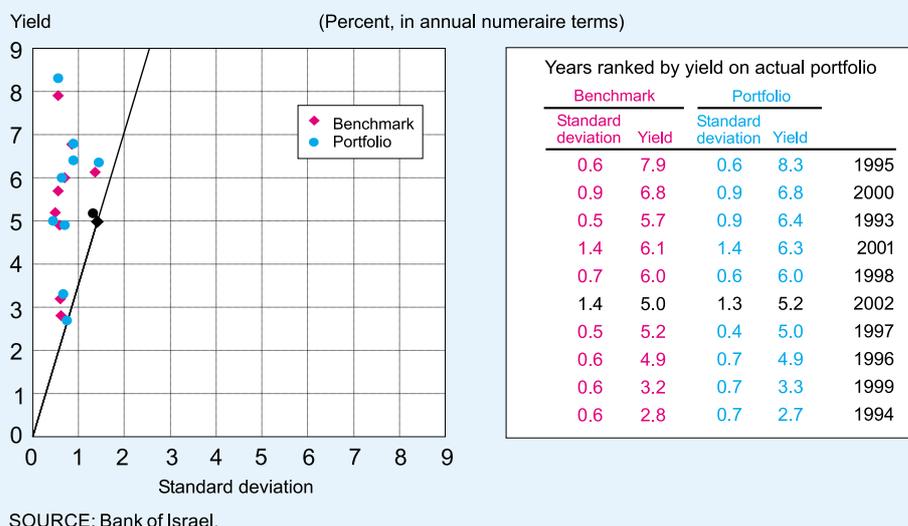
Figure 1.4 shows the holding-period rate of return of the benchmark and of the portfolio and their volatilities for each year since 1993; it can be seen that the rate of return of the portfolio and its volatility were very close to those of the benchmark every year. The figure also highlights the fluctuations in the annual holding-period rates of return of the benchmark and of the portfolio that result from market developments in the different years. The relative stability of intra-year volatility stands in sharp contrast to the fluctuations in the holding-period rates of return. In 2001 and 2002, however, the intra-year volatility of the returns was higher than in the other years, reflecting a rise in the level of risk in the markets in those two years. Market developments in 2002 that led to a combination of higher volatility and a lower holding-period rate of return than in most other years, are expressed by the lower return/risk ratio of the benchmark than in previous years. (Figure 1.4 reflects this in that the observations for all the previous years are above the line joining the observation for 2002 with the origin of the graph.)

Volatility, used above as a risk index, is symmetrical with regard to risk: it expresses the risk of obtaining a return significantly different from the average, either higher or lower. Another index of risk, that estimates the risk of a loss, is provided by the value at risk (henceforth VaR), an estimate of the maximum capital loss that could be incurred within a certain time period and with a certain probability. The VaR of the currency components of the benchmark provides an estimate of market risk in the main markets in which the reserves are invested. Figure 1.5 shows the movements of the VaR of these components.

The rate of return of the portfolio and its volatility were very close to those of the benchmark every year.

Higher volatility and a lower holding–period rate of return in 2002 than in most previous years were reflected in a lower ratio of return to risk in the benchmark.

The Department uses VaR to estimate risks in various financial markets.

13

Figure 1.5
VaR of Various Benchmarks, 1999–2002

SOURCE: Bank of Israel.

The following points emerge from the figure:

- The VaR of the benchmark portfolio in 2002 is estimated at between 0.25 percent and 0.30 percent of the value of the portfolio.[8] This means that in 2002 the risk of a capital loss in excess of $ 65 million in one week was smaller than 5 percent.

- The risk in the US market went down in 2002, after rising steeply in 2001 due to increased economic uncertainty and the rapid deterioration in the security situation following the terrorist attacks of September 11 and the Enron bankruptcy at the end of the year.

- The risk level of the US market in 2002 remained higher than that of the European markets, although the risk gaps narrowed greatly.

- The risks in the various markets, that had fallen slightly in the first half of 2002, rose again in the second half, due to increased uncertainty about economic recovery, the lack of confidence caused by the revelation of serious irregularities in the financial reports and activities of many companies, mainly in the US, and the rise in the geo-political risk related to the approaching confrontation with Iraq.

(b) *The effect of changes in the structure of the benchmark*: The benchmark serves as a means of managing financial risks of the portfolio. Its composition thus reflects the long-term strategy guiding the investment of the reserves, and is not changed very often. Nevertheless, its characteristics and appropriateness are reviewed from time to time, and several changes have been made:

Towards the end of 2002 the benchmark duration of the dollar portfolio was shortened from 16 months to 11 months, in the light of the low yields to maturity in the US bond

[8] The calculation does not take into account correlations between the different markets, and is thus a conservative estimate of the risk.

The risk in the US market went down in 2002, after rising steeply in 2001. The risk level of the US market in 2002 remained higher than that of the European markets, although the risk gaps narrowed greatly. The risk of a capital loss in excess of $ 65 million in one week in 2002 was smaller than 5 percent.

At the end of 2002 the benchmark duration of the dollar portfolio was shortened from 16 months to 11 months, in the light of the low yields to maturity in the US market that increased the risk that the dollar portfolio would give a negative holding-period rate of return.

market. With yields at such low levels, there was greater risk that the dollar portfolio, the largest of the currency portfolios, would give a negative holding-period rate of return in the following year, because even a relatively small rise in yields would result in capital losses that would outweigh interest income. When the yields over different periods rise uniformly, a longer portfolio gives larger capital losses. To reduce this risk, the duration of the dollar benchmark was shortened, as stated. At the same time it was decided to shorten the maximum period to maturity of the assets in the benchmark from five years to three, to avoid a situation in which the share of long assets in the new benchmark would be too small (see Section 4c below).

The duration of the portfolio had previously been changed in 1999, when it was extended from 12 months to 16 in the light of research carried out by the Foreign Currency Department showing that the yield over time on investment for a period of 16 months was higher than that of 12 months, and that the probability that in any year the yield would be below a pre-determined threshold is very low.[9] At that time it had also been decided to extend the maximum period to maturity of the assets in the portfolio from three years to five, to avoid a situation in which the share of short assets in the new benchmark would be too small.

The quality of decisions regarding the composition of the benchmark can be checked only over a sufficiently long period because as stated the benchmark reflects a long-term investment strategy. Nevertheless, following the decision described above to shorten the dollar benchmark, a review was carried out to summarize the period when the duration of the dollar benchmark was 16 months in order to assess that decision. The results, given in Table 1.3, show that in every year since the duration was lengthened, the holding-period rate of return of the extended (16-month) benchmark was above the minimum threshold set, both in the US market and in the German market.[10] Lengthening the benchmark helped to increase the holding-period rate of return in both markets. The change in the dispersion of the benchmark assets had different effects in different parts of the period; its cumulative effect was negative in both markets, and partially offset the incremental yield gained by lengthening the benchmark. The total incremental yield resulting from the change in the dollar benchmark came to 24 basis points a year, and that in the German market has to date amounted to only 4 basis points a year.

(iii) Current portfolio management—deviations from the benchmark
The third factor explaining the level of the holding-period rate of return is, as stated, current management of the portfolio, in the course of which decisions are taken regarding its currency composition, duration, and the selection of assets and their dispersion over the yield curve. In each of these features, the portfolio can either match the neutral benchmark or deviate from it, within the permitted degrees of freedom. A deviation

[9] A detailed description of the research appears in Box 1.4, pp. 16 and 17 in the 2000 Annual Report of the Foreign Currency Department, Bank of Israel.
[10] To perform the check, portfolios with 12-month and 16-month durations were constructed with different asset dispersions, according to principles similar to those used to build the neutral benchmark portfolio. For simplicity, assets on the German market were taken as representing the benchmark assets of the euro portfolio, although the latter incorporates assets issued by other countries too.

The duration of the portfolio had been extended in 1999 from 12 months to 16 months based on research showing that this would raise the return over time, and that the probability of the return being below a pre-determined threshold in any year was very low.

In every year from 1999 to 2002 the holding-period rate of return of the extended (16-month) benchmark was above the minimum threshold set, in both the US and German markets. The total incremental yield to date resulting from the change in the dollar benchmark came to 24 basis points a year, and that in the German market to only 4 basis points a year.

The management contribution to incremental yield is the spread between the holding-period rates of return of the benchmark and the portfolio; it results from decisions to deviate from the benchmark composition. In 2002 management contributed 20 basis points to the overall yield of the portfolio, with a volatility of 16 basis points.

Table 1.3
The Effect of the Change in the Neutral Duration, 1999-2002

(percent, in annual terms)

	Holding-period rate of return of neutral benchmark				Yield spread		
	12-month duration	16-month duration					Over
	Up to 3 years dispersion	Up to 3 years dispersion	Up to 5 years dispersion	Minimum threshold [a]	Duration decision	Dispersion decision	minimum threshold
	(1)	(2)	(3)	(4)	(2)–(1)	(3)–(2)	(3)–(4)
US							
1999	3.83	3.44	3.26	2.43	–0.39	–0.18	0.83
2000	7.13	7.56	7.64	3.09	0.43	0.08	4.55
2001	6.58	7.50	6.59	2.21	0.92	–0.91	4.38
2002	3.86	4.84	4.86	0.89	0.98	0.02	3.97
1999–2002	5.35	5.83	5.59		0.48	–0.24	
Germany							
1999	2.34	2.14	1.80	1.39	–0.20	–0.34	0.41
2000	4.34	4.49	4.62	2.06	0.15	0.13	2.56
2001	5.09	5.36	5.04	2.17	0.27	–0.32	2.87
2002	4.49	4.95	4.95	1.65	0.46	0.00	3.30
1999–2002	4.06	4.24	4.10		0.18	–0.14	

[a] Fifty percent of the yield on a risk-free asset. In the dollar portfolio this asset was defined as a 3-month Treasury bill, and in the euro portfolio as the one-month LIBOR interest rate.
SOURCE: Bank of Israel and Bloomberg.

Table 1.4
Contribution of Management Decisions to the Yield Spread
vis-à-vis the Neutral Benchmark, 2002

(basis points, in annual terms)

	Total contribution	Duration	Investment in the GNMA sector	Asset Selection	Dispersion along curve	Currency Management
Total[a]	**19.6**	**–1.9**	**–0.4**	**20.5**	**–1.4**	**2.8**
Currency portfolios						
Total[a]	**16.8**	**–1.9**	**–0.4**	**20.5**	**–1.4**	
Dollar portfolio	17.6	–2.0	–0.4	21.3	–1.3	
Euro portfolio	–1.0	–0.2		–0.7	–0.1	
Other portfolios	0.2	0.3		–0.1	0.0	
Currency positions	**2.8**					**2.8**

[a] The total contribution equals the total of the contributions from the different decisions and from the different portfolios for each month. In switching to an annual calculation differences between them may be introduced.
SOURCE: Bank of Israel.

from the benchmark composition (a position) means a difference in yield from that of the benchmark, together with an increase in risk. Comparing the yield of the benchmark with that of the actual portfolio enables the contribution of current management to the yield to be assessed. The comparison shows that in 2002 management contributed 20 basis points to the overall yield of the portfolio. The volatility of this spread was 16 basis points (Tables 1.2 and 1.4, and Figures 1.3 and 1.6).

Figure 1.6
The Cumulative Yields of the Actual Portfolio and the Benchmark
and the Monthly and Cumulative Contribution of Active
Management, 2002
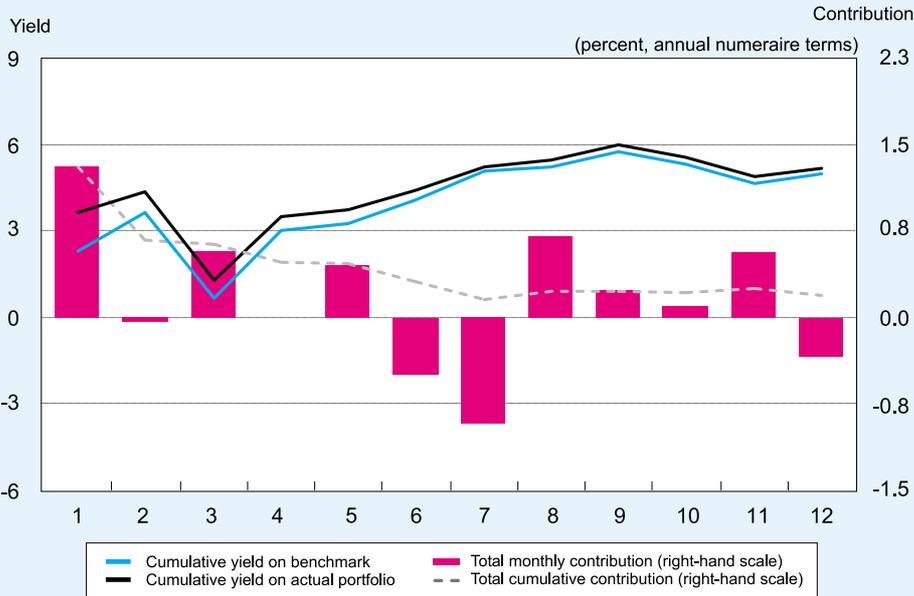
SOURCE: Bank of Israel.

Figure 1.7
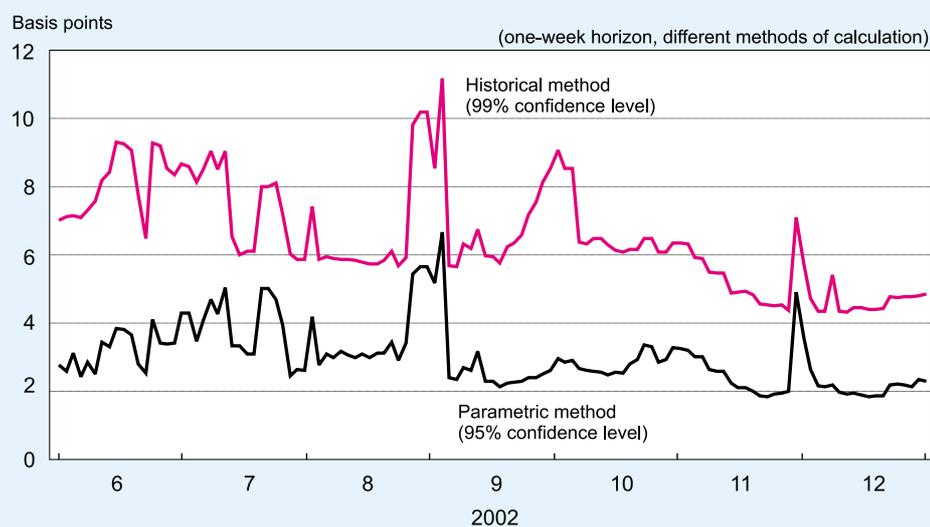**Yield Spreads vis-à-vis the**
Benchmark, 1993–2002
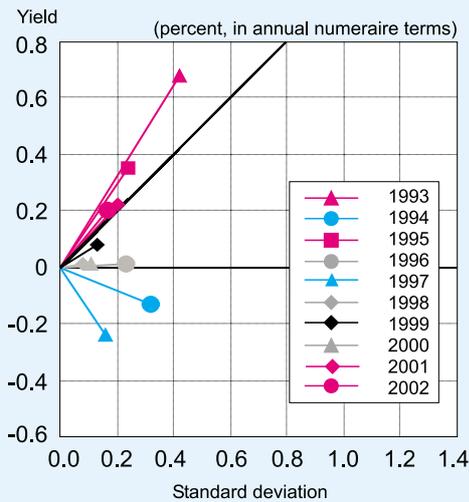
SOURCE: Bank of Israel.

The yield spreads vis-à-vis the benchmark and their volatility indicate management expertise, i.e., management's ability to outperform the benchmark consistently over time. As the performance of each manager fluctuates, the best result is the achievement of a positive incremental yield together with relatively low volatility.

Figure 1.7 and Table 1.2 show the average yield spreads and their volatility for each year from 1993 to 2002. The ratio of the incremental yield to its volatility (the 'information ratio') is reflected in the figure by the slope of the line for each year. The objective is to achieve a ratio greater than one, because in that situation the incremental yield more than compensates for the additional risk incurred. The figure shows that the ratio

The ratio of the incremental yield to its volatility, which indicates the ability to outperform the benchmark over time, was positive in most years in the last decade, and greater than 1 in four of them.

