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Summary

This study finds a long-term relation between the level of investment in the business sector, GDP, and the cost of capital which is consistent with the neo-classical theory. The main variable among the cost of capital variables which is negatively related to business-sector investment is the relative price of the investment (relative to the price of business-sector product). This price reflects the technological advances from abroad which improve the quality of capital stock in general, and equipment in particular, as well as the real exchange rate in import terms.

Variables directly related to monetary and fiscal policy, such as the short-term post factum real interest rate and the statutory tax rate for all direct taxes, were found, as expected, to have a negative effect on long-term investment, and their effect varies according to the type of asset (equipment and buildings). The elasticity of foreign direct investment (FDI) to business-sector investment is positive but relatively small (about 5.5 percent). Thus a real rise of NIS 1 billion in FDI would increase business-sector investment by about NIS 250 million.

In the short term the rates of change of business-sector investment are positively correlated with changes in the level of economic activity, equipment utilization (obtained from the Bank of Israel Companies Survey), and shifts in FDI, and negatively correlated with changes in variables connected with the cost of capital (e.g., the relative price of the investment and the statutory tax rate). In addition, we found a significant negative effect on investment of the uncertainty resulting from a change in business-sector product and the terms of trade.

הקשרים ארוכי וקצרי הטווח של ההשקעה בסקטור העסקי בישראל 1968-2008

יעקב לביא ויגאל מנשה

תקציר

בעבודה זאת נמצא קשר ארוך טווח בין רמת ההשקעה בסקטור העסקי, התוצר ועלות ההון, התואם את התיאוריה הניאו-קלאסית. המשתנה המרכזי מבין משתני עלות ההון והקשור שלילית להשקעה העסקית הוא המחיר היחסי של ההשקעה (בהשוואה למחיר התוצר העסקי). מחיר זה משקף את השיפורים הטכנולוגיים מחו״ל המשפרים את איכות מלאי ההון בכלל והציוד בפרט וכן את שער החליפין הראלי במונחי יבוא.

משתנים הקשורים ישירות למדיניות המוניטרית והפיסקלית כמו הריבית הריאלית הקצרה בדיעבד ושיעור המס הסטטוטורי של סך המיסים הישירים נמצאו כמשפיעים על ההשקעה בטווח הארוך באופן שלילי כצפוי, והשפעתם שונה בין סוגי הנכסים (ציוד ומבנים). גמישות ההשקעה בין ההשקעה הריאלית הישירה של תושבי חו״ל להשקעה בסקטור העסקי היא חיובית אך קטנה יחסית (כחמשה וחצי אחוזים). מגמישות זאת ניתן לגזור כי גידול ראלי של ההשקעה הישירה של תושבי חו״ל במיליארד שקל תביא להגדלה של השקעה בסקטור העסקי בכ-250 מיליוני שקלים.

בטווח הקצר שיעורי השינוי של ההשקעה העסקית קשורים חיובית לשינוי בפעילות, לניצולת הציוד (המתקבל מסקר החברות), לשינוי בהשקעה הישירה של תושבי חו״ל ושלילית לשינוי במשתנים שונים הקשורים לעלות ההון (מחיר יחסי של ההשקעה, שעור המס הסטטוטורי). כן נמצאה השפעה שלילית ומובהקת של אי הודאות הגלומה בשינוי בתוצר העסקי ובתנאי הסחר על הגידול בהשקעה.

1. INTRODUCTION

The rate of investment in relation to business-sector product is a pivotal variable in the long-term growth process of an economy, and particularly of a developing economy such as Israel's, both as a factor input and in the transmission of technological know-how. An examination of the rate of investment in the business sector (Appendix 2b) shows that this trend has changed, declining from the 1970s to the late 1980s, rising in the first half of the 1990s, and falling subsequently until 2005. The object of this study is to explain these developments by using an estimation that describes the long-term relation between the level of investment and that of business-sector product, while emphasizing the importance of the effect of the relative price as a central cost variable in the investment equation. The study also relates to the short-term relations among these variables as well as those between them and an error-correction factor. The neo-classical approach (Hall, 1977, Sargent, 1979), and its development by Bean (1981), constitutes the main conceptual framework for explaining the development of investments in the long run. According to this approach, the main variable which should determine investment in the long run is the level of economic activity and the cost of using capital stock.[1] In the short term there may be several important effects apart from the variables connected with a change in the cost of capital, such as utilization variables, uncertainty, and other variables which describe business cycles. The results of the regressions for long-term investment (and alternatively of investment rates) indicate that there is a long-term relation between the rate of investment and the rate of investment in equipment and structures, on the one hand, and the main variable describing the cost of capital stock, namely, the relative price of investment relative to the price of business-sector product. Investment is related in the long run to additional cost variables (rates of depreciation/discards of capital stock, and sometimes also the share of tax in GDP and the real interest rate). This long-term relation was found to be stable even when the predicted estimation of the relative price of investment in equipment was used, as derived from the auxiliary equation between this variable and those representing the effect of the real exchange rate in import terms, as well as the price of investment in the US, representing world prices.

The economic literature contains several empirical studies by scholars and central banks which focus on an analysis of this kind, e.g., those in the UK by Ellis and Price (2003) and Bakshi and Thompson (2002), which describe the long-term trend shift between investment in the UK's principal industries and GDP and the cost of using it, focusing in particular on the downward trend over time of the relative price of investment, expressing the acceleration of technological improvements in recent

[1] One of the first-order conditions for maximizing a firm's profit is the initial long-term equilibrium relationship between GDP, capital stock, and the cost of using capital. The identity equation of gross investment ensures the second long-term relation between investment and capital stock. By substituting these two relations for one another we obtain a third long-term equilibrium relation ('a reduced form'), i.e., between investment, GDP, and the cost of using capital stock.

decades in developed economies such as the UK. In this context these studies also focus on the acceleration of technological advances in the information and communications (ICT) industries, as this is reflected in the sharp drop in the relative price of investment in these industries relative to product price.

Several studies of investment have been undertaken in Israel but most of them have concentrated on the short term. Lavi's study (1990) discusses the effect of the interest rate and other cost variables on investment in the short term only, finding that monetary policy has a significant effect on the timing of investment. Lavi and Strawsczinsky (1998) examine the effect of policy variables on GDP and per capita investment in the business sector, within the framework of a cointegrative equation, and found that the tax/GDP ratio, the domestic deficit/GDP ratiio, and the short-term interest rate in particular, have a negative effect on the level of per capita investment. The main disadvantage of using the neo-classical approach is that this framework assumes a fixed growth rate of GDP, i.e., that the economy is in steady-state equilibrium. Since Israel's economy is still defined as developing, and the country absorbed a massive influx of immigrants only a decade ago, it is fairly certain that it has not yet reached steady-state growth in the long term. Hence, we also formulated an alternative possibility of an investment equation, for the medium term, based on an adjustment equation of capital along the lines proposed by Jorgensen (1963), namely, an investment equation which expresses the process of adjustment of actual to desired capital. Thus, this equation also includes actual capital stock with a lag of some kind as an explanatory variable. The results of the estimation at quarterly and annual frequencies using this approach indicate a stronger long-term relation (cointegration) than that indicated by the neo-classical approach.

Another subject which we examined relates to the extent of substitutability or complementarity between the main investment components, i.e., investment in equipment and in structures. This question is particularly important in view of the different development of these two investment components over time: the rate of investment in structures declined relative to business-sector product in most years while the rate of investment in equipment has displayed the opposite trend and has risen, primarily since the late 1980s. On the one hand, these investment components can be regarded solely as alternative factor inputs (Hercovitz, 2001), in which case a long-term regression equation should be estimated only for equipment and structures separately. This question of substitution could also be relevant for the short term by examining the degree of irreversibility (inability to sell equipment/to reverse investment). An examination of the lifespans of equipment and structures indicates that that of equipment is significantly smaller than that of structures, so that the extent to which investment in structures is irreversible would appear to be greater than that of investment in equipment. However, the empirical evidence in various countries, such as the US (Ramey and Shapiro, 1998), indicates that the extent of sales of second-hand investment equipment is very small; the price of second-hand equipment in the manufacturing industry averaging about one-third of the value of similar equipment when new. This may be because equipment is characterized by being for a specific use which is closely connected with the trend of technological advances over time. This last consideration might indicate that investment in equipment has a greater degree of irreversibility than investment in structures, which have the option of being sold more easily to different firms in the industry, or to companies in other industries. On the other hand, the acceleration of technological advances, accompanied *inter alia* by the miniaturization of equipment, may in fact indicate that there are complementary relations between investment in structures and in equipment. Thus, in the latter situation there is some justification for estimating the equation of total investment without distinguishing between its components. The empirical results indicate that while the element of substitutability between the two investment components exists, it is relatively small, and there is a great extent of complentarity between them, so that it is possible to estimate the total investment equation in the short term, and not only the investment equation for equipment and structures separately.