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Figure 1.8
The VaR of the Portfolio vis-à-vis the Benchmark (the VaR of the Positions),
June–December 2002

Basis points

(one-week horizon, different methods of calculation)

Historical method
(99% confidence level)

Parametric method
(95% confidence level)

2002

SOURCE: Bank of Israel.

exceeded one in 1993, 1995, 2001 and 2002 (the slope of the lines in those years was greater than the slope of the rising dotted line, which represents a ratio of 1), it was close to one in 1999, and it was negative in only two years in the last decade.

Another indicator of the risk incurred by various positions vis-à-vis the benchmark is provided by the Value at Risk (VaR) of the positions, i.e., the VaR of the difference between the actual portfolio and the benchmark. The VaR of the positions during the second half of 2002, calculated in various ways, is shown in Figure 1.8.[11] It can be seen that the VaR measured by the parametric method[12] fluctuated between 0.02 percent and 0.06 percent of the value of the portfolio, with an average of 0.025. This does not take into account the positions in GNMAs and TIPS. If the estimated VaR of these investments is included in the calculation, the average VaR of the positions is 0.05 percent of the value of the portfolio. This means that in the period reviewed the chances of losing more than about $ 12 million on these positions in one week was less than 5 percent. By comparison, the incremental yield of 19 basis points for the year was worth about $ 46 million.

The VaR of the positions during the second half of 2002 was 0.05 percent of the value of the portfolio. This means that the chances of losing more than about $ 12 million on these positions in one week was less than 5 percent, while the incremental yield of 19 basis points for the year was worth about $ 46 million.

[11] For technical reasons the VaR of the positions calculated by various methods and shown in Figure 1.8 does not include the VaR of the positions in GNMAs and TIPS. The VaR of those positions in the period under review is estimated at about 2.5 basis points on average.

[12] In this method parameters of the distribution are estimated from historical data of the holding-period rates of return of different assets. Assuming that the yield distribution is normal, a link can be established between the estimated standard deviations and the probability of a specified loss or profit. The VaR using the parametric method and shown in Figure 1.8 makes this assumption, and is calculated for a one-week horizon at a 95% confidence level.

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The VaR calculated by the parametric method but at a 99% confidence level[13] shows the loss that could be incurred under more extreme circumstances. The data show that in such cases the VaR of the positions opened in the portfolio increased to up to three times that estimated by the parametric method, that gives an estimate of VaR in 'normal' times. This approach to the historical VaR is consistent with the estimate of the loss that the positions at the end of 2002 were likely to incur in the 'worst case scenario' in the markets (0.14 percent of the value of the portfolio).

The changes in the VaR of the positions reflect the size of the positions and also the changes in risk in the market, described above. The fact that the VaR is relatively low derives from the relatively small actual positions. Full utilization of the degrees of freedom afforded to the Foreign Currency Department in management of the various risks would raise the VaR of the positions to 0.24 percent of the value of the portfolio.

c. The yield on the reserves portfolio compared to that achieved by other managers

Comparing the performances of different portfolios is problematic, firstly because they are generally managed against different benchmarks, and secondly because of the different investment policies governing them. Nonetheless, something can be learned from a comparison of similar portfolios.

Information is available relating to the performance of several funds which operated in the US market from 1994 to 2002. The group consists of nine funds which invest mainly in US government bonds. Some are classified as 'Investors in short Treasuries,' and the others as 'Investors in medium Treasuries.' The funds do not invest a large part of their portfolios in TIPS, and invest only a very small amount in assets with ratings lower than AA. These features enable the performance of the Bank of Israel's dollar portfolio to be compared with that of the funds, despite the differences between them.

Figure 1.9a shows the distribution since 1994 of the annual holding-period rates of return of the funds in the group, as well as the yield distributions of each of the sub-groups (i.e., those investing in short-term Treasuries and those in medium-term) (Figure 1.9b). For each period the lowest, average, and highest yield of the portfolios in the group are shown. The performances of the Bank of Israel's dollar portfolio and that of the dollar benchmark are also shown in the relevant periods. The results show that throughout the period the performance of the Bank's dollar portfolio was within or higher than the range of distribution of the funds' performance. In the years when the dollar portfolio outperformed the funds (in 1994, 1996 and 1999), the yields to maturity in the US Treasury market rose, and the performance of the short funds exceeded that of the medium ones. The better performance of the dollar portfolio at these times suggests that it has a shorter duration than those of the other funds, which would also explain its relatively low position among the holding-period rates of return in the years when the yields to maturity declined.

[13] This method is also based on historical data of holding-period rates of return, but makes no assumption about the distribution. Actual profit-and-loss is graded, and the VaR is determined according to its position in the grading. The VaR using this method and shown in Figure 1.8 is calculated for a one-week horizon at a 99% confidence level.

The estimate of VaR under extreme circumstances is three times greater than that in 'normal times,' and came to 0.14 percent of the value of the portfolio.

Full utilization of the degrees of freedom afforded to the Department in risk management would have raised the VaR of the positions to about 0.24 percent of the value of the portfolio.

Comparing the performances of different portfolios is problematic; nonetheless, something can be learned from a comparison of similar portfolios.

The performance of the Bank's dollar portfolio in the last few years was within or higher than the range of performance of comparable funds.

Figure 1.9
Performance Distribution of Managers of Short- and Medium-Term Funds in US Market, 1994–2002
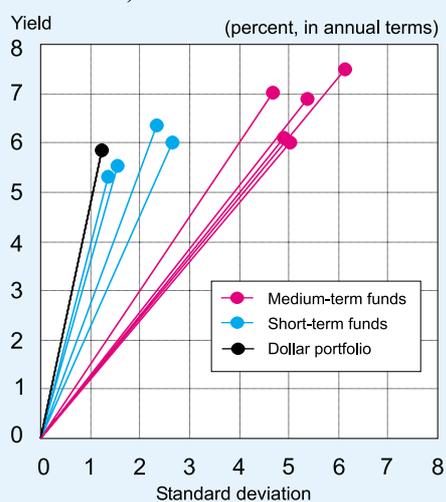

a. All funds

b. Short- and Medium-Term Funds
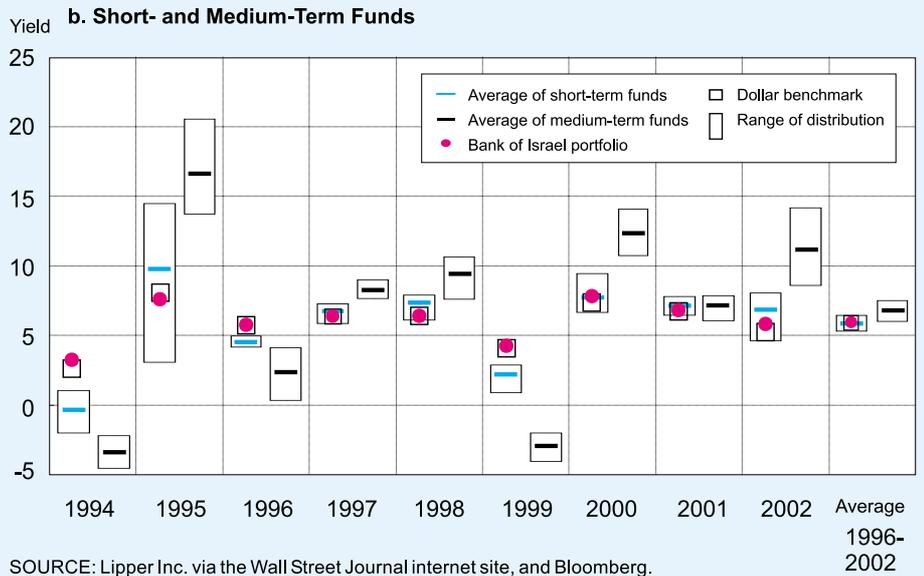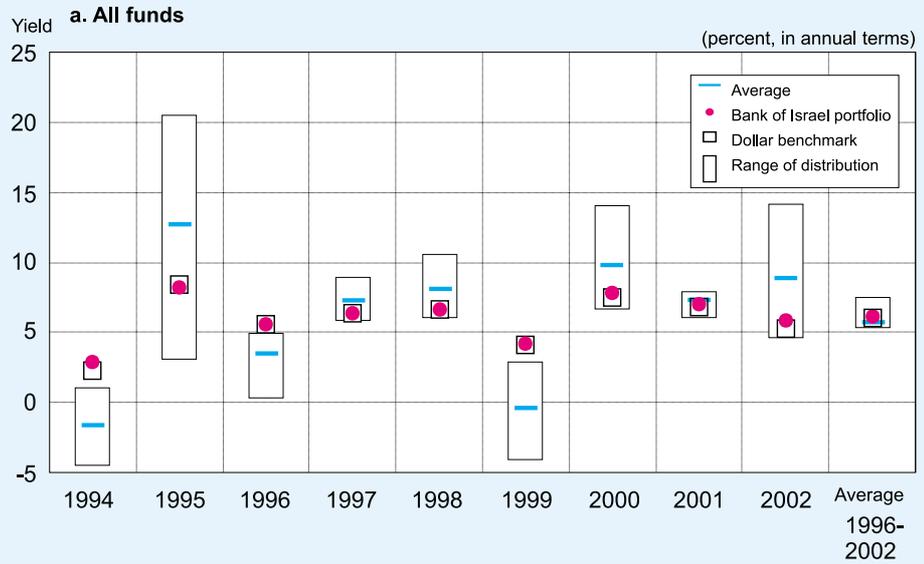
SOURCE: Lipper Inc. via the Wall Street Journal internet site, and Bloomberg.

The dispersion of the funds' yields shows the broad range of the composition of their investments and the greater yield volatility of the medium ones than of the short ones, due in part to the longer duration of the latter. All the funds in the medium group had negative yields in 1994 and 1999. Nevertheless, the range of cumulative yields of the funds in each group is very narrow, and is similar to the range in the other group.[14]

[14] The cumulative yield is calculated for the period from 1996 to 2002, because no information relating to two of the funds is available for 1994 and 1995.

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Figure 1.10
Yield and Risk: the Dollar
Portfolio vis-à-vis Funds in the US
Market, 1996–2002

Yield (percent, in annual terms)

Legend:
- Medium-term funds
- Short-term funds
- Dollar portfolio

Standard deviation

SOURCE: Bank of Israel.

It would thus appear that the profit derived from the incremental risk incurred by the medium funds is relatively small. This is even more apparent when the average yield of each fund is compared with its volatility in the years 1996–2002 (see Figure 1.10). The figure also shows the average yield of the dollar portfolio and its volatility in the period reviewed. The high ratio of return to risk achieved by the dollar portfolio relative to that achieved by the other funds is noteworthy. (The ratio is represented in the figure by the slope of the line that connects the observations with the origin.) The higher ratio of return to risk of the short funds relative to the medium ones is also notable. The differences between the ratio of the dollar portfolio and that of the other funds is due to the relatively narrow range of variation of the returns compared with the relatively wide range of variation of their volatilities. The performance of the dollar portfolio was very close to that of the benchmark, due to the relatively small extent of the positions opened in it.

The ratio of return to risk achieved by the dollar portfolio was higher than that of the other funds. Moreover, the relatively small profit derived from the incremental risk incurred by the medium funds is noteworthy.

3. RISK MANAGEMENT AND ITS CONTRIBUTION TO THE YIELD ON THE PORTFOLIO

In the course of day-to-day management of the portfolio, decisions are taken regarding the deviation of the portfolio from the benchmark in its various aspects—its currency composition and duration, the assets included in it, and their distribution along the yield curve. A deviation from the benchmark composition (a position) means a difference in yield from that of the benchmark, together with an increase in risk. In position management it is customary to impose a maximum potential loss; the position is closed if the cumulative loss reaches the limit. As mentioned above, the extent of actual positions is far smaller than their potential scope. In the last few years the main effort in the ongoing management of the portfolio has focused on asset selection, and the contribution of this aspect does indeed form an important part of the total contribution of active management. At the same time the extent of positions in interest-rate exposure has been greatly reduced (the duration and the dispersion along the curve) as have positions in exposure to currency risk. A description of the contribution of the main investment decisions follows.

Figure 1.11
VaR of the Positions, June–December 2002

Basis points (one-week horizon, parametric method, 95% confidence level)

Total
TIPS
Currency positions
GNMA

2002

SOURCE: Bank of Israel.
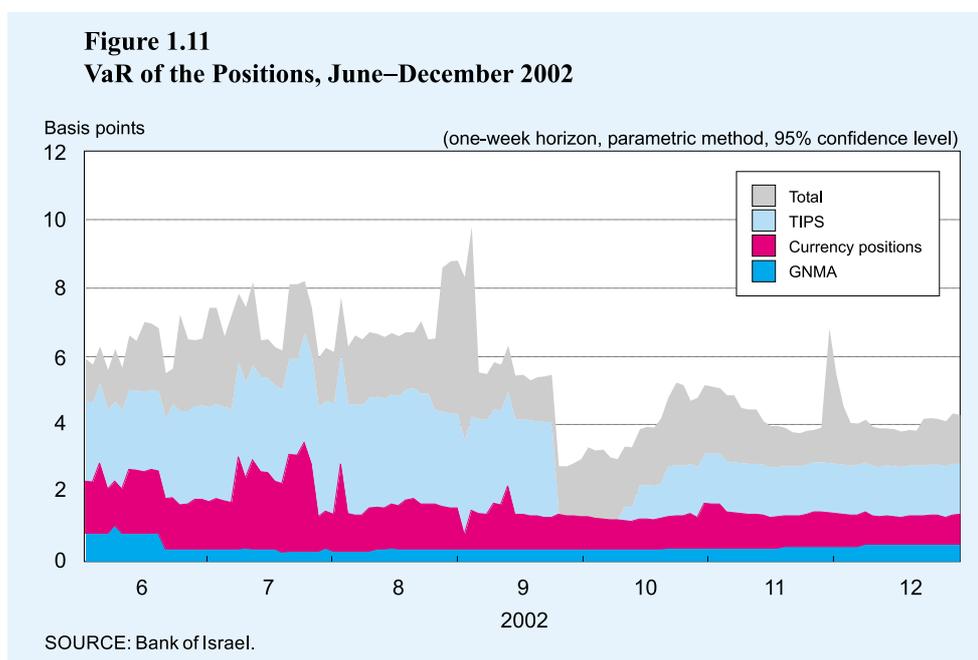
a. Currency management

The difference between the currency composition of the portfolio and that of the numeraire is called the currency position. The currency management contribution amounted to 2.8 basis points in 2002. Small currency positions are managed according to models, tactical considerations and assessments of economic variables.

Decisions in the field of currency management determine the difference between the currency composition of the portfolio and that of the numeraire. This gap is called the currency position. The currency management contribution, which includes cross-rate differentials, interest, and capital gains on the currency positions, amounted to 2.8 basis points in 2002 (Tables 1.2 and 1.4).

Various currency positions were opened in the course of the year based on tactical considerations and based on assessments of economic variables. These positions contributed an incremental yield of 3.4 basis points to the yield of the portfolio. Other currency positions were managed with the aid of models—a tool for the management of short-term currency positions used by the Department since 2000. The amount invested based on each model is fixed and relatively small. A limit on the accrued losses that might derive from their use was also set when they were introduced; the use of the models would cease if the accrued losses reached this ceiling. The use of some of the models was discontinued in 2002 as their performance was worse than expected. Many positions, held for different periods of time, were managed with the help of the models during the year. The profit or loss from this activity is relatively volatile, and in 2002 resulted in a small loss of 0.6 basis points.

The risk incurred in currency positions is higher than that of other positions managed in the portfolio.