The structure of the study is as follows: in Section 2 we present the theoretical framework and the various approaches which constitute the basis for the empirical estimation. In Section 3 we give the main data and variables in the regression equations, while examining the degree of integration between them by means of unit root tests. Section 4 presents the results of the estimation of the regressions in the long term using the various approaches. Section 5 contains the results of the dynamic equations of investment describing the short-term effects. Section 6 gives our main conclusions.

2. THE THEORETICAL FRAMEWORK

We examined two main theoretical approaches for explaining investment: 1) The neo-classical model of investment; 2) A model of investment derived from the adaptation of actual to desired capital stock.

A. The neo-classical model of investment

The neo-classical approach constitutes the main conceptual framework of this study for explaining the development of investment in the long term. According to this approach, as outlined by Bean (1981), the main variable which should determine the rate of investment in the long term is the cost of using capital stock:

A first-order condition for maximizing the profit of the firm is a situation where there is a production function CES which has two factor inputs, capital and labor. The marginal productivity of capital is:

$$(1)\ \frac{\partial Y}{\partial K} = \alpha\,(\frac{Y}{K})^{\frac{1}{\sigma}}$$

Where capital stock (K) and product (Y) α are constant and σ. there is elasticity of substitution between factor inputs at equilibrium conditions in the long term, real capital costs (RUC) are equal to the marginal productivity of capital:

$$(2)\ \alpha\,(\frac{Y}{K})^{\frac{1}{\sigma}} = RUC$$

And in logarithmic terms:

$$(3)\ \text{k - y} = \tilde{\alpha} - \sigma ruc \quad \tilde{\alpha} = \sigma \log(\alpha)$$

where $\tilde{\alpha}$ is constant. Note that the capital stock at the beginning of the period is derived from investment (I), the rate of depreciation (δ), and capital stock in the preceding period:

$$(4)\ \mathrm{K}_{t+1} = (1-\delta)K_t + I_t$$

and at long-term equilibrium the growth rate of capital stock is constant and equal to g, then:

$$(5)\ \mathrm{I}_t = (g+\delta)K_t$$

We now present equation (5) in logarithmic terms in equation (3) and get:

$$(6)\ \mathrm{i} = y + \tilde{\alpha} - \sigma ruc + \ln(\delta + g)$$

B. An investment model derived from the adaptation of actual to desired capital stock

The idea in this model, which was presented by Jorgensen (1963), is that the adaptation of actual to desired capital takes time, as expressed in the parameter λ by the following equation:

$$(7)\ \mathrm{K}_{t+1} - K_t = \lambda(K_t^* - K_{t-1})$$

where desired and optimal capital represented by K_t^* and λ is constant, so that the object of an increase in capital stock is to close the gap between actual and desired capital.

If we substitute equation (4) we get

$$(8)\ I_t = \lambda(K_t^* - K_{t-1}) + \delta K_t = f(RUC, Y, \delta, \sigma, K_{t-1})$$

namely, investment is not only a function of the optimal capital stock (the cost of capital and product), as in the previous approach, but because of the element of adjustment also includes capital stock in the past. Note that this approach, in contrast with the neo-classical one, describes a dynamic process of investment rather than a long-term equation, but in empirical and technical terms it is also possible to relate to the investment equation that includes capital stock with a lag in the framework of cointegration, especially if the extent of the lag is significant.

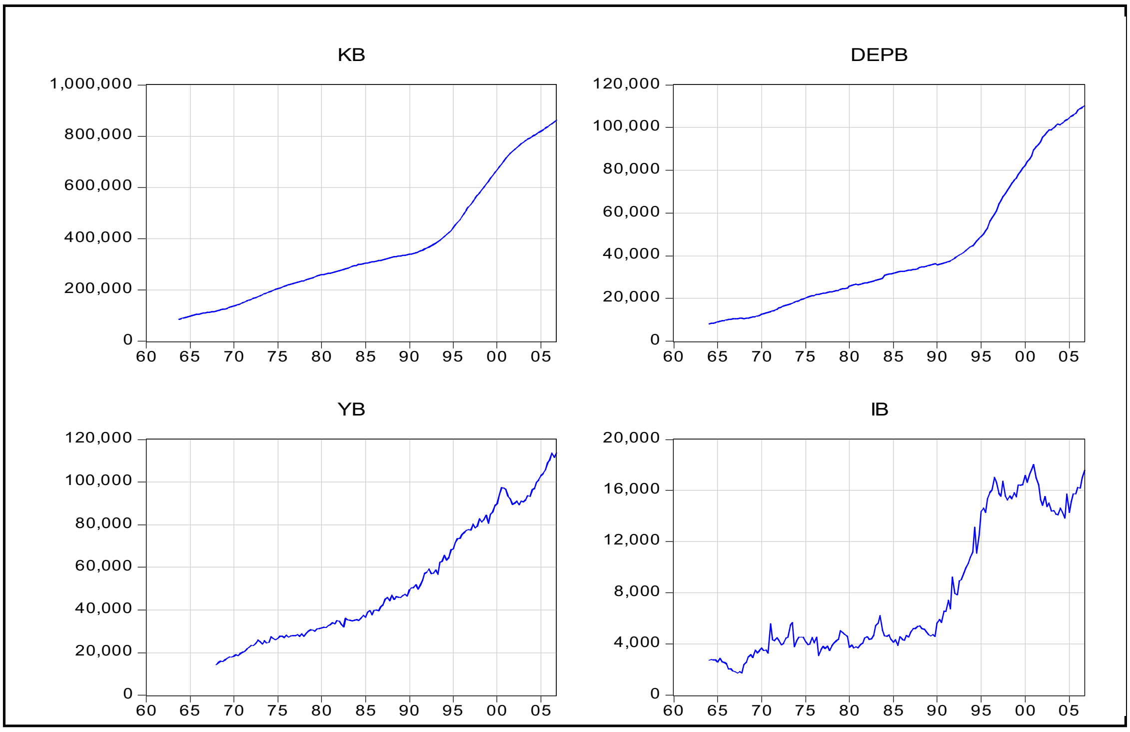
3. DEFINITION OF VARIABLES AND UNIT ROOT TESTS

In this study we examine a series of variables which we used to analyze the long-term investment equation. The main variables: all the data of the variables examined are seasonally adjusted, at quarterly frequencies, and at constant (2005) prices. The sample extends from 1968:I to 2006:IV, including those two quarters. Some of the regressions were expanded and estimated to 2008:IV. The main variables examined were the extent of investment in the business sector (IB), as a total and broken down by type of asset; investment in machinery and equipment (IB_EQ), in structures (IB_ST), the capital stock in the business sector (KB), in general and in structures (KB_ST), and in machinery and equipment (KB_EQ) in particular; business-sector product (YB), the extent of depreciation of total business capital (DEP_GB), of equipment (DEPB_EQ), and of structures (DEPB_ST) in this sector. The index of the relative price of investment (average 100 of 2005) was derived from the relation between the price of investment in general – and alternatively the price of investment in equipment and in structures (PIB_ST_PYB) – and the price of business-sector product in Israel (PIB_PYB), as well as the relative price of investment in the US (PIB_PYB_US).

The measured productivity of the business sector (AIL) and in manufacturing (AIND) in Israel, and the measured productivity of these sectors in the US is (A_US) and (AIND_US) respectively. The real short-term (ex post) interest rate is derived from the interest on demand deposits and overdraft facilities (RS), and the share of manufacturing product in total business-sector product (YIND_YB), which grasps the structural change in the economy and the decline in the share of the manufacturing industries in the economy in the course of the period reviewed (for graphs of the main variables in this study, see Appendix 2). The data in most of the series are from the CBS (Central Bureau of Statistics). The data on investment, capital stock, the price of investment, and depreciation in the business sector in general, and in equipment and structures in particular, are taken from the Bank of Israel's capital stock system, with the quarterly data being from 1995 onwards. For previous years we calculated the investment data and derived capital stock, depreciation, and investment data from them on the basis of the annual data on investment, under the assumption that the quarterly increase each year is consistent with the quarterly rates of change of investment in the principal industries and in equipment and structures in general in the National Accounts. The total productivity figures in the business sector and in manufacturing were calculated as a Solow residual, assuming constant production elasticities of capital and labor of one third and two thirds respectively. The data on capital stock, investment,[2] and total productivity in the US were taken from the website of the US Bureau of Labor Statistics, and as they originally give annual figures they were converted to quarterly frequencies using an HP filter.