The risk incurred in currency positions is higher than that in other positions managed in the portfolio. This can be seen from their share in the VaR of all the positions in the portfolio managed in the second half of 2002, shown in Figure1.11; despite the small extent of the currency positions (less than one percent of the total reserves) relative to the total of all the positions in the portfolio in the period reviewed, their VaR constituted on average a quarter of the VaR of all the positions.

b. Duration management

Duration positions are those taken by choosing a duration different from the neutral duration of the reserves portfolio, which was 16 months for all the currency portfolios. The size of the duration positions in the currency portfolios has contracted significantly in the last few years; in 2002 very small duration positions were managed in the various currency portfolios, and these contributed a negative incremental yield of about 1.9 basis points vis-à-vis the benchmark (Table 1.4 and Figure 1.12).

The duration management of *the dollar portfolio* resulted in a 2-basis-points loss of yield on the reserves portfolio in 2002. Both long and short positions were opened during the year: the duration of the portfolio was slightly above neutral in the first few months of the year and below neutral from May to July and in September.

Underlying the different positions opened during the year were varying assessments by the Foreign Currency Department of expected developments in the US economy: at the beginning of the year it was expected that the recession in the US economy would last longer than originally assessed, while in the middle of the year it was estimated that the economy was recovering at a faster rate than that assessed by the market, and a tight monetary policy was expected to be introduced by the Fed. The portfolio was shortened in September against the background of the low yields to maturity that increased the risk of obtaining a negative holding-period rate of return in the future.

In practice yields to maturity rose in the first quarter of the year, as investors assessed that in the light of the expansionary policy pursued in 2001 the US economy would recover faster than originally thought. This assessment changed in the following months. The change, together with increased expectations that the Fed would cut the interest rate, and the discovery of accounting irregularities in many companies and several bankruptcies, including some very large companies, resulted in more severe declines in the stock market and a trend change in the bond market. Yields began to fall as the curve flattened. The Fed did reduce the interest rate in November by 50 basis points, from 1.75 percent to 1.25 percent, its lowest level in more than forty years.

Due to the actual changes in yields to maturity, the duration positions in total resulted in a loss: the loss arising from the shortening of the portfolio in July was only partially offset by the profits from the positions in April and September.
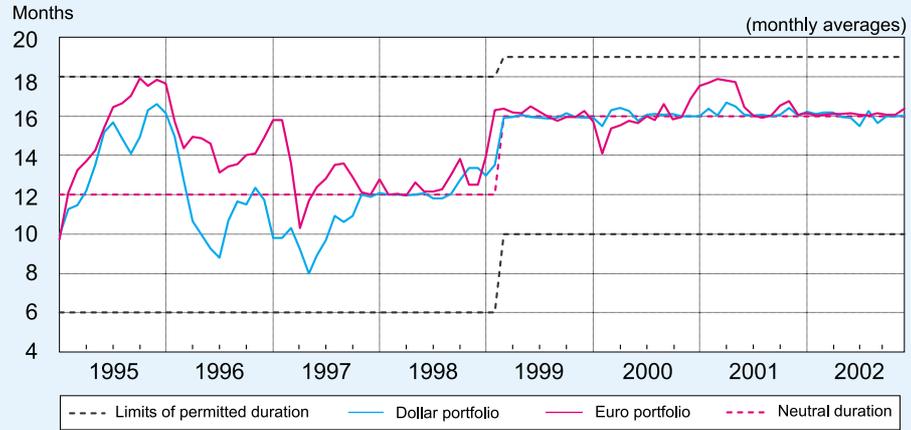
A few small duration positions were opened in the *euro portfolio* in the course of the year. The portfolio was slightly longer than the benchmark for several periods during the year, based on the assessment that the recession in Europe would lead to a cut in the interest rate by the European Central Bank (the ECB). This did occur at the end of the year, when the ECB cut the interest rate by 50 basis points to 2.75 percent. The duration positions resulted in a loss at the beginning of the year, when yields to maturity rose by more than the rise reflected in the yield curve. The loss was partially offset by the profits in the next few months, when the yields to maturity fell. A few duration positions in other currencies also yielded profits. Due to the very small extent of the positions in the euro and other currency portfolios, their contribution to the yield of the reserves was minimal.

The difference between the actual portfolio duration and the neutral duration is called the duration position. These positions contributed a loss of 1.9 basis points in 2002.
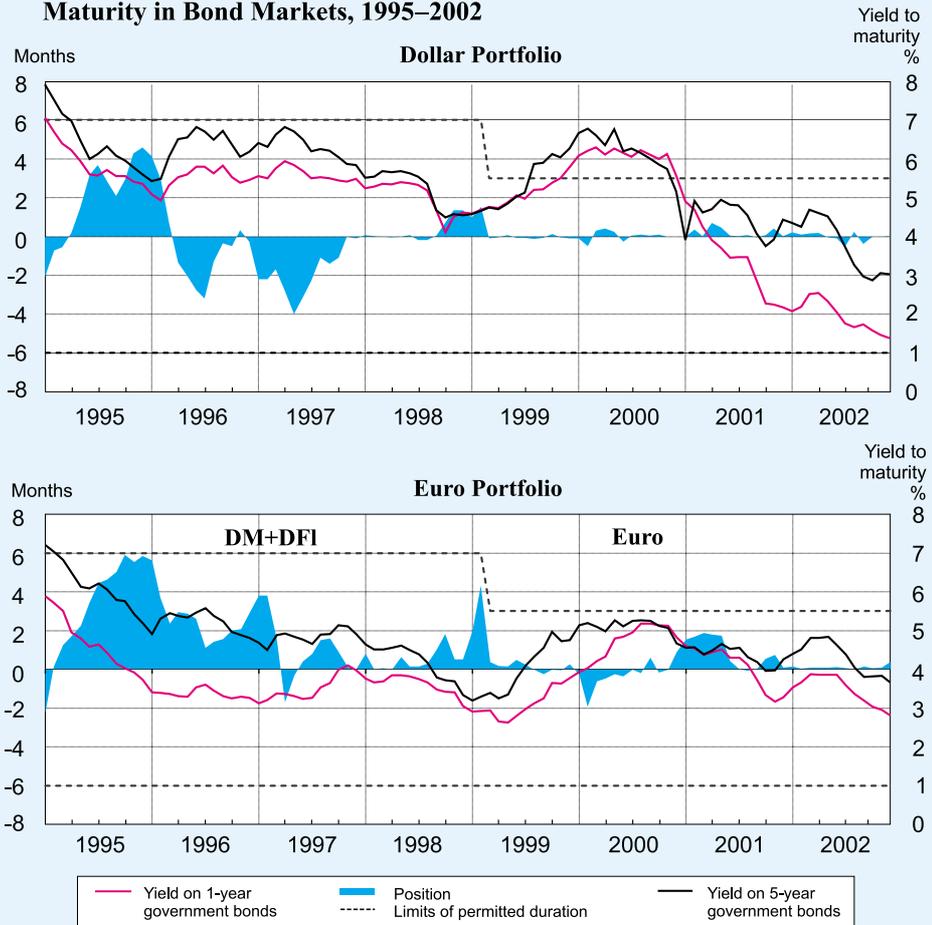
Both long and short positions were opened during the year. Holding-period rates of return rose in the US market in 2002:I, and then declined by more than the rise. The economy did not follow the path expected by the Foreign Currency Department, so that duration management of the dollar portfolio gave a loss of 2 basis points.

In the euro portfolio a few small duration positions were opened in the course of the year. Their contribution to the yield of the reserves was minimal.

Figure 1.12
**a. Duration of the Major Currency Portfolios, 1995–2002**

Months

(monthly averages)

20
18
16
14
12
10
8
6
4

1995   1996   1997   1998   1999   2000   2001   2002

- - - - Limits of permitted duration   —— Dollar portfolio   —— Euro portfolio   - - - - Neutral duration

b. Duration Positions in Various Currency Portfolios, and Yields-to-Maturity in Bond Markets, 1995–2002

Yield to maturity %

Months   **Dollar Portfolio**

8
6
4
2
0
-2
-4
-6
-8

8
7
6
5
4
3
2
1
0

1995   1996   1997   1998   1999   2000   2001   2002

Yield to maturity %

Months   **Euro Portfolio**

8
6
4
2
0
-2
-4
-6
-8

DM+DFl   Euro

8
7
6
5
4
3
2
1
0

1995   1996   1997   1998   1999   2000   2001   2002

—— Yield on 1-year government bonds   ■ Position   —— Yield on 5-year government bonds
- - - - Limits of permitted duration

SOURCE: Bank of Israel.

Figure 1.13
Contribution of Currency Portfolios to Portfolio Spread vis-à-vis the Benchmark Portfolio, by Partial Duration, 2002
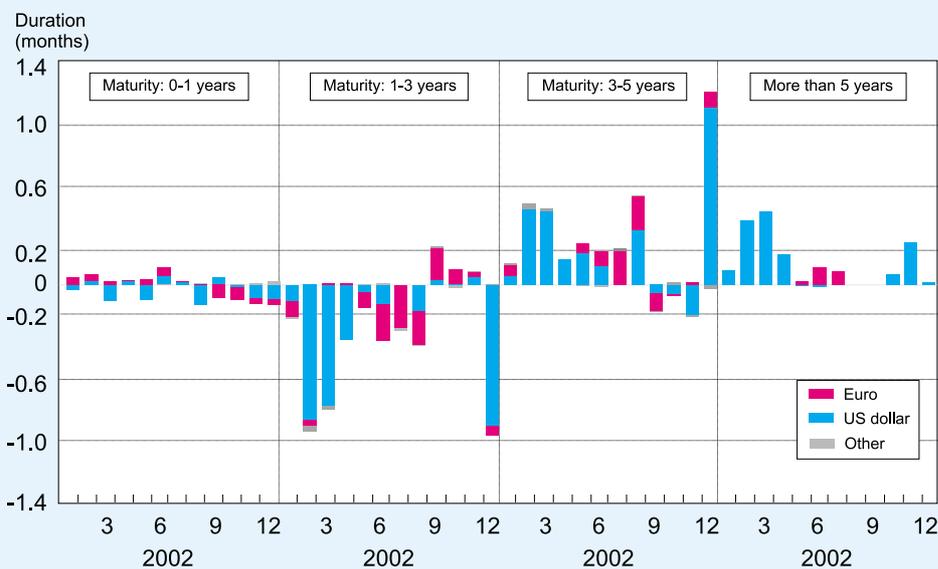
SOURCE: Bank of Israel.

c. The dispersion of assets along the curve

The dispersion of the reserves portfolio by period to maturity of the assets (henceforth assets dispersion) differed only slightly from that of the benchmark. This becomes evident when one looks at the dispersion of the duration over the different parts of the yield curve (the 'partial duration')[15] compared with that of the duration of the benchmark (Figure 1.6). The figure shows that the portfolio was less exposed than the benchmark to changes in the yield curve up to three years to maturity, and more exposed in the section of more than three years to maturity.

The total contribution of the dispersion of the portfolio compared to the benchmark was negative and small, only 1.4 basis points. By far the greatest part of the dispersion compared with the benchmark derived from that of *the dollar portfolio*, due to its large weighting in the total reserves portfolio. During the year several dispersal positions were opened based on the assumption that the curve would flatten. In total the positions resulted in a small loss of yield of one basis point that resulted mainly from the positions managed in the second quarter of the year, when the actual steepening of the curve was greater than that implied by the forward curve over the period when positions were held.

In *the euro portfolio* dispersal positions were managed in the first part of the year based on the assessment that the curve would flatten. In total these positions resulted in a small negative contribution to the yield on the portfolio due to the steepening of the curve that took place over the period for which the positions were opened relative to the change implied by the curve.

[15] For a definition of partial duration see Appendix 1.2.

The difference between the dispersion along the yield curve of the reserves portfolio and that of the benchmark is called the dispersion position. Several such positions were opened in the dollar and euro portfolios on the assumption that the yield curves would flatten. These positions gave a negative incremental yield of 1 basis point in 2002, as the steepening of the curve was greater than that implied by the forward curve over the period when positions were held.

d. The strategic decision to invest in the GNMA sector

Several years ago the Foreign Currency Department made a strategic decision to invest a certain part of the dollar portfolio in GNMA mortgage-backed securities. The contribution of this decision is assessed as the difference between the GNMA market index and the yields on Treasuries with maturities of between one and five years.[16] In 2002 its contribution was a small negative one of 0.4 of a basis point, due to market developments and a cutback in investments in the GNMA sector.

• *Market developments*: Overall, the GNMA sector performed less well than US Treasuries in 2002, but did not change uniformly throughout the year: in the first quarter the spread between yields to maturity on GNMAs and on Treasuries narrowed, as the yields to maturity in the Treasury market rose and their volatility dropped markedly. This led to a fall in the price of the option component of the spread between the yields on GNMAs and those on Treasuries. The rest of the yield spread (the option-adjusted spread, or OAS) also contracted in this period, as did those in the other spread assets described above. Hence in this period GNMAs outperformed Treasuries (Figures A.1.1–A.1.4).

In the second quarter the trend changed, and the spreads in yields to maturity between GNMAs and Treasuries widened significantly as the latter declined steeply, while becoming more volatile. The trend change in yields to maturity and volatility led to a reversal of the direction of the change in the price of the option component of GNMAs: this rose sharply and led to a marked widening of the spread between yields to maturity on GNMAs and on Treasuries. The price of the option declined in November, but rose again in December. The OAS continued to contract in this period, unlike the spreads of the other spread assets. The rise in the risk of spread assets did not adversely affect GNMAs, due to their high credit rating. The contraction of the OAS offset only part of the rise in the price of the option so that as stated the spread between the yields to maturity on GNMAs and on Treasuries widened, reflected by the underperformance of the former vis-à-vis the latter in this period.

• *The cutback in investments in GNMAs*: In the middle of 2002 the Foreign Currency Department greatly reduced the extent of the investment in GNMAs, due to the low level of the option adjusted spread that provided too thin a cushion against the market risk entailed in investing in this asset, and in the light of the assessment that the price of the option was likely to rise if yields to maturity in the Treasury market were to fall, as actually transpired. The cutback in this investment thus acted to reduce the effect described above of an expanding spread in the yield on the portfolio in the second half of the year, and to reduce the negative contribution of the investment in GNMAs in 2002.

[16] The comparison is made after adjusting for the duration gap between the GNMA market index and these Treasuries. Treasuries in this market segment constitute the benchmark for the long part of the dollar portfolio. As the investment in GNMAs was carried out with a reduction in this part of the dollar portfolio, the benchmark of this component provides a yardstick for assessing the decision.

e. Asset selection

The Bank of Israel Law and the Foreign Currency Department's policies permit the investment of the foreign exchange reserves in various types of spread assets. The most important of these include bank deposits, tradable certificates of deposit (CDs), commercial paper (CP), floating-interest bonds (FRNs) and Eurobonds, CPI-indexed bonds (Treasury Inflation-Protected Securities—TIPS), and mortgage-backed securities (GNMAs). The Bank of Israel, like many other central banks, is more sensitive to the credit risk incurred by investing in spread assets than it is to other risks such as interest-rate risk. The control and management of credit risk therefore assume an important role in the risk management of the reserves. They are achieved by internal restrictions the Bank imposes on itself—quantitative ceilings on exposures to various risks and a system of investment rules, as well as by pricing the risk of tradable spread assets by revaluing them.

Spread assets are not included in the benchmark portfolio, so that the contribution of asset selection is the contribution of the decision to invest in them rather than in the benchmark assets. It is measured by the difference between the holding-period rate of return on those assets and that on the assets with similar durations included in the benchmark, taking their share in the portfolio into account. Much of the effort invested in the last few years in the active management of the portfolio has been devoted to asset selection. In 2002 these decisions contributed 20 basis points to the yield, with the main contribution coming from asset selection in the dollar portfolio, which is the largest currency portfolio, and specifically from investment in Eurobonds, TIPS and GNMAs. Securities-lending activity also contributed to incremental yield (Table 1.5 and Figure 1.14). The relatively large share of asset positions in the total positions in the portfolio and in the total incremental yield from active management is also reflected in their large share of the incremental risk incurred in positions management. This risk, in terms of VaR, is shown in Figure 1.11.