Most of the series are I(1), i.e., there are unit roots at the levels and stationarity in the series of intervals, with the exception of the series for capital stock and depreciation (Appendix 8). In these series it is reasonable to assume that there is a break in the data due to the influx of immigrants in the early 1980s, which led to a massive rise in investment and was characterized by relatively long adaptation processes of capital stock, particularly in the context of the fact that Israel's economy is relatively small and young. The graphs of these series (Figure 1) support the existence of an ongoing break since the early 1990s. For control purposes we examined the existence of an ongoing break by means of a Perron-Vogelsang (1992) test for these series and for investment and product in the business sector.

Figure 1
Capital Stock, Investment, Depreciation, and Product in the Business Sector
(quarterly data, NIS million, constant prices)



[2] Prices of investment and GDP were taken from:
http://www.bea.gov/national/nipaweb/SelectTable.asp?Selected+Y#S2

This test allows for the existence of a break at a given point in time (a one-off jump) – the early 1990s – i.e., the four quarters of 1991, and an ongoing break (from a given point in time onwards) – from 1991:I onwards, using appropriate dummy variables, DUM91 and DUM91END. The regression examining any Z variable is of the following type:

$$\text{(9) } DZ_t = \alpha + \beta_1 DUM91 + \beta_2 DUM91END + \beta_3 DZ_{t-1} + \gamma Z_{t-1} + \varepsilon_t$$

The relevant coefficient for the test is γ and its *t*-value is adjusted to the degrees of freedom of the equation (similar to an ADF test), only this time taking the existence of a break in the series into account. If the statistical value of *t* is higher than the critical adjusted value (as in the tables in the article by Perron-Vogelsang, 1992), we will find that the series is of a level of integration which fits the break in the series. As stated earlier, the breaking point is defined as being from the beginning of the 1990s. The results of the above test for the relevant series are given in Table 1.

Table 1
Results of the Perron-Vogelsang (1992) Test

No. of observations	No. of lags	Critical *t*-value 5%	Critical *t*-value 10%	Statistical *t*-value	Variable
164	2	-4.17	-3.75	-4.57	KB
156	1	-4.14	-3.76	-5.48	EQ_KB
156	2	-4.17	-3.75	-5.09	ST_KB
164	2	-4.17	-3.75	-3.85	DEPB
163	2	-4.17	-3.75	-3.89	IB
161	2	-4.17	-3.75	-2.07	YB

The table shows that the variables for business capital stock, both as a total and when broken down by equipment and structures, pass the test at the 5 and 10 percent significance levels, the business depreciation variable passes the test at the 10 percent significance level, as does investment, while with regard to the variable for product there is no evidence for the existence of a break in the series at the beginning of the 1990s. This means that it can be claimed that all the relevant series in the long-term equations have identical unit roots and levels of integration I(1).

4. RESULTS OF ESTIMATION OF LONG-TERM EQUATIONS

In this study we undertook an empirical examination of two main theoretical approaches for explaining investment: 1) The neo-classical model of investment; 2) A model of investment derived from the adjustment of actual to desired capital.

(i) The neo-classical model of investment

As described above, the neo-classical approach constitutes the main conceptual framework of this study for explaining the development of investment in the long run. According to this approach, the main variable which supposedly determines the rate of investment in GDP in the long run is the cost of using capital stock. Under the first-order condition of maximizing a firm's profits the first relation of equilibrium in the long run exists between GDP and capital stock, and the cost of using them. The identity equation of gross investment guarantees the second-order long-term relation between investment and capital stock. By substituting these two relationships we get the third equilibrium relation of the long term ('reduced form'), namely, between gross investment, GDP, and the cost of using capital stock.

The findings from the long run regressions of investment in the business sector in the first neo-classical model indicate that there is a positive long-term relation between the log of business-sector investment (IB) and the log of business-sector product (YB), and a negative relation between the variables describing the cost of capital stock, namely, the relative price of investment in the business sector vis-à-vis the price of business-sector product (PIB/PYB) and the log of depreciation (DEPGB) or scrap (GRTB) of capital stock. We also added an explanatory variable to the equation expressing the structural change in the industry composition of the economy, namely, the share of manufacturing in business-sector product (YIND_YB), in which there has been a downward trend in the last few decades. The share of this industry is important because it is relatively capital-intensive, particularly in comparison with the other business-sector industries. While this last variable does not intrinsically express the long term, because a large part of the estimated period examined reflects the time in which capital stock was built up in Israel's young economy, in our opinion it is important to include it in the cointegration equation of the long run.

Table 3.1 sums up the results of the estimation of the cointegrative relation for the period between 1968:I and 2006:IV for the log of the level of investment in business-sector product and the variables connected with the cost of capital. The high 1.3 to 1.5 negative elasticity of the relative price of investment is notable, although we would have accepted unitary elasticity, as is indicated by a state of a Cobb-Douglas production function, or even one that is smaller than unitary.[3] The other cost variables have a negative but weaker effect on the level of investment in business-sector product: the extent of the depreciation of capital stock falls by 0.4 percent, and the effect of the scrap rate of capital stock is 0.3 percent. The effect of the real short-term interest rate (moving average over a year) on the rate of investment is also negative, but minor in

[3] In various studies elsewhere in the world the elasticity of the cost of capital relative to long-term investment is unitary. Ellis and Price (2003) found that this elasticity amounts to half a percent for the business sector in England. If, however, we accept the existence of a break in these equations by means of a dummy variable for the intercept and indemnities the elasticity of the relative price is reduced, and ranges from 0.7 to 1.

intensity. Note that in most of the regressions there is a unitary relation between business-sector product and investment, so that alternatively it is possible to measure the integrative relation for the rate of investment in business-sector product, and the results are very similar to those in Table 3.1 (Appendix table 6). Note in this context that in empirical terms there is nothing to prevent the estimation of the cointegrative relation between endogenous variables, but in the present study we have also tried to reduce endogeneity to some extent by estimating alternative long-term regressions which are similar to the regressions for the rate of investment in product and those which endeavor to use other auxiliary variables instead of the variable of the relative price for explaining investment (Table 3.3.). The estimation of the equations in such a way as to include the change in the relative price as well as the relative price, in line with the empirical examination in the study undertaken by Ellis and Price (2003), did not alter the results significantly.

Table 3.1
The Cointegrative Relation Between the Level of Business-Sector Investment and the Cost Components of the Use of Capital
(sample period: 1968:I – 2006:IV; numbers in parentheses are SD of variables)

Cointegrative Relation Between Level of Business-Sector Investment and Cost Components of Capital Use
(sample period: 1968:I to 2008:IV, figures in parentheses are SDs of coefficients)

Cointegrative correlation estimated = $$LOG(IB)_t - \gamma_0 - \sum_{i=1}^{m} \gamma_i ' X_{it} + \varepsilon_t = 0$$

	Variables							*Statistics*		*Examination of residual*	
No. of equation	*LOG(IB)*	*C*	*LOG(YB)*	*LOG(PIB/PYB)*	*LOG(DEPGB)*	*LOG(GRTB/KB)*	*ER*	$R^2 Adj$	*D.W.*	*A.D.F*	*D.W.*[1]
1.	1.000	0.866	-0.915	1.504				0.962	0.62	-4.091*	1.99
		(0.20)	(0.02)	(0.08)							
2.	1.000	13.302	-1.269	1.497	0.378			0.966	0.75	-4.155*	2.00
		(2.65)	(0.08)	(0.08)	(0.09)						
3.	1.000	3.405	-1.029	1.318		0.271		0.965	0.70	-4.200*	1.99
		(0.66)	(0.03)	(0.09)		(0.07)					
4.[2]	1.000	-0.051	-0.833	1.788			0.128	0.962	0.60	-3.751***	1.98
		(0.36)	(0.03)	(0.14)			(0.00)				

1)Belongs to equation estimating the A.D.F.
2) The sample period in the equation is 1972:III to 2006:IV
Significance level of A.D.F. is consistent with the number of variables and the number of observations:
* Significant at the 1 percent level
** Significant at the 5 percent level
*** Significant at the 10 percent level

The cointegrative relation should also be examined while accepting the existence of a break in it due to the influx of immigrants. In order to do this, we used a Lagrange multiplier (LM) test, as presented in the study by Carrion-i-Silvestre and Sanso (2006). This test examines the null hypothesis that cointegration exists in models in which the variable on the left-hand side (investment, in our case) is suspected of having a break in the continuum or of being a one-off event. The test is based on adding dummy variables representing the break in the series in the wake of the influx of immigrants, as regards their effect on both the intercept and the coefficients of the explanatory variables, to the equation of the long term (for a detailed explanation of the test, see Appendix 9). The results of the test show that at every significance level the hypothesis of the existence of cointegration in these equations cannot be rejected. The decline found in the adjusted equations, which include the dummy variables for the intercept and interaction variables with the explanatory variables, and in the elasticity of the relative price, which ranges from 0.7 to 1 in the various specifications (Table 3.1b in Appendix 9), is notable.

Note that the elasticities in the interaction variables in general, and the relative price in particular, after the start of the massive influx of immigrants in the early 1990s, rose (in absolute terms), but we do not regard this influx as a temporary feature deriving from a temporary crisis in the series, so that after several years of adjustment, the elasticities will return to their previous state. This contention is reinforced by the fact that there was no significant change in the elasticities of the explanatory variables after the influx of immigrants as compared with those prevailing beforehand in the model of the adjustment of capital stock, which incorporates the processes of the adjustment of investment and capital stock to the influx of immigrants. In equation 5 in Table 3.1b we used the variables of the real effective exchange rate (REER)[4] and the elasticity of this variable is around 1. In equation 6 we added a variable for direct (nonfinancial) investment in Israel by nonresidents in real terms (FDI_R_MA)[5] and obtained an elasticity of 5.5 percent relative to investment. From this elasticity it is possible to infer that a real NIS 1 billion rise in direct investment by nonresidents will lead to a NIS 250 million increase in investment in the business sector.

The cointegrative relation was also estimated for a more up-to-date sample for the period from 1995:I to 2008:IV. The results of this relation are presented in Table 3.2 and go in the expected direction. On the one hand, product (unitary elasticity) and the structural change in the economy had a positive effect on investment, while on the

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[4] For a more detailed account, see Bank of Israel, *Annual Report, 2008*, pp. 58-60 (Hebrew).

[5] The nominal direct investment by nonresidents is in dollar terms and was converted into NIS terms and adjusted by investment prices. In addition, we divided the data by a moving four-quarter average. Razin, Hecht, and Shinar (2003) and found that a one-dollar rise in the rate of direct investment in GDP leads in the long run to a 68 cent incre ase in domestic investment as a share of GDP. This figure is an average for a panel of 64 developing countries, including Israel, for 1976—1997. Their model was estimated by means of simultaneous equations linking the rate of domestic investment, the rate of direct investment, and the rate of financial and other investments as a percentage of GDP.

other that of the cost variables (particularly that of the relative price) was negative. Note that this time the elasticity of the relative price (representing the elasticity of the substitutability of factor inputs) does not vary significantly from unitary elasticity. The negative effect of the extent of depreciation on investment rises significantly in this period, which came after large investments in the 1990s with the massive influx of immigrants from the former Soviet Union. Note that the residual of the long term passes the ADF test at the five percent significance level.

Figure 2, which describes the residuals of the long run, shows that there was overinvestment from the beginning of 2007 until 2008:III, as reflected in the fact that actual investment was higher than that derived from long-term equilibrium. This means that there were short-term forces which acted to depress investment in order to return to long-term equilbrium**.** Despite these short-term forces, business-sector investment rose in the first half of 2008 because of the expansion of business-sector product and the decline in the relative price due to real local-currency appreciation.

Table 3.2
The Cointegrative Relation Between the Extent of Business-Sector Investment and the Components of the Cost of Capital Use
(sample period: 1995:I to 2008:IV, figures in parentheses are SD of the coefficients)

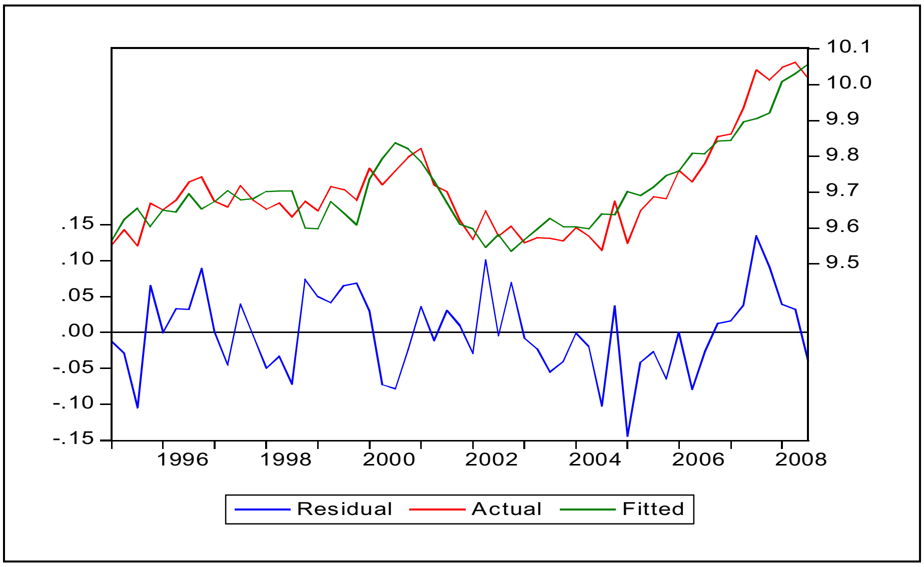
The Cointegrative Correlation of Investment in the Business Sector, by Costs of Use of Capital
(Sample period 1995:1 to 2008:4. Figures in parentheses are standard deviations of the coefficients)

Cointegrative correlation estimated = $LOG(IB)_t - \gamma_0 - \sum_{i=1}^{m} \gamma_i ' X_{it} + \varepsilon_t = 0$

	Variables						Statistics		Examination of residual	
No. of equation	*LOG(IB)*	*C*	*LOG(PIB/PYB)*	*LOG(DEPGB)*	*LOG(YB)*	*YIND_YB*	R^2 *Adj*	*D.W.*	*A.D.F*	*D.W.*[1]
1.	1.000	24.39 (5.68)	1.267 (0.19)	0.716 (0.09)	-1.138 (0.12)		0.746	1.23	-5.19*	2.13
2.	1.000	16.65 (6.02)	1.184 (0.17)	0.655 (0.13)	-1.036 (0.12)	-4.190 (1.50)	0.746	1.23	-4.82*	2.15

1)Belongs to equation estimating the A.D.F.
2) The sample period in the equation is 19972:3 to 2006:4
Significance level of A.D.F. is consistent with the number of variables and the number of observations:
* Significant at the 1 percent level
** Significant at the 5 percent level
*** Significant at the 10 percent level

Figure 2
Log of Actual Business-Sector Investment and at Equilibrium According to the Neo-Classical Model



The relative price of investment constitutes a central cost variable in the investment equation. Naturally, this variable is endogenous and is determined together with the quantity and level of investment, but is also influenced to a great extent by the relative world price of investment, as a result of the large share of imports in investment in general, and in equipment in particular. In effect, the relative price of investment in equipment in Israel, which is a small open economy, reflects two factors, namely, the effect of technological change represented by the relative US price and total productivity in the US, on the one hand, and other factors affecting the exchange rate in import terms (Lavi and Friedman, 2005), on the other. Table 3.3 presents the results of the long-term relation that exists between the relative price of investment in equipment and product price (the GDP deflator)[6] as a function of total productivity in the US (A-_US), and the relative price of investment in equipment in the US (PIB_EQ_US/PYB_US), the demand expressed by per capita GDP (GDP_PER_C), the unemployment rate (UP), and the variable of the (deterioration in the) terms of trade or the ratio between import and export prices derived from the National Accounts (PM_PX). The results go in the expected direction, i.e., a negative correlation with demand and total productivity, and a positive correlation with the relative price of investment in equipment in the US as well as with a deterioration in the terms of trade (the ratio of import to export prices). Moreover, if we use the predicted value from this equation of the relative price of investment as an auxiliary variable for the explanatory

[6] Similar results are obtained if we examine the cointegrative relation of the relative price of total business-sector investment.

variable of the relative price, we get similar results in the long-run equations for explaining business-sector investment.[7]

Table 3.3
The Cointegrative Relation Between the Relative Price of Business-Sector Investment and Demand and Productivity Variables
(sample period: 1968:I to 2006:IV, figures in parentheses are SD of the coefficients)

The Cointegrative Correlation of the Relative Price of Investment in the Business Sector with Demand and Productivity Variables
(Sample period 1968:1 to 2006:4. Figures in parentheses are standard deviations of the coefficients)

Cointegrative correlation estimated = $LOG\left(\frac{PIB\_EQ}{PYB}\right)_t - \gamma_0 - \sum_{i=1}^{m}\gamma_i' X_{it} + \varepsilon_t = 0$

	Variables								Statistics		Examination of residual	
No. of equation	LOG(PIB_EQ/PYB)	C	LOG(A_USA)	LOG(PM_PX)	LOG(GDP_PER_C)	LOG(UP)	UP	LOG(PIB_EQ_US/PYB_US)	$R^2 Adj$	D.W.	A.D.F	D.W.[1]
1.	1.000	-0.185 (0.05)		-1.183 (0.15)		-0.086 (0.02)		-0.540 (0.04)	0.836	1.04	-5.54*	1.99
2.	1.000	-4.169 (0.55)	0.695 (0.16)	-1.400 (0.16)	0.218 (0.09)	-0.065 (0.03)			0.804	0.96	-5.42*	2.00
3.	1.000	-4.729 (1.00)	0.859 (0.29)	-1.725 (0.16)	0.250 (0.12)		-1.406 (0.44)		0.985	0.80	-7.35*	2.10