The incremental yield from the investment in *Eurobonds* was 6.2 basis points in 2002. The improved performance of these securities vis-à-vis the benchmark derived from their positive spreads compared with Treasuries and from the contraction of those spreads. The amount invested in Eurobonds changed during the year: in the first half it was reduced, together with the narrowing
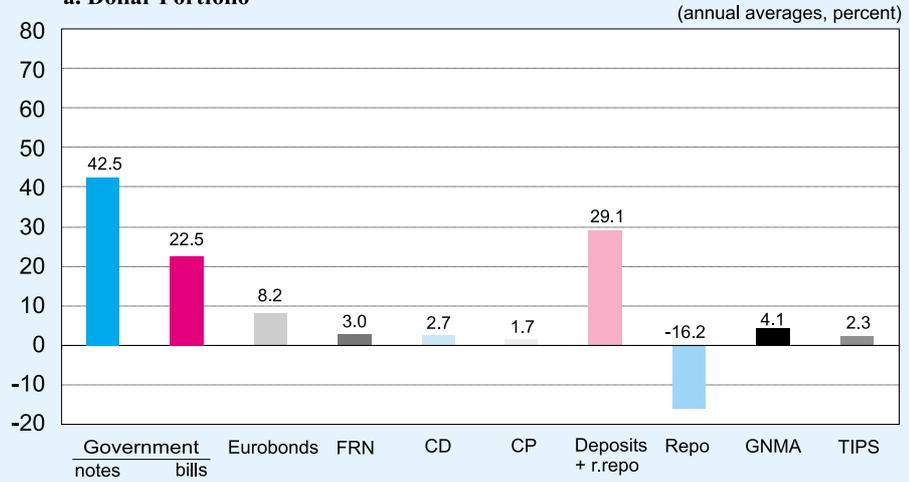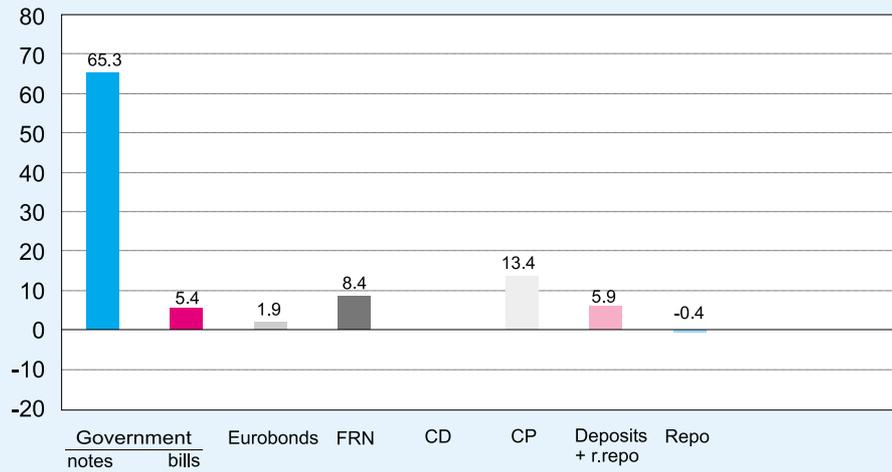
Table 1.5
The Contribution of Asset Selection, 2002

(basis points, in annual terms)

	Total reserve portfolio
Dollar deposits, repo, and reverse repo	3.5
of which Securities lending	3.3
Eurobonds	6.2
TIPS	5.5
GNMA	5.4
of which Tactical positions	1.6
Portfolio management	3.8
Other assets	–0.1
Total	**20.5**

SOURCE: Bank of Israel.

Figure 1.14
Distribution of the Currency Portfolios, 2002
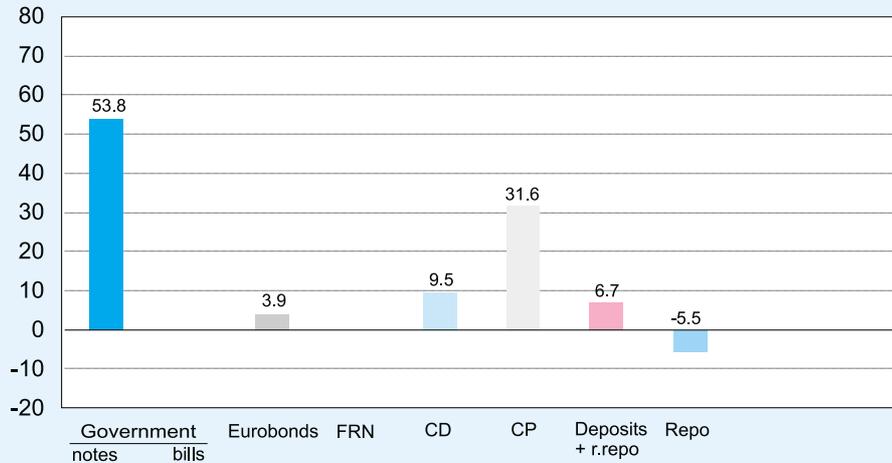
a. Dollar Portfolio

(annual averages, percent)

b. Euro Portfolio

c. Other Currencies

SOURCE: Bank of Israel.

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of the yield spreads between spread assets and Treasuries, described above; in October it was increased after the spreads widened somewhat, and towards the end of the year it was considerably reduced following a marked contraction of the spreads.

The investment in *TIPS* gave an incremental yield of 5.5 basis points in 2002. At the beginning of the year the TIPS portfolio included bonds very close to maturity. In 2002 this investment provided incremental yield because the actual rise in prices at the beginning of the year was faster than that implied in the prices of the bonds. In the middle of the year long TIPS were bought against the sale of Treasuries with between one and five years to maturity. This investment provided a good incremental yield despite the drop in expected inflation implied in the price of TIPS, because these prices reacted more strongly to the reduction in the nominal yield than had been expected from their reactions in the past. The incremental yield from the investment in TIPS entailed an increase in risk estimated in terms of VaR at 0.02 percent of the value of the reserves, more than one third of the total risk (in VaR terms) incurred by the positions managed in the second half of the year.

The incremental yield on the investment in *GNMAs* was 5.4 basis points, and it comprised two parts:

•   The first is the contribution from management of the GNMA portfolio compared with a benchmark which serves as an index of the GNMA market.[17] The management contribution to the yield on the overall portfolio was a positive one of 3.8 basis points in 2002. As mentioned above, the investment in the GNMA sector was sharply reduced in the middle of the year. Most of the GNMA portfolio is managed by the Foreign Currency Department, and a small part by an external portfolio manager.

•   The second is the position in GNMAs. The investment in GNMAs in the first few months of 2002 exceeded that set in the Department's strategic decision mentioned above. The contribution of this investment is measured by the yield spread between it and the yields on Treasuries of between one year and five years to maturity. This position, which was closed in May, contributed a positive 1.6 basis points to the yield of the portfolio as a result of the superior performance of the mortgage market.

The incremental risk entailed in the investment in GNMAs was estimated for the second half of the year at less than 0.01 percent of the value of the reserves (in terms of VaR). In that period the investment was cut back severely, so that the relatively small risk derived from the smallness of the position.

The contribution of asset selection includes also the contribution made by *securities-lending activity* by the Foreign Currency Department. This activity, in which the Department has engaged for some years, is performed mainly in dollar securities. The activity consists of linking a pair of transactions—a repo trade with a reverse-repo

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[17] As stated, a certain part of the dollar portfolio is invested in GNMAs, following a strategic decision of the Foreign Currency Department. It is assessed by the spread between the yield on the GNMA benchmark and the yield on Treasuries. The actual benchmark of the GNMA portfolio is the GNMA market index, and the contribution of the management of the portfolio is measured by the yield spread between the actual GNMA portfolio and the index of the GNMA market. The total contribution of the investment of this part of the portfolio in GNMAs is the sum of the contribution of the strategic decision to invest in them and the management contribution.

The investment in TIPS gave an incremental yield of 5.5 basis points in 2002.

Management of the GNMA portfolio gave an incremental yield of 5.4 basis points. Part of the investment, the size of which was determined by the strategic decision to invest in this sector, was managed vis-à-vis the index of the sector, and the rest as a position vis-à-vis the Treasuries benchmark.

For some years the Department has engaged in securities-lending activity, mainly in dollar securities. In 2002 this activity yielded an incremental yield of 3.3 basis points.

Figure 1.15
Exposure to Banks and Governments, 1993–2002

SOURCE: Bank of Israel.
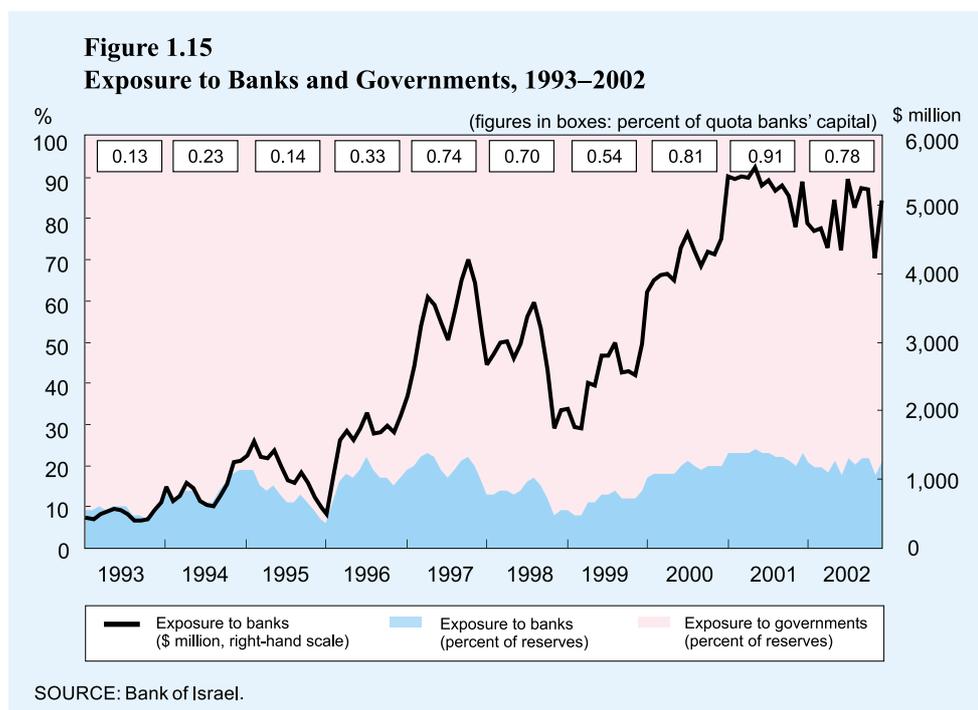
trade or a bank deposit. In the repo transaction a security is lent. The cash received is 'deposited' in a reverse-repo transaction against another security, or is invested in a bank deposit. The two transactions are for the same period, and have no effect on the duration of the portfolio. The profit from such a pair of transactions arises from the fact that the securities which are lent in the repo transaction are in demand in the market by parties who are prepared to borrow them and to lend the equivalent value in money to the securities lender at a lower rate of interest than they could receive by depositing it elsewhere.

Income from securities lending in 2002 totaled $ 8 million, about 3.3 basis points. In most of these transactions the money received in the repo was invested in bank deposits; as a result, this activity used part of the ceiling on the exposure of the reserves to the banking system (see below). As the investment horizon in lending transactions was very short, so too was the period of exposure to the relevant banks.

In addition to the above securities-lending activity by the Foreign Currency Department, several financial institutions which hold the Bank's securities in the foreign exchange reserves portfolio in custody also lend some of these securities on behalf of the Bank. This activity is performed using securities denominated in euro and in other currencies (excluding US Treasuries). The risk in lending is very low, and this activity does not harm the Bank's current activity in the securities which have been lent. Income from this lending by the institutions in 2002 amounted to about $ 0.7 million, about 0.3 of a basis point.

Bank deposits are one of the spread assets in which the Bank of Israel is permitted to invest under the Bank of Israel Law. The exposure of the reserves to the banking system,

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which includes exposure to banks both due to deposits placed with them and due to other transactions with them, constitutes a substantial part of the exposure of the reserves portfolio to credit risk. This exposure is restricted to 25 percent of the size of the portfolio.

The annual average exposure of the reserves to the banking system declined from 22 percent of the reserves in 2001 to 20 percent in 2002 (Figure 1.15). This decline was accompanied by a small reduction in exposure relative to the capital of the banks in which the Bank invests, despite the fact that the exposure in 2002 was very low, as can be seen in the figure.

The reduction in 2002 in the use made of exposure to the banking system occurred against the background of the very low TED spread in the dollar market. In such a situation the incremental yield for an increase in the risk entailed through banking exposure is small. At the same time, half of the banking exposure was utilized for dollar-securities-lending activity. Due to the very short investment horizon of this activity, the banking exposure it entails is over very short periods. Moreover, the restrictions on credit quality in the reserves portfolio are quite strict, so that the risk to which the portfolio is exposed is very low.

f. The liquidity of the reserves

In assessing the level of liquidity of the reserves, an estimate has to be made of the part of the portfolio that can be realized quickly without its losing value. For this purpose the Bank of Israel classifies the assets in the portfolio according to the possibility of selling them without the sale itself causing a loss (see Box 1.2 for a definition of liquidity of the reserves).

The criterion employed in classifying securities into different levels of liquidity is the bid-offer spread. Nontradable assets are classified by time to maturity. As can be seen from Figure 1.16, about 16 percent of the total reserves on average is invested in the most liquid assets, i.e., assets which are traded in very deep and liquid markets, and which can be sold very quickly without the sale itself leading to a loss. A further 60 percent of the portfolio is invested in highly liquid assets, but less liquid than the first group, and about 12 percent is invested in assets maturing in less than a month.

Some 12 percent, on average, of the reserves portfolio in 2002 was invested in assets with relatively low liquidity. This group consisted mainly of Eurobonds, GNMAs and TIPS, and deposits in banks for more than one month. The share of this group increased slightly in 2002. (The mirror image of this rise is a certain decline of the share of the liquid part of the portfolio, shown in Figure 1.16.) There were two reasons for this: firstly, the reduction in the liquidity of TIPS—in 2002 these were not included in the liquid group, although in 2001 they were included in the 'less liquid' group, which is part of the liquid group; and secondly, the change in the composition of the portfolio, especially the rise in the share of bank deposits for periods longer than one month, mainly in the last quarter of the year. This effect was partially offset by the reduction of the investment in GNMAs referred to above.

The exposure of the reserves to the banking system is restricted to 25 percent of the size of the portfolio. In 2002 it stood at 20 percent, on average, with about half utilized for dollar-securities-lending activity.

The level of liquidity of the reserves estimates the share of the portfolio that can be realized quickly without its losing value. The criteria employed as a basis for the estimate are the bid-offer spread and time to maturity. In 2002 liquidity was on average 88 percent of the value of the portfolio.

The liquidity of the reserves declined somewhat in 2002, due to the reduction in the liquidity of TIPS and the increase in the share of deposits of more than one month, the effects of which were partially offset by a cutback in investment in GNMAs.

Figure 1.16
Liquidity of the Reserves Portfolio, 2000−02

SOURCE: Bank of Israel.
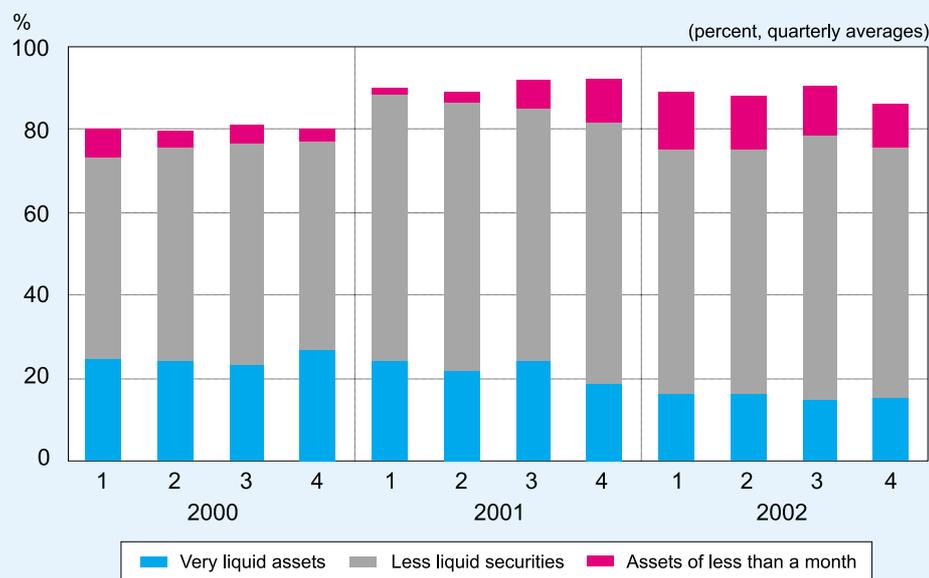
In the light of the high level of the reserves and the ability to sell a large part of them in a short time without thereby incurring a loss, it appears that their liquidity level is high enough. The high liquidity of the reserves derives from two main factors: one is the Bank of Israel Law and the investment policy derived from the spirit of the Law that prescribe a conservative approach to the management of financial risks, and in particular of credit risk. This in effect achieves one of the main objectives of the reserves management process. The second factor consists of economic considerations based mainly on the level of financial spreads of the various spread assets and the paths they are expected to follow relative to their inherent risk. In the light of this second factor, the Bank has made only partial use of the degrees of freedom to invest in spread assets with low liquidity during the last few years.