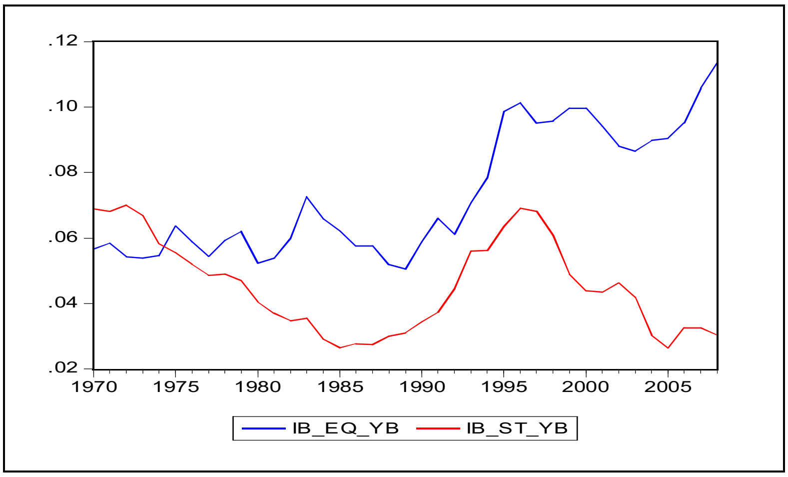
1)Belongs to equation estimating the A.D.F.
2) The sample period in the equation is 1972:III to 2006:IV
Significance level of A.D.F. is consistent with the number of variables and the number of observations:
* Significant at the 1 percent level
** Significant at the 5 percent level
*** Significant at the 10 percent level

An important question is whether investment and equipment capital stock is a complementary or replacement factor for structure capital stock. An examination of these two investment components over time shows that they have developed differently (Figure 3). The rate of investment in structures relative to business-sector product (IB_ST_YB) declined in most years (except at the end of the 1980s and the beginning of the 1990s), whereas the rate of investment in equipment (IB_EQ_YB) displays the opposite trend, rising primarily from the late 1980s, largely due to the decline in the relative price of investment in equipment, which was not accompanied by an equal fall in the relative price of investment in structures (Appendix 2b). Hercowitz (2001) referred to this subject and assumed substitutability between these investment components. In his study he examined the relative price of investment vis-à-vis the price of GDP, and claimed that until the 1980s Israel's economy was young, had just

[7] Alternatively, it is possible to use the auxiliary variables of equation 3.3 instead of the variable for the relative price to explain the investment equation, and to get similar results which preserve the cointegrative relation and in which the coefficients have the expected sign.

been opened to the world, and was characterized by the accelerated growth processes associated with the building up of the economy. Hence, there was a rise in the relative price of investment (real local-currency depreciation, primarily due to the decline in the price of GDP (□the GDP deflator), in the wake of the effect of the rise in supply following increased domestic production as a substitute for imports and in order to bolster the balance of payments, which was in deficit at that time, alongside a deterioration in the terms of trade. As a result, there was a concurrent fall in the rate of investment in business-sector product. In the 1980s and until the mid-1990s, as well as subsequently, when the economy was more open, investment in equipment predominated because of the positive effect of the acceleration in technological advances on equipment capital, as reflected in the decline in the relative price of this investment. In the late 1990s and the beginning of the 21st century the slump in demand and economic activity led to a renewed rise in the relative price and a decline in the investment rate. This rate began to rise again following the local-currency appreciation of 2006-2008.

Figure 3
The Rate of Investment in Equipment and Structures as a Share of Business-Sector Product



If we assume that these investment components constitute substitute factor inputs only (Hercowitz, 2001), it is possible to estimate long-run regression equations for equipment and structures separately. The consideration that the assets maintain a relation of substitutability between them can also be relevant for the short run, by examining the degree of irreversibility (inability to sell the equipment or reverse an investment) of these two types of asset. However, the acceleration in technological advances accompanied, inter alia, by the miniaturization of equipment, indicates that there is complementarity between investment in structures and equipment. Thus, in the latter case there is some justification for estimating the equations for total investment without distinguishing between its various components. The figure in Appendix 2a and the empirical results indicate that while the element of substitutability between the two investment components exists, there is a considerable extent of complementarity between them, so that it is possible in the long run to estimate the equation for total investment and not only the separate equations for investment in equipment and structures. If we assume that there is substitutability between the assets and we estimate the long-term equations for business-sector investment in equipment and structures separately, we obtain confirmation of the conclusion that the extent of complementarity between these components is relatively high (Table 3.4). The results of the regression show that investment in structures is also explained, alongside cost factors, by the positive relation with investment in equipment, and in effect had it not been for this factor the residual in the regression would not be stationary and there would be no cointegrative relation in the equation for investment in structures. The complementary relation according to the long-run equation is significant and attains elasticity of 0.8 between investment in equipment and in structures. Similar results are obtained when we examine the correlation between the capital stock of these two assets. However, incremental investment in structures does not contribute to the long-run correlation with investment in equipment which existed previously. Furthermore, adding the variable of relative price of the price of investment between these two assets to these regressions in order to measure the substitution effect (beyond the effect of the level of the relative price of each asset vis-à-vis the price of GDP) leads to the significant impairment of the cointegrative correlation.

Table 3.4

The Cointegrative Relation of Investment in Equipment and Structures with GDP, Different Investment Costs

(sample period: 1968:I to 2006:IV, figures in parentheses are SD of the coefficients)

Cointegrative Correlation Between Investment in Equipment and Structures and GDP and the Various Investment Costs

(Sample period: 1968:I to 2006:IV; figures in parentheses are SD of coefficients)

Cointegrative correlation estimated = $LOG(IB)_t - \gamma_0 - \sum_{i=1}^{m} \gamma_i' X_{it} + \varepsilon_t = 0$

Type of investment	Sample period	Variables							Statistics		Examination of residual	
									R^2 Adj	D.W.	A.D.F	D.W.[1]
		LOG(IB_EQ)	C	LOG(YB)	LOG(PIB_EQ/PYB)	LOG(GRTB_EQ/KB_EQ)	TAX_STAT_D					
Equipment[2]	1968:1 - 2006:4	1.000	5.613	-1.171	0.743	0.316			0.985	0.62	-4.263*	1.98
			(0.45)	(0.03)	(0.07)	(0.06)						
		1.000	6.000	-1.204	0.677	0.333	0.334		0.985	0.59	-4.196*	1.97
			(0.50)	(0.03)	(0.08)	(0.06)	(0.19)					
		LOG(IB_ST)	C	LOG(YB)	LOG(PIB_ST/PYB)	ER	TAX_STAT_D	LOG(IB_EQ)				
Structures	1972:3 - 2006:4	1.000	-0.453	-0.839	2.342	0.810		-0.815	0.895	0.53	-4.597*	2.20
			(1.12)	(0.07)	(0.29)	(0.00)		(0.13)				
		1.000	-0.674	-0.840	2.110	0.607	1.806	-0.781	0.90806	0.59	-4.87*	2.17
			(1.06)	(0.06)	(0.28)	(0.08)	(0.41)	(0.12)				

1) Belongs to equation estimating the A.D.F.

Significance level of A.D.F. is consistent with the number of variables and the number of observations:

* Significant at the 5 percent level

This finding reinforces the importance which should be attached to the complementary relations between equipment and structures relative to the element of substitutability between them. Note, however, that in the regressions which examined capital stock and not investment, and which studied the correlation between the price of investment in equipment and in structures as explaining the correlation between the capital stock of equipment and structures (Appendix 7)[8], the coefficient was negative at approximately 0.4, indicating that there is nonetheless some degree of substitutability between them, at least in the longer run.[9] This coefficient was found to be stable in regressions of annual data, too. In all the regressions we also found that the residuals of the long-run equations were stationary. Another variable that was found to have a negative effect on investment in equipment, and especially on investment in structures, was the statutory tax rate in total direct taxes (TAX_STAT_D).[10] If we derive the elasticity we find that a one percent decline in the statutory tax rate in total direct taxes increases investment in equipment in the long term by 0.3 percent, and by 0.8 percent in structures. The difference in the elasticity of the assets may be due to the fact that investment in structures is for a longer term because of the longer lifespan of structures than of equipment, so that its elasticity to a change in the share of taxes is greater. A change in the real interest rate will affect investment in structures only in the long run, and its elasticity reaches 0.8 percent.