Box 1.2: The Management and Level of the Liquidity of the Reserves Portfolio

Liquidity has several aspects: the level of liquidity of an asset is generally defined as the ability to realize the asset, i.e., to convert it into cash quickly and without reducing its value; the management of the reserves portfolio also has an aspect of liquidity management, i.e., the supply of cash out of the portfolio and the investment of cash received; another aspect is the distinction between the liquidity of the reserves portfolio and the international liquidity of the country, which is affected by the level of the country's foreign exchange reserves, among other things. The first two aspects are discussed below; the third aspect is dealt with in Section 4a of this chapter.

1. Day-to-day management of liquidity of the reserves portfolio

The day-to-day management of liquidity deals with cash flows of various currencies into and out of the reserves portfolio. The liquidity manager meets the demand for cash and invests monies received. The cash flows originate from various sources:

• The government makes payments abroad in foreign currency, and receives foreign-currency payments from abroad. These payments and receipts, which are performed via the government's accounts with the Bank of Israel, create cash flows into and out of the reserves portfolio.

• The domestic banks have foreign-currency accounts with the Bank of Israel, and reduce or increase these deposits according to their deposits abroad, so that there is a need to transfer money from the reserves portfolio and to absorb new cash flows into it.

• Cash flows arise in the current management of the investment of the reserves, due to various events and decisions in the investment process: receipts of principal and interest; changes in the currency composition of the reserves and its daily adjustment to the composition of the currency numeraire; changes in the duration and dispersion of assets along the curve; changes in the asset composition of the portfolio; use of derivatives, etc. These involve the creation of cash flows in various currencies on any given day.

The transactions of the government and the banks create a positive or negative net flow in the portfolio, whereas cash flows that arise from investments of the reserves are not reflected in a net change in the size of the portfolio but by a change in its composition.[1]

Current management of liquidity ensures that the net cash flow of the portfolio matches the net supply or demand from those entities entitled to receive foreign currency from the Bank of Israel, while minimizing the costs involved. This forms an important component of the management of the portfolio, and significant resources are devoted to it. *Reverse repo* and *repo* transactions are important tools in cash-flow management. In a repo transaction a security is sold, with the seller undertaking to repurchase it at a specified future date and at a predetermined price. The transaction is equivalent to receiving a loan fixed-term against collateral. In a reverse repo transaction a security is purchased, with the buyer undertaking to sell it back to the seller at a specified future date and at a predetermined price. This transaction is comparable to creating a fixed-term deposit. Using these tools therefore enables the time gaps in cash flows in the portfolio to be

[1] In principle, intervention in the domestic foreign-currency market can create the need to realize part of the reserves or to absorb new money in them. However, it is now more than five years since the Bank of Israel last intervened in the foreign-currency market, in accordance with its declared policy of non-intervention in this market as long as the exchange rate remains within the band.

bridged. Currency swaps are another important tool used in the management of cash flows; they enable one currency to be converted into another for a fixed term and at a preset exchange rate, and thus bridge the gaps between the liquidity requirements of different currencies. Other instruments used to manage liquidity include other short-term investments such as short-term bank deposits and short-term securities. The cash flow is managed in a special portfolio that absorbs the fluctuations in the reserves portfolio. The external flow therefore does not affect the investment portfolios, and thus does not cause them to deviate from the benchmark. Hence fewer adjustments need to be made, reducing transaction costs.

2. The liquidity of the reserves portfolio

Daily cash flows of the reserves portfolio are small relative to the size of the reserves. The question arises, therefore, whether the Bank of Israel could meet a large demand for foreign currency—relative to the size of the reserves—from those entitled to receive it. Such demand can only arise in extremely rare circumstances, such as a national emergency or a deep financial crisis. Although the probability of such a situation is generally assessed as being extremely low, immediate availability of the required volume of foreign currency is likely to afford great advantages to policy makers. Maintaining a high level of liquidity of the reserves is thus one of the principles implemented by most central banks.

The liquidity level of the total reserves portfolio in an emergency is a function of the liquidity of the various assets in the portfolio, in other words, of the extent to which each of them can be sold without the sale reducing its value. There are several aspects to the liquidity of an asset. The first is narrow bid-offer spreads, that imply low transaction costs relative to the midpoint price, reducing the cost of ongoing activity in these assets. The second is the ability to trade large volumes without affecting the market price. In the market for a particular type of asset the bid-offer spread may be reasonable, and the asset can be traded at small volumes without affecting its market price, but any attempt to sell a large quantity of the asset within a short period will lower the selling price, so that the asset can only be realized at a price lower than that prevailing prior to the sale. The Bank may also not be able to realize its total holding of a particular type of asset on one day (without incurring a substantial loss), but may have to spread the sale over a longer period. In general the two measures of the liquidity of a market in which a certain asset is traded—the bid-offer spread and the possibility of trading in large volume without affecting the price—lead to the same market ranking.

To enable the level of liquidity of the reserves portfolio in its entirety to be monitored over time, the assets in the portfolio have been divided into groups, based on the degree of their liquidity:

1. Very liquid securities, i.e., those with a spread of 0–2 basis points, or 0–2 cents;
2. Less liquid securities, i.e., those with a spread of 3–5 basis points, or 4–6 cents;
3. Securities whose maturity is within a month, and deposits and repo and reverse repo transactions of less than a month;
4. All other assets.

The liquid part of the reserves consists of the first three of these groups. The distinction between the degrees of liquidity of these three groups is not clear-cut: as liquidity is measured using two different criteria—period to maturity and the bid-offer spread—the comparison of the liquidity of the third group with that of the first two is discretionary. It is clear, however, that the second group is less liquid than the first.

4. OTHER ISSUES

a. The role of the reserves in a floating-exchange-rate regime in Israel and other countries

i. The role of the reserves in Israel

In the eighteen years since the Economic Stabilization Program of 1985, the purposes for which Israel's foreign exchange reserves are held have changed, in accordance with changes in the exchange rate regime and in macroeconomic policy. At the beginning of the period, the regime was a fixed exchange-rate system, or one that was managed according to strict rules, which served as a nominal anchor for the price level. In that situation, the main function of the reserves under normal circumstances was to provide the liquidity required to manage the exchange rate. In the last few years Israel's macroeconomic policy changed radically, and is currently based on a declared inflation target. The change enabled several developments to take place in the sphere of foreign exchange: the exchange-rate regime became far more flexible as a result of the gradual widening of the exchange-rate band, until it reached 49.4 percent at the end of 2002 (in terms of the average of the upper and lower limits); the Bank of Israel has not intervened in the foreign-currency market for more than five years, in accordance with its declared policy of non-intervention while the exchange rate is within the band; all restrictions on movements of capital into and out of Israel were gradually removed; and the foreign-currency market developed and deepened. The significance of these changes is that the exchange rate currently acts very much as it would in a free-float regime, especially when the rate is a long way from the limits of the band.

In the light of the above changes, and although the band has not yet been abolished, under normal circumstances the reserves are no longer important as a source of liquidity for the current management of exchange-rate policy. Several fundamental questions arise: what are the objectives of holding foreign exchange reserves in the current

In the years following the Economic Stabilization Program of 1985, a feature of which was a fixed exchange-rate system or one that was managed according to strict rules, the main function of the reserves was to provide the liquidity required to manage the exchange rate.

conditions? Are those objectives the same in Israel as in other countries in which the exchange rate floats freely or within a wide band? Is the level of the reserves appropriate for the achievement of the objectives? Does that level bear a reasonable relationship to the levels of foreign exchange reserves held by other countries?

In view of experience acquired throughout the world, especially at times of financial crises, and based on the professional literature dealing with reserves, it is possible to identify several key functions currently fulfilled by Israel's foreign exchange reserves:

- *To reduce the probability of a crisis in the foreign-currency market.* Despite the Bank of Israel's declared policy of non-intervention in the foreign-currency market as long as the exchange rate is within the band, the knowledge that the central bank has access to a large reserve of foreign currency calms foreign investors and the country's residents on the one hand, and deters speculators on the other. This will be discussed in greater detail below. It must be emphasized that the importance of the reserves in preventing crises in the foreign-currency market is secondary to that of a responsible, credible macroeconomic policy which acts to achieve economic and financial stability.

- *To provide the country with a strategic reserve of international liquidity* for dealing with a foreign-currency market crisis (together with other policy instruments, such as the interest rate), should one arise, or for use in a national emergency. In such situations the higher the level of the reserves the greater the economy's resilience and the wider the range of options available to policy makers.

- *To improve Israel's status in the international financial environment.* Important entities in the international capital markets, including the major rating agencies, perceive the level of a country's foreign exchange reserves as an important indicator of its financial stability. A higher assessment of the country's standing eases the government's and the business sector's access to international capital markets and helps lower the cost of raising capital.

- *To allow the government a certain flexibility in managing the currency composition of its liabilities.* The government transfers its foreign-currency receipts to the Bank of Israel, and these are usually converted into local currency. The government also has the legal right to purchase foreign currency from the Bank of Israel with local currency. This affords the government a certain degree of flexibility in managing the currency composition of its liabilities: it can finance repayment of its current external debt from local currency sources and purchase foreign currency from the Bank of Israel for that purpose. This use of the reserves is of limited benefit, however, because if it reduces them by a significant amount, their ability to fulfill the other functions outlined above will be curtailed.

ii. The investment policy of the reserves

The investment policy guiding the management of the foreign exchange reserves is founded on three principles:

- *Maintaining the real value of the reserves.* The yardstick for the real value is purchasing power in international markets in terms of the foreign-currency uses of the economy. This is expressed in the determination of the currency composition of the

Currently, against the background of policy based on an inflation target and effectively a floating-rate regime, the role of the reserves is focused on supporting financial stability—reducing the probability of a crisis in the foreign-currency market, dealing with crises or emergencies and improving Israel's access to capital markets.

The importance of the reserves in carrying out the functions specified is secondary to the importance of a responsible, credible macroeconomic policy which acts to achieve economic and financial stability.

Another role of the reserves is to afford the government a certain degree of flexibility in managing the currency composition of its liabilities between local and foreign currency.

reserves, the management of their interest risk and the limitations on their exposure to credit risk.

- *Managing the reserves with a high degree of liquidity,* in other words, investing most of the reserves in assets which can be sold in large volume and at short notice without lowering the sale price. This is expressed mainly in the restrictions on the types of asset in which the reserves may be invested (most of these restrictions are specified in the Bank of Israel Law and the relevant legal interpretations of it, and some of them are determined by internal Bank of Israel decisions that are consistent with the spirit of the Law).

- *Achieving a reasonable yield on the reserves portfolio subject to the above two principles.* This is expressed in decisions on the duration of the portfolio, the permitted level of exposure to credit risk and active portfolio management.

The investment policy is described in greater detail in several Boxes in the Annual Reports of the Foreign Currency Department for 2000 and 2001. It is particularly noteworthy that an international comparison shows that the principles outlined above also guide most central banks in the industrialized countries in their management of their foreign exchange reserves, despite significant differences between the roles of the reserves in the different countries. These differences are reflected in the details of the implementation of the principles, including the criterion used to quantify the real value of the reserves. The Bank of Israel periodically reviews ways of improving the correlation between the investment policy and the main functions of the reserves.

iii. The purposes of holding reserves: an international view

The reasons given by different countries for holding foreign exchange reserves show that they are determined in accordance with each country's economic and financial characteristics. These characteristics, which also affect the level of the reserves, include:

- The exchange-rate regime and intervention policy;
- The principles of monetary policy;
- The level of development of the domestic capital market, particularly of the foreign-currency market and its derivatives;
- The cost of capital faced by the country, and its ability to obtain local-currency loans from residents and nonresidents;
- The degree of economic openness; the nature of trade and capital flows to and from the country, including administrative restrictions, if any;
- The economy's ability to withstand different types of external shocks, and the extent of its geographical and economic diversification.

It therefore seems that in order to understand the degree to which Israel's objectives in holding foreign exchange reserves match those of other countries, a reference group of countries similar to Israel in certain respects should be defined.

The most important of the characteristics listed above seem to be the exchange-rate regime and the principles of monetary policy. In Israel, as mentioned above, monetary policy is based on a published inflation target and the exchange-rate regime allows free floating within a very wide band. Furthermore, the preferred path of future

The principles guiding the investment of the foreign exchange reserves are: maintaining their real value; managing them with a high degree of liquidity; and achieving a reasonable yield on the reserves portfolio subject to the above two principles. These principles also guide most central banks in their management of their reserves.

exchange-rate policy leads to the abolition of the exchange-rate band and the transition to a completely free float. It is appropriate, therefore, to select the countries for the reference group on the basis of those characteristics—a free-float regime or a float within a wide band, and monetary policy based on an inflation target. According to an IMF classification,[18] at the beginning of 2002 there were sixteen countries (apart from Israel) that satisfied these criteria. Table 1.6 shows the countries and some relevant data.

The table shows that Israel is close to the group median with regard to most of the characteristics. The index of the actual mobility of the exchange rate is the percentage of the monthly observations in the previous three years in which the absolute value of the percentage change in the exchange rate is less than one percent. The higher the index, the closer the regime is to a fixed-exchange-rate regime, a feature known in the literature as "fear of floating."[19] The index is calculated for each of the three main currencies (dollar, euro and yen), and the table shows the highest value. The ratio of the reserves to the money supply is based on IMF data according to its definitions of M2, which for some countries differ (as in the case of Israel) from the definitions of the domestic authorities. The index of the effect of a change in the exchange rate on the price level relates to the medium term (twelve months). This index was taken from research carried out under the auspices of the Inter-American Development Bank (IADB),[20] where a more detailed explanation of how it was calculated may be found.

Various sources provide information on the declared purposes for which the countries in the reference group hold foreign exchange reserves: official central bank publications, articles and addresses by senior officials, information transmitted directly to the Bank of Israel by other central banks, and IMF publications.[21] Table 1.7 gives a summary of the main reasons for holding foreign exchange reserves quoted by fifteen countries in the group (no detailed information was received from the sixteenth country). Most countries mentioned two or three of the six main purposes listed in the table as their own essential objectives.

Although Israel's objectives are not formulated in the same terms as those used by the other countries, the picture that emerges from Table 1.7 does not indicate a significant difference between them. The objective of *reducing the probability of a crisis in the foreign-currency market* is parallel to that of *supporting monetary policy/confidence in the financial markets.* Moreover, the aim of most countries in the group to maintain the ability to intervene in the foreign-currency market (although most of them in fact do so very rarely) indicates an awareness not only of the possibility that conditions may arise in which intervention would contribute to stability, but also of the fact that

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[18] The table in *Exchange Rate Regimes and Anchors of Monetary Policy* in "International Financial Statistics."

[19] G.A. Calvo and C.M. Reinhart, "*Fear of Floating,*" National Bureau of Economic Research, Working Paper 7993, November 2000.

[20] See note 6 above.

[21] See "*Issues in Reserves Adequacy and Management,*" IMF Monetary and Exchange Affairs Department and Policy Development and Review Department, October 2001 and "*Guidelines for Foreign Exchange Reserve Management: Accompanying Document,*" IMF Monetary and Exchange Affairs Department, March 2003.

Table 1.6
Data on Countries in the Reference Group[a]

	Exchange-rate regime	Credit rating	Nonresidents' participation in local-currency government bond market	Index of actual exchange-rate mobility[b]	Foreign exchange reserves $ million [c]	Foreign exchange reserves Percent of money supply[d]	Effect of exchange rate on price level[e]
				(percent)		(percent)	(percent)
Australia	Free float	AA+	*	13.5	18,708	6.9	21
Iceland	Free float	A+		27.0	355	12.1	N/A
Brazil	Free float	B+		16.2	35,868	23.9	N/A
UK	Free float	AAA	*	35.1	40,460	2.7	3
South Africa	Free float	BBB-	*	32.4	7,638	10.9	11
Hungary	Band (30%)	A-		42.1€	10,755	51.6	N/A
Czech Republic	Free float	A-		56.8€	14,466	34.6	2
Mexico	Free float	BBB-		40.5	44,805	29.6	58
Norway	Free float	AAA		56.8€	15,818	24.7	9
New Zealand	Free float	AA+		18.9	3,008	7.7	N/A
Poland	Free float	BBB+		37.8	26,569	41.6	62
Chile	Free float	A-		21.6	14,382	48.5	N/A
Columbia	Free float	BB		32.4	10,245	44.7	38
Korea	Free float	A-		35.1	102,876	27.0	18
Canada	Free float	AAA	*	43.2	34,254	7.1	7
Sweden	Free float	AA+		54.1€	15,637	16.0	14
Median		A-		35.1	18,708	24.3	14
Israel	Band (50%)	A-		35.1	23,181	22.8	16

[a] All these countries operate monetary policy based on a declared inflation target.
[b] See text. €—measured by euro. For comparison: euro/dollar, 37.8 percent; ¥/dollar, 32.4 percent.
[c] At end of 2001, including gold at market price.
[d] Monthly average (January 1999 to December 2001) ratio of the reserves including gold to the M2 money supply.
[e] Based on 1990–99.
SOURCE: Credit ratings, S&P, 19 December 2002; Reserves, based on International Financial Statistics; Effect of exchange-rate, IADB working paper 418, Hausmann, Panizza and Stein.

final and irrevocable relinquishing of this option may itself jeopardize stability, as described below. The desire to ensure that foreign exchange reserves are available in an emergency and that the government has foreign exchange liquidity is common to Israel and a significant number of the countries in the group. The purpose of *improving Israel's status in the international financial environment* may be considered parallel to that of *supporting confidence in the financial market* and *ensuring payment for debt servicing* listed in Table 1.7.

iv. The level of the reserves in the reference group of countries compared to that in Israel

Table 1.6 shows that the levels of the reserves held by the different countries in the group and the ratio of the reserves to the M2 money supply are spread over a wide range. Thus the fact that Israel is close to the group median in these two measures, although encouraging, is not enough to justify the conclusion that the level of the

Israel's objectives in holding reserves are not significantly different from those of the countries in the reference group. Most of those countries aim to preserve the ability to intervene in the foreign-currency market, as relinquishing of this option may itself jeopardize stability.

Table 1.7

The Role of Foreign-Exchange Reserves in Countries with Inflation Targets and Floating-Exchange-Rate Regimes

Objective	Number of countries
Maintaining the ability to intervene in the foreign-currency market	13
of which Intervention only to prevent market collapse or extreme volatility	4
Ensuring servicing of the government or country foreign-currency debt	9
of which Countries acting according to the Guidotti rule[a]	4
Maintaining foreign-currency liquidity for the government	6
Ensuring availability in a crisis/handling external shocks	5
Supporting monetary policy and confidence in financial markets	4
Maintaining a long-term store of national wealth	2

[a] According to the Guidotti rule, a country should hold reserves equal to its debt-servicing requirement for the next twelve months. Israel has not adopted this rule; see Box 1.1 in 2001 Annual Report of the Foreign Currency Department.
SOURCE: Bank of Israel.

IADB researchers used a model that explains the level of the reserves in terms of the coefficient of the passthrough from the exchange rate to inflation and the currency exposure of the economy. The Bank of Israel ran a regression on those countries that were in the reference group. It appears that the level of Israel's reserves is not very different from the level predicted by the model.

reserves in Israel is in line with the levels in the group. Moreover, a closer examination is likely to clarify why countries that do not generally intervene in the foreign-currency market hold reserves. One approach to the question of the level of the reserves is based on the findings of the IADB research referred to above. (Another approach is described in Section 4b below.) The authors propose a macroeconomic model which supports the contention that in practice the mobility of the exchange rate in countries that declare they operate a floating exchange-rate regime (some of which exhibit clear signs of 'fear of floating') is explained by the effect of the exchange rate on the price level and by the extent of the economy's exposure to external shocks due to currency mismatch in the balance sheets of private-sector or public-sector entities. The latter factor is difficult to assess directly, and the authors therefore used as a proxy the amount of interest shown by nonresident investors in the market for local-currency government bonds. The authors ran a regression on a large number of countries, and found a significant relation between the effect of the exchange rate on inflation and the level of the reserves. The Bank of Israel ran a similar regression on only those countries in the reference group, i.e., those that also pursue an inflation-target policy, and found that in this case the significance of the regression increased, and its R^2 reached 37%. When a binary variable was added to the regression, that distinguishes between countries whose local-currency government bonds are sold to international investors and other countries, the R^2 of the regression reached 77%. This second regression is shown in Figure 1.17 (the gap between the regression lines represents the coefficient of the binary variable).

From the two regressions it appears that the level of Israel's reserves is not very different from the expected level based on the behavior of countries that operate a floating-exchange-rate regime and monetary policy based on an inflation target.

Figure 1.17
Foreign Exchange Reserves of Countries with Floating-Exchange-Rate Regimes and Inflation-Target Policies

Reserves as percent
of money supply

Regression line
Countries in which nonresidents purchase domestic government bonds
Other countries
Israel

Effects of exchange-rate changes on the price level over twelve months
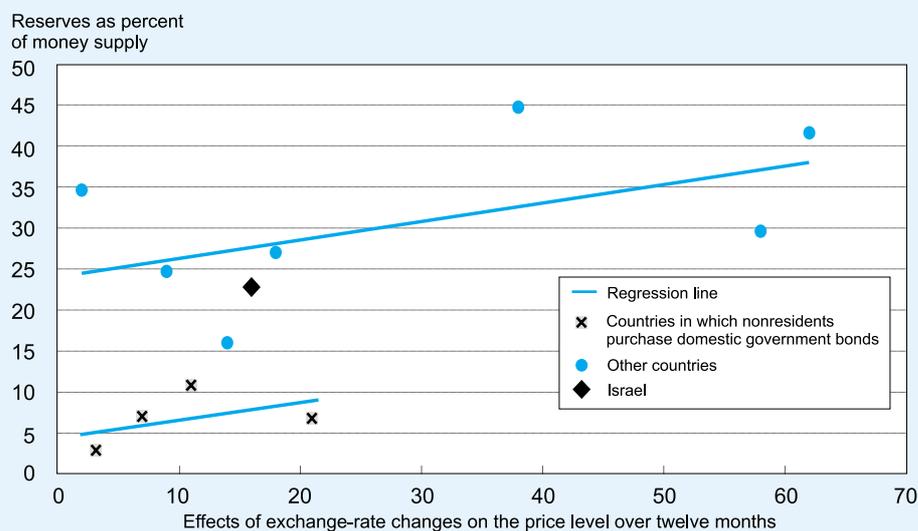
SOURCE: Based on findings of Housmann, Panizza and Stein.

v. The role of the reserves in reducing the probability of a crisis: a closer look

It is obvious that the regression shown above should not be considered as providing a complete answer to the question of the required level of the foreign exchange reserves. Nevertheless, it is appropriate to undertake a closer examination of the reasons for holding a higher level of reserves in countries in which currency depreciation adversely affects inflation and which do not benefit from significant participation of nonresidents in the market for their governments' local-currency debt instruments.

One reason for the reduction over the last decade in the number of countries that operate a fixed-exchange-rate regime is that in such a regime the central bank, in certain macroeconomic conditions, can become the target of a speculative attack. In these conditions a situation of 'guaranteed profit' may arise for those who sell local currency (short) or 'guaranteed loss' for those who delay disposing of it. A comprehensive discussion of this issue is beyond our present scope. However, one of the conditions that could lead to such a situation is the reduction of a country's foreign exchange reserves to below a certain threshold. Many of the countries that still operate fixed-exchange-rate regimes use arrangements—such as a currency board—that require a very high level of reserves. Countries with floating-rate regimes and inflation-target policies in which depreciation has a considerable inflationary effect are forced to respond to depreciation by raising nominal interest rates, not in order to affect the exchange rate, as this is not the policy objective, but to reduce inflation expectations when they rise as a result of depreciation. As heavy use of the interest-rate instrument over a long period can have adverse effects on growth, in the event of exceptionally large depreciation those countries may have to resort to market intervention combined with

Countries operating fixed-exchange-rate regimes can become targets of speculative attacks, so they tend to use arrangements that require a very high level of reserves.

Countries with floating-rate regimes and inflation-target policies in which depreciation has a considerable inflationary effect, must respond to depreciation by raising interest rates. In the event of a large depreciation they may also have to resort to market intervention to achieve the declared inflation target. To avoid creating opportunities for successful speculative attacks they must hold high levels of reserves.

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use of the interest rate to achieve the declared inflation target. To avoid creating the type of opportunities for speculative attacks that occur in countries with fixed-rate regimes, they must hold high enough levels of reserves. Another way in which a sharp depreciation can undermine stability is via the balance sheets of public-sector or private-sector entities. This occurs mainly when there is a currency mismatch between their assets and liabilities. Those countries whose local-currency bond markets can attract investments from nonresidents are far less exposed to such problems, and they can therefore allow themselves to hold lower reserves.

b. A different approach to countries' demand for foreign exchange reserves

The Bank of Israel's Foreign Currency Department carries out research into various subjects related to the holding and management of foreign exchange reserves. A discussion paper written within the Department[22] presents a model of the levels of reserves held by the "middle group" of countries, i.e., those with a high level of economic development as reflected by their credit rating and their membership of the OECD, but who are not included among the eight largest and most advanced economies.[23] The model shows that the level of the reserves in these countries is a function of the size of their economies and the geographical diversification of their physical and human capital. The first parameter is measured by the broad money supply, M2, and the second by population density. The main variable of the model represents the division of the effect between these two parameters.

An estimation of the model using historical data of thirty-one countries over a twenty-one-year period (1980–2000) shows a correlation with a high confidence level ($R^2 > 88\%$). In addition to the estimation based on all the data, the model was also estimated using data of sub-periods and sub-groups of countries: 11 countries, about half of them Western European, over the period 1981–1995; 21 countries, about half of them Western European, over the period 1992–1997; and 19 countries from various regions (excluding the eurozone) over the period 1996–2000. The variables were also estimated according to several technical variations in the structure of the model itself. A range of estimated values of the foreign exchange reserves for any particular country can be derived from the values of the variables of the model obtained in the various estimations in accordance with the size of its economy and its geographical diversification. The width of this range, at least in Israel's case, suggests that the sensitivity of the results to changes in the model and in the group of data described above is reasonable.

Figure 1.18 shows the range for Israel's reserves over the last five years. The highest estimate (the top line in the figure), is that derived from the third sub-group mentioned above, for which the data relate to the most recent years and which contains a high proportion of newly industrialized European and Far East countries. It may thus be claimed that the highest estimate is the most relevant to Israel and to the currently prevailing conditions in the international scene.

[22] D. Hoffman (2003) *"Adequacy of Foreign Exchange Reserves: Evidence from Panel Time Series Modeling"* (forthcoming).

[23] Canada, France, Germany, Italy, Japan, Switzerland, the UK and the US.

Figure 1.18
Range of Estimated Levels of Israel's Foreign Exchange Reserves,
1998 to mid–2002
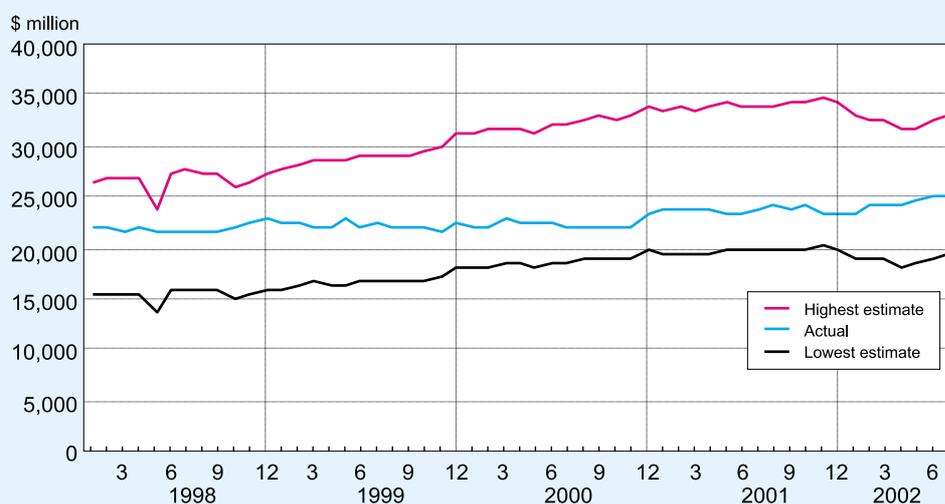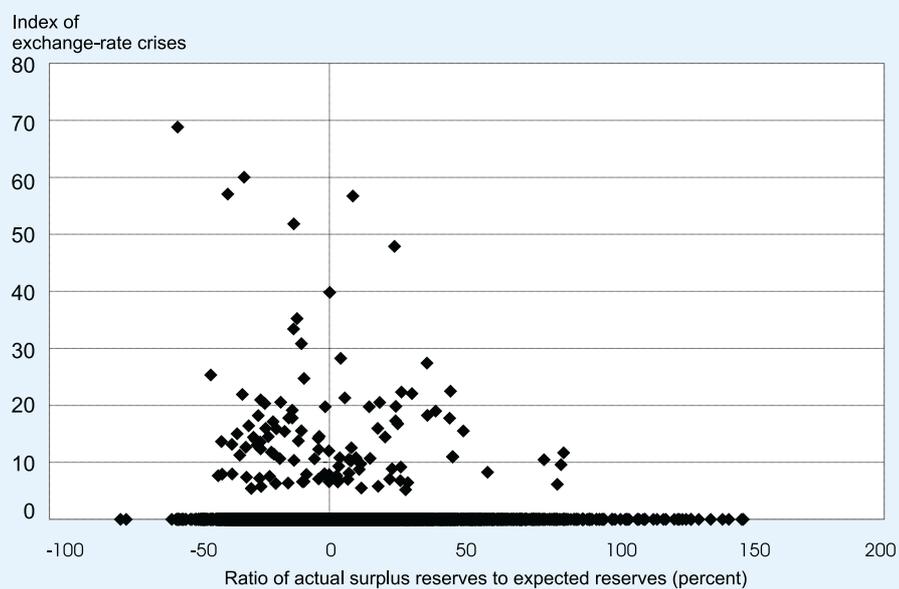

SOURCE: Bank of Israel.

Hitherto the research focused on the actual behavior of countries and not on setting norms for the optimum level of a country's reserves. The question arises, however, whether holding reserves higher than those estimated by the model has positive results, and vice versa. In the light of the view that one important benefit of holding reserves is to reduce the probability of a crisis developing in the domestic foreign exchange market, it is appropriate to examine whether there is a link between the actual level of the reserves relative to the level derived from the model on the one hand, and the incidence of crises and their severity on the other. For this purpose an index was devised to indicate the incidence and severity of exchange-rate crises. In accordance with the usual methods used in academic literature dealing with crises in foreign-currency markets, the index is based on the incidence and severity of extreme occurrences relating to the exchange rate and the interest rate, such as depreciation that is significantly steeper than the past trend or a sudden steep hike in the interest rate (or both events simultaneously). The index gets a value that expresses the severity of the crisis for the months in which it took place, and the value zero for the other months. The horizontal axis in Figure 1.19 shows the ratio (in percent) of the actual level of the reserves and their estimated level, *minus* one, while the vertical axis shows the index.