All in all, it appears that until the mid-1980s the relative price of investment, particularly in structures, rose. This constitutes the main reason for the decline in the investment rate. Note that the considerable share of capital-intensive manufacturing in business-sector product at that time served to increase the extent of investment. Since the mid-1980s the main cause of the rise in investment has been connected with the decline in the cost of capital in general, and in the relative price of investment in equipment (relative to the price of GDP) in particular, largely as a result of technological advances but also because of other factors which affect this relation, such as the decline in import prices relative to export prices (an improvement in the terms of trade leads to real local-currency appreciation), and the rise in demand, at least for some of the period. Another factor which helped to increase investment in the early 1990s was the permanent reduction in the statutory tax rate in total direct taxes in GDP, which fell from 23 percent to 16 percent and to even less in subsequent years. As

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[8] These variables are I(1), i.e., they have a unit root at levels and are stationary in the series of differences.

[9] Similar regressions for the relation between investment in equipment and structures do not give cointegrative relations. Regressions for stocks of these assets, where all the variables are in logs, gave a cointegrative relation only for some periods, with a substitution coefficient that was lower than one and ranged between 0.5 and 0.6.

[10] Hercowitz (2001) found that the regressions on per capita investment in equipment and structures yielded elasticity that was slightly smaller between the share of tax in GDP and investment in structures, but the result was not significant as regards the elasticity of investment in equipment. A similar result was obtained when we used total tax rate in GDP.

stated, the decline in demand in the late 1990s and beginning of the 21st century served to raise the relative price once more.

(ii) The investment model including the adjustment of capital stock

Since Israel's economy is still a developing one, and one which absorbed a massive influx of immigrants only ten years ago, it is highly likely that it has not yet reached long-run growth equilibrium. Hence, we also formulate an alternative possible investment equation for the medium run, based on an adjustment equation along the lines of that described by Jorgensen (1963), i.e., an investment equation which expresses the process by which actual capital is adjusted to desired capital. Consequently, an equation of this kind also includes actual capital stock with some kind of lag (in our case, two years, i.e., eight quarters) as an explanatory variable. Note that the investment equation in this approach, which includes capital stock with a log, will inevitably describe a dynamic process rather than a long-term process, as is the case with the neo-classical approach, but it is the empirical and technical consideration which supports the empirical examination of the investment equation in this alternative approach. The relatively large lag of eight quarters in capital stock weakens the possible technical relation between capital stock and investment. An increase in the lag and the adaptation of capital stock slightly weakens the intensity of the integrative relation of the equation examined.

The results of the estimation (Table 3.5) go in the expected direction with the exception of the sign of the coefficient which examines the effect of the extent of depreciation on investment. This may express the need to increase investment at a time of greater economic depreciation. The elasticity of the relative price to investment is approximately unitary. Note that according to the statistical values of the residuals of the equations the intensity of the long-term relation (cointegration), using the alternative approach which includes the adjustment of capital, is greater, the elasticity being between 1 and 1.6, and the time for the adaptation of measured capital stock on the basis of the extent of the lag in the long-term equation amounts to eight quarters. However, the elasticity of the relative price effect is smaller in this approach vis-à-vis the extent of investment in comparison to its effect in the neo-classical model, and the statutory tax rate is not included in the variables in the long-term equation either. Similar results can be obtained if we examine the long-term equation, which includes capital stock with a lag, to explain investment in equipment and structures separately. Note that these equations were also run with the addition of dummy variables representing the possibility of a break in the investment series to the intercept and indemnities (interaction variables), and the results of this elasticity did not change significantly. Our test also showed that the hypothesis that the equations maintain a cointegrative relation cannot be rejected, even if there is a break in this relation.

Table 3.5
The Cointegrative Relation of Investment to the Variables for the Jorgensen Adjustment Equation
(figures in parentheses are SD of the coefficients)

Cointegrative Correlation Between Investment and Variables Consistent with the Jorgensen Adaptation Equation
(Figures in parentheses are SD of coefficients)

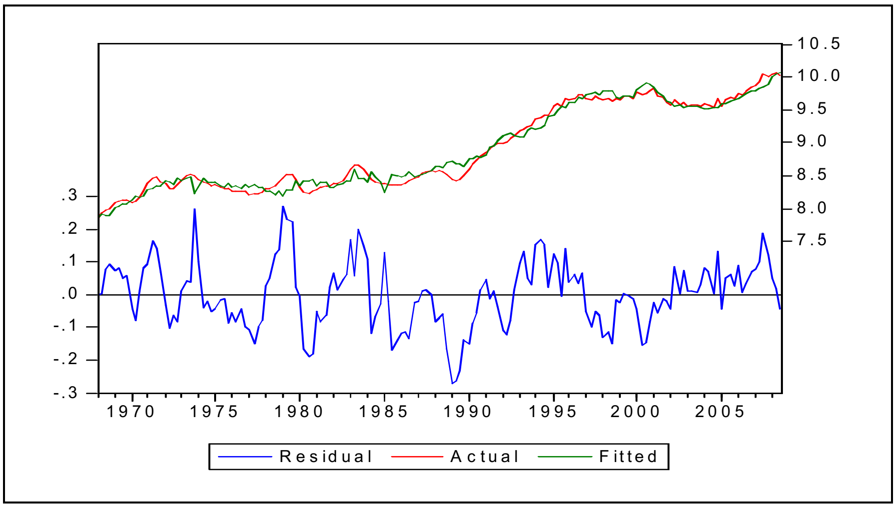
Cointegrative correlation estimated = $LOG(IB)_t - \gamma_0 - \sum_{i=1}^{m} \gamma_i' X_{it} + \varepsilon_t = 0$

No. of equation	Sample period	Variables								Statistics		Examination of residual	
		LOG(IB)	*C*	*LOG(YB)*	*log(PIB/PYB)*	*LOG(DEPGB)*	*LOG(KB(-8))*	*YIND_YB*	*ER*	R^2 *Adj*	*D.W.*	*A.D.F*	*D.W.*[1]
1.	1968:1 - 2006:4	1.000	-6.942 (1.22)	-1.260 (0.09)	0.890 (0.09)	-0.999 (0.21)	1.491 (0.22)			0.973	0.97	-5.009**	1.98
1.a	1972:3 - 2006:4	1.000	-6.869 (1.31)	-1.240 (0.10)	0.969 (0.14)	-0.939 (0.24)	1.423 (0.25)			0.971	0.81	-4.537**	1.98
2.	1972:3 - 2006:4	1.000	-7.279 (1.33)	-1.245 (0.09)	0.802 (0.18)	-1.082 (0.26)	1.565 (0.27)		0.001 (0.00)	0.972	0.83	-4.545***	1.99
3.	1968:1 - 2006:4	1.000	-2.257 (1.24)	-1.416 (0.08)	1.214 (0.09)	-0.607 (0.19)	1.063 (0.20)	-5.436 (0.75)		0.980	0.89	-6.624*	2.09
4.	1972:3 - 2006:4	1.000	-2.922 (1.29)	-1.423 (0.08)	0.946 (0.15)	-0.853 (0.22)	1.305 (0.23)	-5.562 (0.79)	0.0010 (0.00)	0.979	0.69	-5.324**	2.01

1) Belongs to equation estimating the A.D.F.
Significance level of A.D.F. is consistent with the number of variables and the number of observations:
* Significant at the 1 percent level
** Significant at the 5 percent level
*** Significant at the 10 percent level

Figure 4, which describes the residuals of the long run for the updated equation including 2008, shows that in this approach, too, there was over-investment from the beginning of 2006 to 2008:III, reflected in the fact that actual investment was greater than that derived from the long-term equilibrium.

Figure 4
Log of Actual Business-Sector Investment and at Equilibrium, According to the Model Including the Adjustment of Capital Stock



Similar results for the long run were also obtained according to this approach with regressions using annual data for the period between 1963 and 2006, with the active variables being GDP and alternatively total measured productivity in the business sector (Appendices 3 and 4).

5. THE RESULTS OF THE ESTIMATION OF THE SHORT-RUN EQUATIONS

These equations are dynamic equations with an 'error-correction' variable, defined as a residual with a lag from the equations of long-term equilibrium (the cointegration equations). This variable is very important because if it is significant and negative this means that there is a process of convergence to long-term equilibrium, thus supporting the existence of equilibrium. We also examine the dynamic effect of variables which appear in the long run and are found to be significant in explaining investment in the short run. Additional variables whose level of integration does not fit the long run are also included in these equations.

(i) Equations for total short-term investment according to the neo-classical model

The results of the short-run regression, in which the residuals with a one-quarter lag are taken from equations 1 and 2 of the long run in Table 3.1 of the neo-classical model, are given in Table 3.6. The table shows that there is a cointegrative relation in the various regressions and the correlation coefficient of the deviations in the short run for long-term equilibrium derived from the error-correction variable ranges between 0.15 and 0.3, similar to the result obtained in equivalent studies undertaken in England and Iceland. All the variables take signs in the expected direction, and almost all of them are significant. The long-run elasticity of investment to the relative price of investment is negative and generally unitary, although in the updated sample for 1995-2008 this variable is not significant. With regard to business-sector product the elasticity is positive and almost unitary. Half of the elasticity to the real interest rate is negative, but relatively low, ranging from 0.8 to 1.2, in several variations. The variables for the utilization rate of equipment in manufacturing, taken from the Companies Survey (NIZUL_SA), and the share of manufacturing in business-sector product are positive, as expected. The coefficient examining the effect of the rate of depreciation on investment also takes a positive sign.