It can be seen from the figure that holding reserves lower than the estimated level is not a sufficient condition for the outbreak of a crisis, as many observations fall on the horizontal axis (i.e., no crisis) and to the left of the origin (i.e., reserves lower than expected). Moreover, holding reserves at or above the estimated level cannot entirely prevent the occurrence of crises in countries' foreign-currency markets. Nonetheless, it seems that there is a connection between the level of reserves relative to the estimate and the maximum degree of severity of a possible crisis. Also, the lower the relative

The research also examined the connection between the actual level of the reserves relative to the estimated level, on the one hand, and the incidence of crises and their severity on the other.

It was found that holding reserves lower than the estimated level is not a sufficient condition for the outbreak of a crisis, but the lower the relative level of the reserves, the higher the frequency of crises. Moreover, when the level of reserves is somewhat higher than the estimate, very severe crises are avoided.

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Figure 1.19
Actual Level of the Reserves vis-à-vis the Expected Level,
and Exchange-Rate Crises

Index of
exchange-rate crises

Ratio of actual surplus reserves to expected reserves (percent)
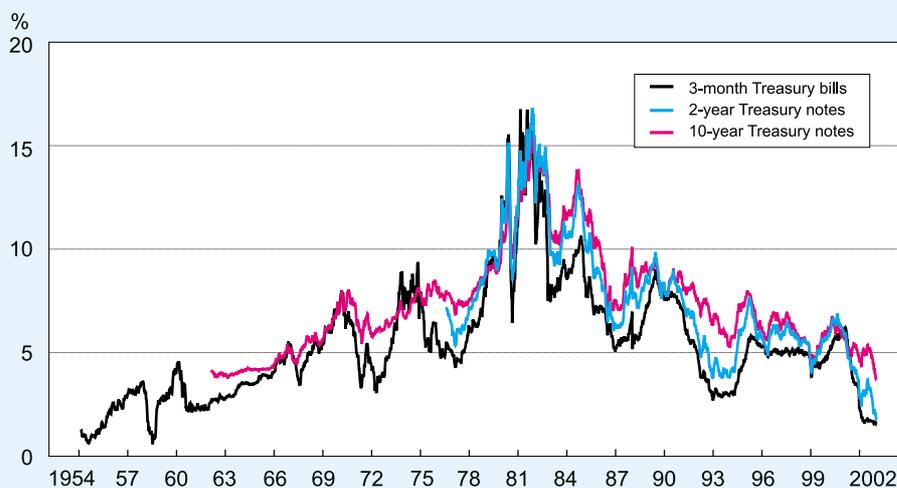
SOURCE: Bank of Israel.

level of the reserves, the higher the frequency of crises. Moreover, it appears that when a country holds a higher level of reserves than the estimate, it manages to avoid very severe crises whose implications for the economy and the financial system are particularly harmful. These results show the benefit of holding higher levels of reserves, on the one hand, and the importance of other factors, headed by transparent management of a responsible and credible macroeconomic policy aimed at stability, on the other.

c. Shortening the duration of the dollar benchmark

Towards the end of 2002 the duration of the dollar benchmark was shortened from 16 months to 11 months. The background to the decision was the level of yields that prevailed in the US bond market at the end of 2002, when short-term interest was at its lowest level for more than 40 years, only 1.25 percent (Figure 1.20). When interest rates are so low, the margin of safety provided by interest income is very narrow, so that a relatively small rise in yields to maturity is likely to result in capital losses greater than interest income, and thus negative holding-period rates of return. One of the important features of the reserves portfolio which strongly affects the holding-period rate of return is its duration. Generally, the longer the duration the greater the risk of obtaining a negative holding-period rate of return when yields to maturity rise.

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Figure 1.20
Yields to Maturity on US Treasuries, 1954–2002

SOURCE: Bank of Israel.

The duration of the portfolio was set at 16 months four years ago in the wake of research carried out by the Department. The approach adopted in the study was to set a target duration for the benchmark portfolio that would give annual holding-period rates of return greater than a desired minimum threshold with a probability of 95% (the 'shortfall' approach). The desired minimum threshold was defined as half of the yield on a 3-month T-bill. The duration of the benchmark reflects the Bank of Israel's preference regarding the yield/risk ratio, where the risk is defined as receiving a holding-period rate of return that is negative or below the minimum threshold. Assuming no change in the Bank of Israel's attitude to the yield/risk ratio, at the current level of yields leaving the duration unchanged at 16 months would have exposed the Bank to worse ratios than in the past: for a portfolio with a 16-month duration the holding-period rate of return next year would be negative if bond yields rose by 2.1 percent compared to 5.6 percent in 1999 when the duration was set at 16 months.

The tests and their results

In the light of the rising risks of obtaining negative holding-period rates of return, the performance of portfolios of different durations was examined under different possible scenarios regarding the path of yields to maturity. Two types of test were performed: the first, a naïve test using a simple scenario analysis providing estimates of possible losses on the neutral benchmark with a 16-month duration vis-à-vis portfolios with other durations, assuming a rise in market yields. The second test was based on the study that was used to determine the duration of the benchmark and applies the same model to current market conditions under different scenarios regarding the path of yields to maturity.

The duration of the benchmark reflects the Bank of Israel's preference regarding the yield/risk ratio, and it was set at 16 months in 1999 based on the 'shortfall' approach. The yield/risk ratio expressed by the 16-month duration at the time it was set was different from the ratio obtained at the level of yields to maturity at the end of 2002.

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Table 1.8
Expected Annual Holding-Period Rates of Return on Portfolios of Different Durations according to Various Scenarios

(percent)

Change over a year in yield to maturity	Minimum threshold level	Portfolio duration		
		16 months	11 months	8 months
–1.50	0.8	2.91	2.20	1.80
–1.00	0.8	2.49	2.00	1.72
–0.50	0.8	2.07	1.79	1.64
0.00	0.8	1.66	1.58	1.56
+0.50	0.8	1.25	1.38	1.48
+1.00	0.8	0.85	1.18	1.41
+1.50	0.8	0.45	0.98	1.33
+2.00	0.8	0.05	0.78	1.26
+2.25	0.8	–0.14	0.68	1.22
+2.50	0.8	–0.34	0.59	1.19
+3.00	0.8	–0.72	0.39	1.12

SOURCE: Bank of Israel.

A portfolio with a 16-month duration would give a negative annual holding-period rate of return if the interest rate rises by 2.25 percentage points during 2003. The return would have to rise by slightly more than 1 percentage point for this portfolio to give an annual holding-period rate of return of less than the desired minimum threshold.

The first test showed that a portfolio with a 16-month duration would give a negative annual holding-period rate of return if the interest rate rises by 2.25 percentage points during the year; portfolios with 11-month and 8-month durations would give returns of 0.7 and 1.2 percent respectively in the same scenario (Table 1.8). The test also showed that the return would have to rise by slightly more than 1 percentage point for a portfolio with a 16-month duration to give an annual holding-period rate of return of less than the desired minimum threshold. Nevertheless, even if yields to maturity continue to fall over the next year, shorter portfolios would still perform better than the minimum, even if they would perform less well than the portfolio with the 16-month duration.

The second test was more complex: it estimated the distribution of annual holding-period rates of return of portfolios with different durations one year hence, assuming that the yields to maturity in the course of the next year would change in line with their distribution in three different selected periods in the past. The distribution of the changes in the yields to maturity estimated for each of the periods was therefore projected onto the next year: three scenarios were created, each with the same starting point of the current low market yields, while the development of each was derived from the distribution estimated from a particular period in the past.

The distribution of holding-period rates of return in different scenarios were calculated, based on different periods in the past.

• The first period chosen was 1999, in the course of which the short part of the yield curve (3 months) rose by 0.7 of a percentage point, and the long part (5 years), by 1.6 percentage points.

• The second was 1994, when yields rose more steeply than in 1999. In 1994 the yields on the short part of the curve went up by 2.5 percentage points, and the long part by 3.3 percentage points. This is the most extreme scenario.

• The third scenario is that the change in yields to maturity is similar to the pattern of change in 2002, when yields declined, continuing the trend that started in 2001.

The results show that in the less extreme scenario, in which the rise in yields was similar to that in 1999, shortening the duration to 11 months provides protection against both a negative holding-period rate of return and failure to meet the shortfall conditions. In the 1994-type scenario the results show that the duration should be shortened at least to 8 months to provide protection against negative holding-period rates of return. The results show that if yields continue to fall next year in line with the distribution derived from the changes in yields to maturity that occurred in 2002, the portfolio will suffer an average alternative yield loss of 0.7 percent if the duration is shortened to 11 months, and of 1.1 percent if it is shortened to 8 months. In both cases the portfolio would meet the shortfall conditions, and would of course obtain a positive yield.

In the light of the above, the duration of the reserves portfolio was shortened to 11 months.

The test showed that in the less extreme scenario, shortening the duration to 11 months provides protection against both a negative holding-period rate of return and failure to meet the shortfall conditions. In the more extreme scenario a greater shortening of the duration would be necessary.

APPENDIX 1.1: MAIN MARKET DEVELOPMENTS IN 2002

a. General developments

The economy of the industrialized world marked time in 2002, showing mixed trends: in North America growth was faster than in 2001, while in Europe it slowed down. In Japan economic activity showed a very small increase for the second year in succession. In the US, GDP rose by 2.4 percent, compared with only 0.3 percent in 2001. The increase was even more striking in Canada, where GDP went up by 3.3 percent, compared with 1.9 percent in 2001, giving it the highest growth rate of the large industrialized countries. In the eurozone and the UK growth was slower, down to 0.8 percent from 1.5 percent in 2001 in the former, and down to 1.8 percent from 2.1 percent in the latter. The growth rate in most emerging economies, and also in the newly industrialized Asian countries—Korea, Taiwan, Hong Kong and Singapore— which were hard hit by the slowdown in high-tech industries in 2001, was higher in 2002 than in 2001. Columbia and Argentina were exceptions to the general picture, both undergoing severe financial crises.

North America: The moderate growth in the US in 2002 encompassed several trends and developments some of which had started earlier: the contraction of internet-based high-tech companies continued; a series of scandals relating to dubious accounting methods that started with the collapse of Enron towards the end of 2001 caused several bankruptcies, including the largest in American history (that of WorldCom), and brought a large accounting partnership to the end of the road; the uncertainty caused by the terrorist attacks in September 2001 and other attempts by terrorists to commit further attacks lowered consumers' sense of security and the willingness of the business community to undertake long-term investments. The civil aviation industry was severely affected by several bankruptcies; all West Coast ports in the US were shut down by a strike for twelve days, which disrupted supplies of goods and raw materials which in turn reduced output; the main share-price indices fell for the third year in succession, the first time this has occurred since WWII.

The US economy succeeded in switching to a growth path despite the negative development mentioned above, due mainly to the continuation of the expansionary monetary policy adopted in 2001. The low interest rate supported the positive trend of purchases of retail goods and vehicles. These purchases enabled a reduction in inventories that had accumulated in 2001 and paved the way to recovery. It is nevertheless uncertain whether the US is on the brink of a renewed increase in business investment. The rate of growth in Canada can be attributed mainly to structural reforms instituted over the last few years in various spheres. The Canadian economy also benefits from increased demand for its exports from global goods markets and the US automobile industry.

Europe: Growth in the eurozone was slow, and unemployment remained high. In Germany, the largest member of the EMU, growth was close to zero. This can be explained by the fall in demand from the US, reflecting the effects of some of the

developments outlined above and of strikes in the public sector in France and the UK in the fourth quarter of 2002. Structural problems in the labor markets and in the area of pensions aggravated the difficulties of the European economies. Furthermore, the monetary policy of the European Central Bank (ECB) which was less expansionary than that of the Fed, and the need to observe the stringent limitations regarding budget deficits obligatory on countries that joined the EMU, hampered the transition to faster growth rates. On the other hand, the issue of euro banknotes, the strengthening of the euro against the dollar after several years of weakness, and the agreement reached towards the end of year regarding ten new EU members prevented a further decline in public confidence.

Japan: The developments of the previous two years continued and intensified; these included deflation, falling share prices and an increase in the large banks' portfolios of problem loans. The CPI excluding fresh food was lower in every month of 2002 than in the corresponding month of 2001. The Nikkei index dropped below 8,200 in October, 79 percent below its peak level. Problem loans totaled ¥ 24 trillion at the end of the third quarter. In order to inject new capital into the banks, the central bank announced a new plan in the autumn to purchase some of the banks' investment in Japanese companies. The deterioration of the situation in Japan made two large credit-rating companies downgrade Japanese government bonds in April/May.

b. Exchange rates of the major currencies

The dollar weakened against the euro, the yen and the pound sterling in the six months from the middle of January to the middle of July 2002. From then till the end of November those currencies were traded against the dollar within a relatively narrow range. During December the dollar weakened again. Over the year as a whole the dollar weakened by 15 percent against the euro, 10 percent against the yen, and 10 percent against the pound sterling (Figure A.1.1.1). The Canadian dollar strengthened against the US dollar in the second quarter of the year, but weakened again in July, and at the end of the year stood at the same rate as it had been at the beginning.

c. Interest rates and yields

The central banks of the major economies did not change short-term interest rates in the first ten months of 2002. In the US the Fed held the interest rate at 1.75 percent until the beginning of November, and then cut it by half a percentage point to 1.25 percent, its lowest level since 1961. The ECB held the short term rate on the euro at 3.25 percent until the end of November, and then reduced it by half a percentage point to 2.75 percent. In the UK the interest rate remained at 4 percent throughout the year, and in Japan the rate throughout 2002 remained close to zero.

Yields on US government bonds moved within a relatively narrow range in January–April. In May–September the yield curve declined as it flattened against the background of minimal growth and expectations of further cuts in the short-term interest rate. From

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the end of April until the end of September the six-month yield declined by 0.4 of a percentage point, the two-year yield by 1.5 percentage points, the five-year yield by 1.85 percentage points, and the ten-year yield by 1.5 percentage points. From the end of September until the end of the year the six-month part of the curve declined by a further 0.3 of a percentage point, while the yield for two years and beyond remained constant and actually edged up a little. In the eurozone yields rose from the beginning of the year till mid-March by 0.35 of a percentage point, and from then till the end of the year they fell by between 1 and 1.5 percentage points. In the UK a similar picture emerged: a rise in yields at the beginning of the year, followed by a downward trend. In Japan yields on bonds of up to five years stayed between zero and half a percentage point throughout the year.