The positive effect of the massive influx of immigrants from the former Soviet Union on the acceleration of investment in the early 1990s is expressed by the positive coefficient for the variable (OLIM_AA) describing the share of immigrants in the population (moving four-quarter average). The effect of several variables, such as terror attacks and a change in the share-price index, went in the expected direction, but was not significant.[11] These regressions examined several indices of uncertainty in a number of variables which could have a negative effect on investment in the short term, for reasons connected with the deferment of investment because of its irreversible nature. As several articles (e.g., Pindyck, 1988, 1991, 1993) indicate, there are two main ways for measuring uncertainty: by measuring whether the threshhold value of the marginal return on investment will be worthwhile for a firm, even taking into account the additional costs resulting to the firm from uncertainty (Caballero and Pindych (1996). This approach is complicated to implement because this threshhold value is not observable. Alternatively, it is possible to directly measure the variability of several variables which constitute a source of the shocks which affect the extent of investment. We have adopted the latter approach, as described by Episcopos (1995). The idea is to estimate the rate of change of several variables: the short-term interest rate, business-sector product, total business-sector productivity, relative prices, and prices of shares, using the ARCH estimation method in which both the change in the variable and the variance of the random disturbance make several lags possible (up to two, in our case), so that it is possible to derive the dependent variance of the random disturbance of the equation, constituting an index of uncertainty which is related to a change in these variables (Appendix 5). These variances, with and without lags, were found to be negatively related to a change in investment, but only in two of them (which include lags) was this relation found to be significant – the variance of the change in business-sector product VARD(YB) and the variance of the relative price of imports to exports VARD(PMPX).

[11] The elasticity in the short run of direct investment by nonresidents in Israel to business-sector product is 4 percent.

Table 3.6
The Equations for Total Investment in the Short Run, According to the Neo-Classical Model
(figures in parentheses are t-values)

Table 3.6: Equations of Total Short Term Investment According to the Neo-Classical Model
(Figures in parentheses are t values)

Period	1973:2-2006:3	1983:4-2006:4	1973:2-2006:3	1983:4-2006:4	1995:4-2008:4
Equation / ndependent variable	1 OLS	2 OLS	1	2 [3]TSLS	2
const	0.068 (1.47)	0.070 (2.55)	0.065 (1.37)	0.081 (2.58)	-0.128 -(2.42)
RES_{-1}	**-0.296** -(5.01)	**-0.150** -(2.34)	**-0.292** -(4.83)	**-0.200** (2.48)	**-0.197** -(2.66)
$D(ER)_{-2}$	-0.140 -(2.03)		-0.140 -(1.97)		
DLOG(PIB/PYB)	-1.053 -(6.45)	-1.020 -(5.27)	-1.051 -(6.29)	-1.066 -(5.07)	
DLOG(YB)	1.030 (5.05)	0.765 (2.81)	1.139 (2.23)	1.261 (3.52)	1.215 (2.26)
D(YIND_YB)	5.473 (8.56)	3.206 (3.06)	5.960 (4.40)	6.410 (3.78)	
NIZUL_OSA		0.001 (2.69)		0.000 (1.13)	0.001 (1.63)
DLOG(OLIM_AA)	0.011 (1.48)		0.010 (1.43)		
DLOG(DEPGB/KB)					5.097 (3.28)
$VARD(PMPX)_{-2}$		-0.415 -(1.21)		-0.438 -(1.15)	
$VARD(YB)_{-4}$		-0.616 -(2.16)		-0.784 -(2.38)	-1.759 -(2.30)
AR_1		-0.374 -(3.35)			-0.492 -(3.43)
R^2 adj	0.52	0.52	0.52	0.47	0.46
obs.	135	93	135	93	50
D.W.	2.08	1.97	2.07	1.92	2.16

1) Residual from Table 3.2, long-term equation no.1
2) Residual from Table 3.2, long-term equation no.2
3) Estimated by TSLS, auxiliary variables are all the independent variables including lags

(ii) *The equations for the investment components (equipment and structures) in the short run, according to the neo-classical model*

If we examine the results of the short-term investment equations for equipment and structures separately (Table 3.7) we find that the error-correction coefficient is between 0.11 and 0.15, i.e., the period of adjustment of the deviations from the long term to the new equilibrium is relatively lengthy for investment in structures and equipment.

Note that the explanatory power of the equations for investment in equipment and structures is relatively low in all the estimation methods (OLS, TSLS) compared with that obtained from the dynamic equations for total investment, so that the results of the estimation of the equations for the components of investment in the short run should be treated with a modicum of caution. The elasticities of the main short-term variables, such as GDP and relative price, are low in relation to total investment, and are generally higher for investment in structures than in equipment. Note, too, that this means that the elasticities are for the rise in the rates of change rather than for the levels of the variables, as was the case with the long-term equations. The extent of the change in the depreciation of the capital stock of structures has a positive effect on investment in structures, as we saw was the also case with the long-term equations in the capital-stock-adjustment model.

However, we found that for short-term investment in equipment a one percentage-point rise in the extent of the statutory tax rate (TAX_STAT) of firms (i.e., the difference of the differences of the tax rate) reduces the change in the extent of investment in equipment by about 0.4 percent. An equivalent examination of the effect of a rise in the statutory tax rate on firms on a decline in investment in structures yielded an even higher coefficient of 0.6, although the result is not significant. We also found a positive correlation between an increase in the utilization rate of equipment in manufacturing, as measured by the net balance in the Bank of Israel's Companies Survey, and the change in investment in equipment. Among the indices of variances of uncertainty calculated in the auxiliary regressions (as described in Appendix 5) we found a negative and significant correlation between the variance (taking the lags of changes of up to four quarters into account) of the relative change in import and export prices and the change in investment in equipment, and a negative correlation between the variance of the change in business-sector product and the rise in investment in structures. The negative correlation between the variance of the relative prices of imports and exports and the change in the extent of investment in equipment may reflect the fact that about two-thirds of the equipment is imported and not manufactured locally. Note that in the short term, too, there is a complementary relation between investment in structures and equipment, so that a one percent increase in the rate of change of investment in equipment contributes 0.2 percent to the rate of change of investment in structures.

Table 3.7
The Equations of the Investment Components in the Short Run, According to the Neo-Classical Model
(figures in parentheses are t-values)

Table 3.7: Equations of Components of Short Term Investment According to the Neo-Classical Model				
(Figures in parentheses are t values)				
Period	1983:4-2006:4	1983:4-2006:4	1972:4-2006:3	1974:3-2006:4
Estimation method / Independent variable	OLS	TSLS	OLS	TSLS
	Rate of change of structure investment		Rate of change of equipment investment	
const	0.047 (3.49)	0.044 (3.05)	0.011 (0.42)	0.013 (0.47)
RES_{-1}	**-0.123** -(2.75)	**-0.145** -(2.34)	**-0.115** -(3.01)	**-0.113** -(2.75)
DLOG(PIB_ST/PYB)			-0.529 -(3.79)	-0.495 -(2.03)
DLOG(PIB_EQ/PYB)	-0.198 -(3.64)	-0.212 -(2.07)		
DLOG(YB)	0.321 (1.77)	0.500 (2.04)	0.758 (3.75)	0.484 (1.98)
D(YIND_YB)	0.893 (1.35)	1.920 (1.78)	2.704 (4.13)	2.100 (2.40)
NIZUL_OSA	0.001 (3.36)	0.001 (2.57)		
DLOG(DEPGB_ST)			3.219 (2.44)	3.405 (2.53)
D(TAX_STAT)	-(0.36) -(1.74)	-(0.34) -(1.64)		
$VARD(PMPX)_{-2}$	-0.785 -(3.03)	-0.735 -(2.75)		
$VARD(YB)_{-4}$			-0.548 -(1.84)	-0.542 -(1.84)
DLOG(IB_EQ)			0.202 (1.76)	0.207 (1.81)
R^2 adj	0.32	0.31	0.24	0.14
obs.	94	94	137	130
D.W.	1.96	1.98	1.86	1.88

The residuals are from Table 3.4, long-term equation no.2 for investment in equipment and structures respectively.
Estimated by TSLS, the auxiliary variables are all the independent variables including lags.