Figure A.1.1.1

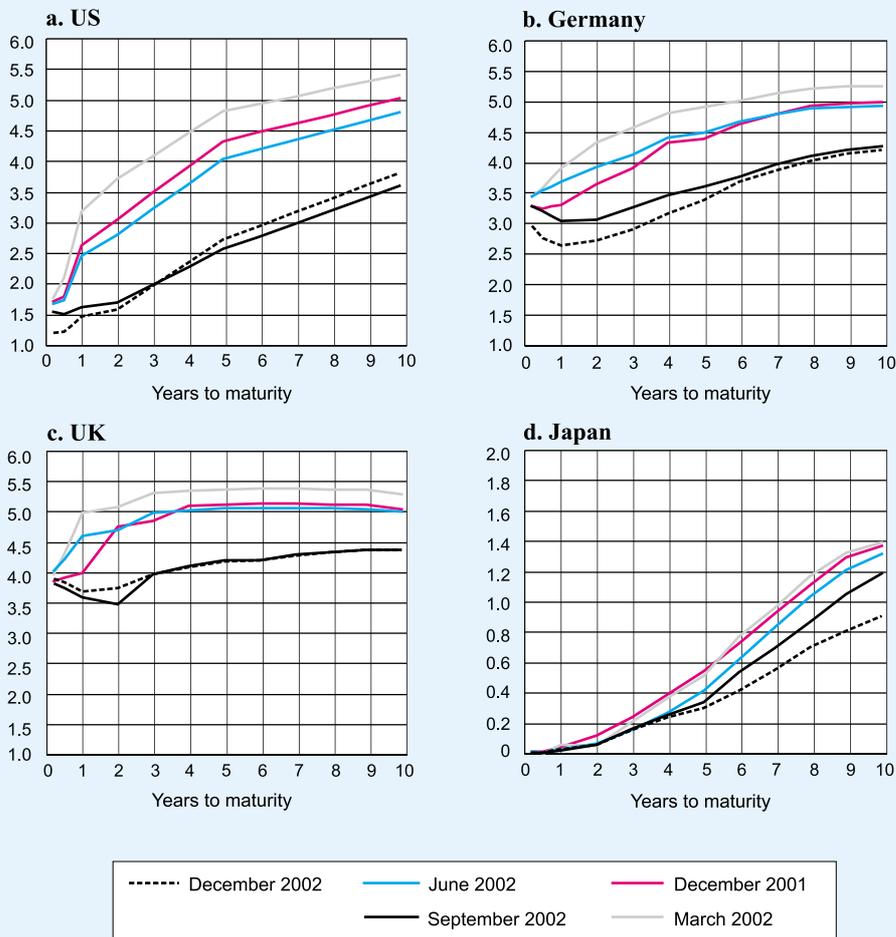**a. Exchange Rates against the Dollar, 1999–2002**

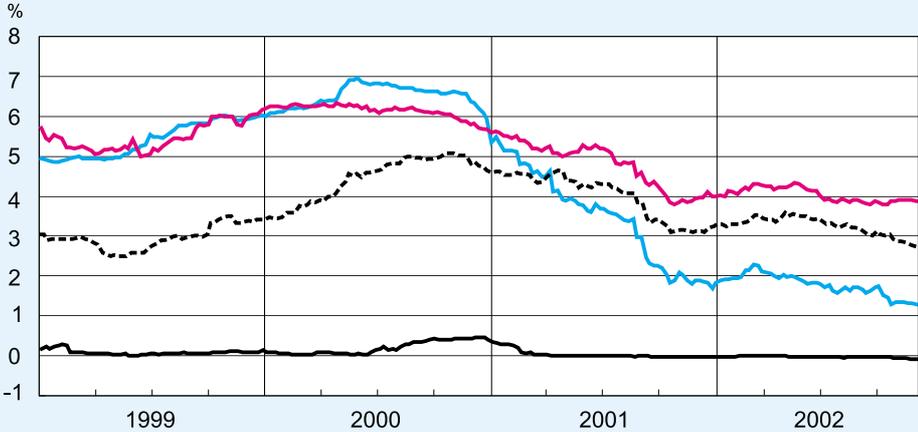**b. Exchange Rates against the Euro, 1999–2002**

SOURCE: Bloomberg.

50

Figure A.1.1.2

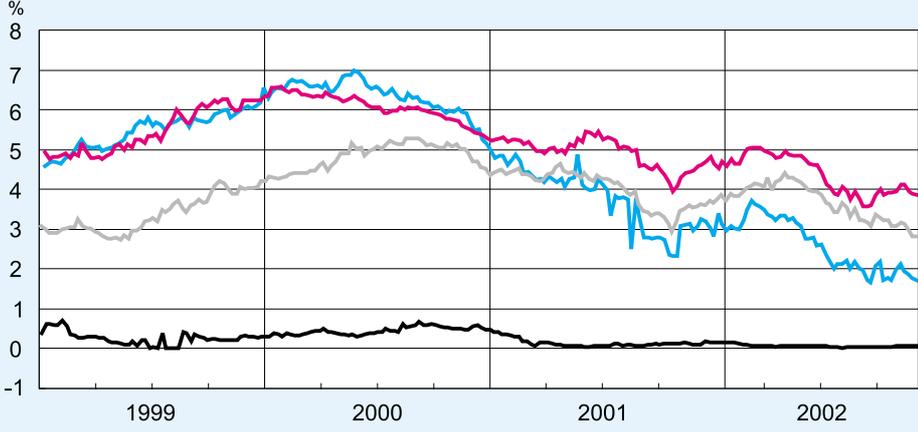**Yield Curves of Government Bonds, December 2001–December 2002**

(percent)

a. US

b. Germany

c. UK

d. Japan

Legend		
------- December 2002	—— June 2002	—— December 2001
—— September 2002	—— March 2002	

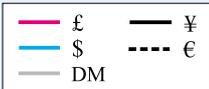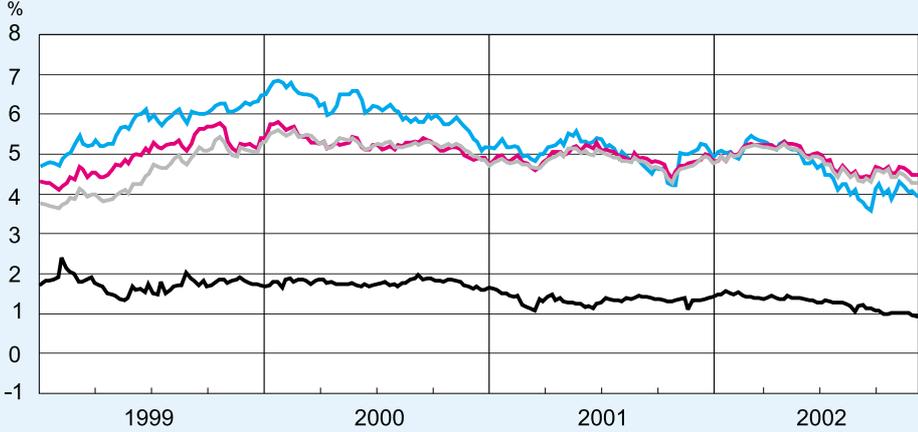SOURCE: Bloomberg.

Figure A.1.1.3

a. 6-Month Euro Interest Rates, 1999–2002

b. 2-Year Government Yields, 1999–2002
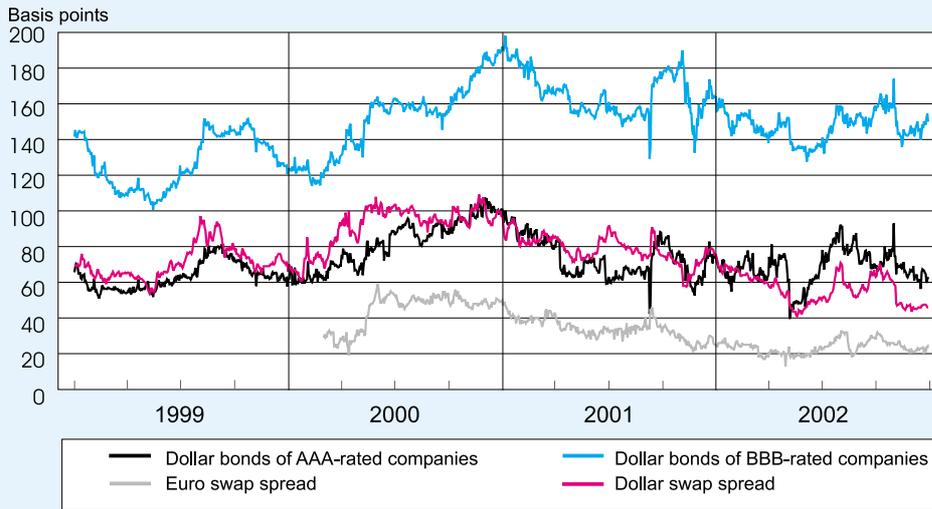
c. 10-Year Government Yields, 1999–2002
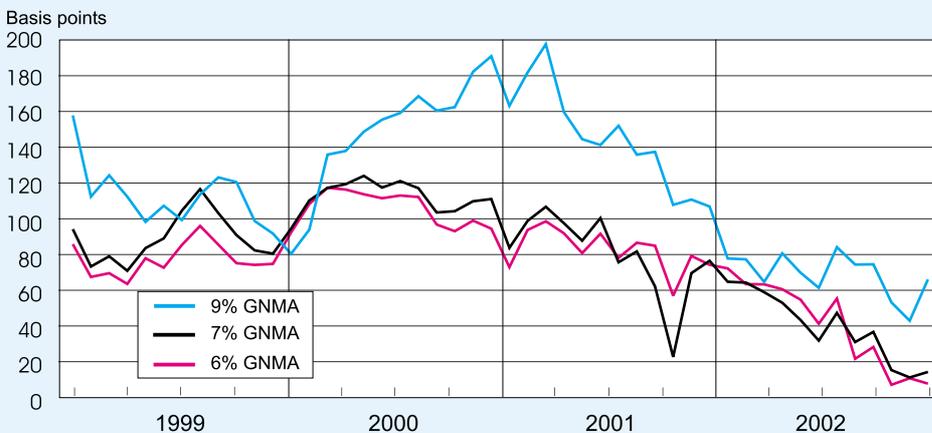
£   ¥
$ €
DM

SOURCE: Bloomberg.

Figure A.1.1.4

a. 3-Month US Dollar TED Spread, 1999–2002

Basis points
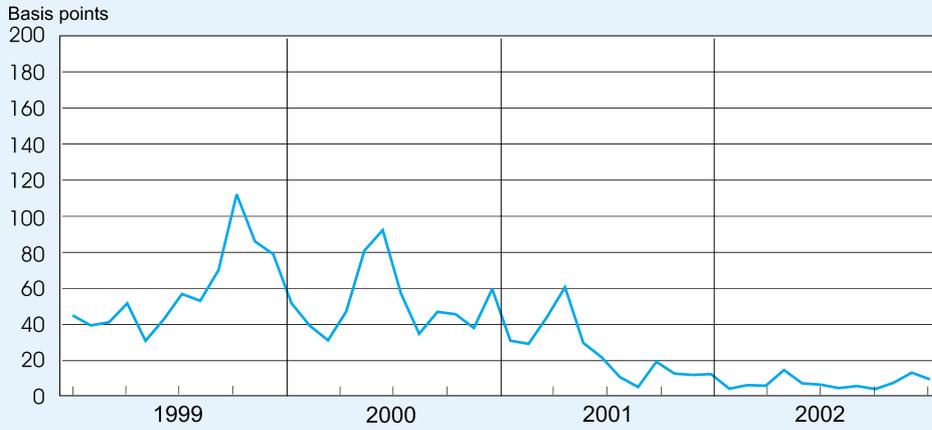
b. Spreads over 5-Year Government Bonds, 1999–2002

Basis points

—— Dollar bonds of AAA-rated companies	—— Dollar bonds of BBB-rated companies
—— Euro swap spread	—— Dollar swap spread

c. GNMA Option Adjusted Spread (OAS), 1999–2002

Basis points

—— 9% GNMA	
—— 7% GNMA	
—— 6% GNMA	

SOURCE: Bloomberg and Salomon Analytics.

APPENDIX 1.2: GLOSSARY

Annual terms	The yield that would have been obtained if the rate of change in the period reviewed would have prevailed for a year.
Basis point	A 0.01 percent change or one ten thousandth part.
Benchmark portfolio	A hypothetical portfolio built according to pre-set rules that serves as a criterion for assessing the performance of an investment manager and as an anchor for managing the risks to which the portfolio he manages is exposed.
Credit risk	Exposure to the possibility of loss as a result of the failure to repay debts on time by an issuer, financial institution, or country, or as a result of changes in the assessment of the probability of such an event by market participants.
Currency risk	Exposure to the possibility of loss as a result of changes in exchange rates.
Currency terms (e.g., US dollar terms)	The yield obtained when the running values of all assets are multiplied by the running exchange rates into a specific currency or basket of currencies.
Duration	Refers to modified duration, unless noted otherwise. The ratio of a small change in the value of a debt instrument, as a percentage of its previous value, to the accompanying change in its yield to maturity (with a reverse sign). It is measured in units of time. See *portfolio duration, partial duration*, below.
Eurobonds	Bonds sold in financial markets outside the country in whose currency they are denominated.
Foreign exchange reserves	Financial assets issued abroad and denominated in foreign currency (including gold) which are owned and controlled solely by the central bank and are not encumbered in any way.

GNMA	Mortgage-backed securities issued by the Government National Mortgage Association and fully guaranteed by the US government.
Holding-period rate of return	Rate of change in the value of an asset or portfolio over a defined period.
Interest-rate risk	Exposure to the possibility of loss as a result of changes in interest rates or yields to maturity.
Investment policy	The standards and procedures set by an investor regarding his investments, in accordance with his long-term preferences, objectives, and strategies.
Legal risk	Exposure to the possibility of a loss as a result of the wording of a contract, in error, to the investor's disadvantage.
Liquidity	The ability to realize assets without delay and without diminishing their value.
Numeraire	The currency composition set as the benchmark for the reserves portfolio.
Neutral	The value of a specific characteristic of a portfolio when it is *risk-free* (see below).
Operational risk	Exposure to the possibility of a loss as a result of system failure, human error, and the like.
Portfolio duration, partial duration	The average *duration* of a portfolio of debt instruments (duration of each asset being weighted by its share in the portfolio) is the accepted index for estimating the interest-rate risk of the portfolio. However, as it is defined, duration measures sensitivity to *parallel and small* changes in the yield curve. In practice, shifts in the curve are often accompanied by changes in its slope. The *partial duration* in a specific area of the curve is obtained by multiplying the duration of the assets invested in that area by their weight in the portfolio, and measures the portfolio's exposure to a parallel

shift in that area only. The sum of the partial durations over the curve is equal to the duration of the entire portfolio.

Repo, Reverse repo	Abbreviation for Repurchase agreement, i.e., the purchase of a security alongside the undertaking to sell it back at a future date and a known price. In economic terms, the transaction is identical to a collateralized loan. When the Bank of Israel buys a security for future sale the transaction is known as a Reverse repo, and in the opposite case as a Repo.
Risk-free	A situation in which the investor can incur neither losses not profits.
Spread asset	An asset whose yield to maturity comprises the yield on another asset (e.g., a government bond) *plus* a yield spread that changes, usually continuously and moderately, in accordance with changes in the supply of and demand for assets of that type.
Standard deviation	A statistical measure of the spread of a distribution around its mean; often used as a measure of the extent of exposure to uncertainty (see *volatility* below).
Swap	A long-term agreement, under whose terms one party pays the other the interest on a specified sum of money (the notional principal) according to a known variable interest rate (e.g., LIBOR), while the other party pays the first the interest on the notional principal at a fixed rate as determined in the agreement. The series of fixed interest rates prevailing in the market is known as the *swap curve*, and the difference between it and the government-bond yield curve at a specific maturity is called the *swap spread* (see below) for that maturity.

Swap spread	The difference between the yield to maturity on a government bond and the fixed interest that one party pays the other in a *swap agreement* (see above) for a similar period.
Synthetic trade	A pair of transactions, in one of which a security denominated in a currency other than that of the portfolio in which it is held is bought, while the other involves a forward foreign exchange trade from the currency of the security into that of the portfolio. The forward foreign exchange trade settles on the date on which the security matures and is for an amount equal to its value at maturity.
TED spread	Treasury-Euro-Deposit spread, i.e., the difference between the yield to maturity on short-maturity government debt and the interest rate on a deposit with the same maturity.
TIPS	Acronym for Treasury Inflation-Protected Security—a CPI-indexed US government bond.
Trade	An agreement to transfer or encumber ownership of financial assets, e.g., foreign currency or securities.
VaR	Acronym for Value at Risk, the greatest loss, with a given probability, that is expected to occur within a defined period of time.
Volatility	The size of the *standard deviation* (see above) of the distribution of the holding-period rates of return on a financial asset, such as a security or portfolio, over a specific period of time (day, week, etc.). It is usually calculated on the basis of the logarithm of the holding-period rate of return, $\log(1 + y)$, where y is the simple rate of return.
Yield curve	A series of yields to maturity of bonds with different dates to redemption and with characteristics in common (e.g., government bonds of a specific country in its local currency).

Yield spread   The difference between the yields to maturity of two debt instruments.

Yield to maturity   The holding-period rate of return, in annual terms, that would be obtained by keeping a debt instrument until its final redemption date, if it were possible to invest all its cash flows at the same yield until the final redemption date (also called internal rate of return).