(iii) *The equations for total investment in the short run, according to the capital stock adjustment model*

Table 3.8 gives the results of the short-term estimation, the residuals in the fourth lag (an error-correction factor) being taken from equations 3 and 5 of the long run in Table 3.5 in the model of adjustment of capital stock described in detail by Jorgensen (1963). The table shows that there is an integrative correlation between the various regressions, and the error-correction coefficient of the deviations in the short run from long-run equilibrium (error correction) is between 0.12 and 0.21. All the variables take the sign in the expected direction and almost all are significant. The findings are similar to those obtained for the short-term equations in the neo-classical model as regards both the explanatory power of the equations and the elasticities of the relative price, and the coefficient is subject to the negative effect of the uncertainty index derived from the variance of the change in business-sector product on the change in investment in the business sector. Note that the regression was found to be negatively and significantly affected by the change in capital stock with a lag, as well as by the change in the statutory tax rate on firms, where a one percentage-point rise in the tax rate (i.e., the difference of differences for the tax rate) leads to a decline of between 0.5 and 0.7 percent in the rate of change of the extent of investment.

Table 3.8

The Equations for Total Investment in the Short Run, According to the Capital Stock Adjustment Model

(figures in parentheses are t-values)

Table 3.8: Equations of Total Short Term Investment According to the Capital Stock Adaptation Model

(Figures in parentheses are t values)

Period	1980:3-2006:4	1983:4-2006:4	1980:3-2006:4	1983:4-2006:4	1995:4-2008:4
Equation	1	1	1	1	2
ndependent variable	OLS		[3]TSLS		
const	0.049	0.042	0.049	0.042	0.041
	(2.06)	(1.82)	(2.06)	(1.82)	(2.38)
RES_{-1}	**-0.125**	**-0.188**	**-0.125**	**-0.188**	**-0.213**
	-(1.95)	-(2.86)	-(1.95)	-(2.86)	-(2.20)
DLOG(PIB/PYB)	-1.104	-1.029	-1.104	-1.029	
	-(5.71)	-(5.64)	-(5.71)	-(5.64)	
DLOG(YB)	0.861	0.628	0.861	0.628	1.620
	(3.68)	(2.43)	(3.68)	(2.43)	(4.12)
D(YIND_YB)	3.338	2.971	3.338	2.971	
	(3.49)	(2.96)	(3.49)	(2.96)	
NIZUL_OSA		0.001		0.001	
		(3.07)		(3.07)	
$DLOG(KB)_{-10}$					-3.723
					-(3.44)
DLOG(DEPGB/KB)					3.631
					(2.86)
D(TAX_STAT)	-(0.70)	-(0.50)	-(0.70)	-(0.50)	
	-(2.32)	-(1.78)	-(2.32)	-(1.78)	
$VARD(YB)_{-4}$	-0.615	-0.529	-0.615	-0.529	
	-(2.07)	-(1.88)	-(2.07)	-(1.88)	
AR_1	-0.370	-0.402	-0.370	-0.402	-0.517
	-(3.51)	-(3.62)	-(3.51)	-(3.62)	-(3.72)
R^2 adj	0.43	0.55	0.43	0.55	0.43
obs.	106	93	106	93	50
D.W.	1.91	1.97	1.91	1.96	2.16

1)Residual from Table 3.5, long-term equation no.3

2)Residual from Table 3.5, long-term equation no.5

3)Estimated by TSLS, auxiliary variables are all the independent variables including lags

6. Results and conclusions

In this study we found a long-term correlation between the extent of investment in the business sector, business-sector product, and the cost of capital, in accordance with the neo-classical theory. The most notable variable in capital cost which is negatively correlated with business-sector investment is the relative price of investment. This price reflects technological advances from abroad, which improve the quality of capital stock in general, and of equipment in particular, as well as the real exchange rate in import terms. Real local-currency depreciation until the mid-1980s, at a time when the economy was relatively young, relied on the domestic market, and increased domestic production as a substitute for imports, in order to try and contend with the balance of payments deficit, and was reflected by a rise in the relative price of investment and a decline in the investment rate. When the economy became more open and technological advances accelerated, starting in the second half of the 1980s, this led to a trend of real local-currency appreciation and a decline in the relative price of investment, and hence to a rise in the investment rate until the mid-1990s. The decline in domestic demand in the second half of the 1990s and the initial years of the 21st century served to increase the relative price of investment once more. In our study we found that while there is substitutability between the capital stock of equipment and structures this is relatively small and there is a considerable extent of complementarity between them, so that it is appropriate in the long run to estimate equations for total investment and not only those for investment in equipment and structures separately. Moreover, the explanatory power of the estimation of the short-term equations for investment was significantly greater than that of the equations explaining the investment components separately. The estimation of the long-term correlation between investment, economic activity, and capital stock, including capital stock with a lag as expressing the adjustment process of capital in accordance with the Jorgensen (1963) model, showed a greater increase in the intensity of the long-term correlation (cointegration) than did that obtained under the neo-classical approach, where the amount of time for the adjustment of capital stock was found to be eight quarters. Variables allied with monetary and fiscal policy, such as the real short-term interest rate, and the statutory tax rate on total direct taxes, in particular, were found to have a negative effect on investment in the long run in general, and especially on investment in structures.

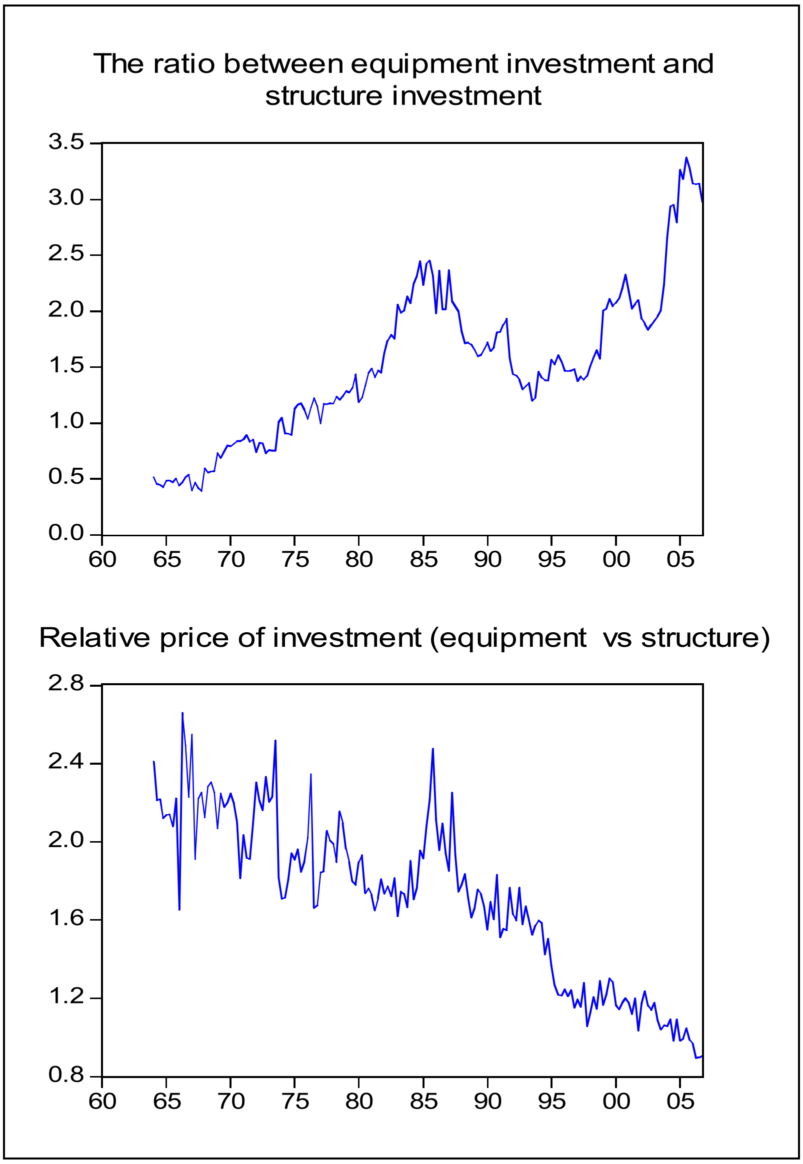
We also found significant correlations in the short term and in the expected direction between the rates of change of business-sector investment and shifts in economic activity, the utilization of equipment (The Companies Survey), and the change in several variables associated with the cost of capital (relative price, depreciation rate, statutory tax rate). Our study shows that the uncertainty embodied in a change in business-sector product and the terms of trade has a negative and significant effect on the expansion of investment. The error-correction coefficients of the deviations in the short run for the long-run equilibrium in the various models varied between 0.3 and 0.15.

These results serve to underline the need for further research on the short-term effects of various factors on the extent of investment, such as that of credit and other financial variables connected directly with firms' profitability. Research of this kind, which could also include an analysis at the microeconomic level, might be able to explain part of the notable unexplained variance in the short run in general, and when investment in equipment and structures is examined separately, in particular.

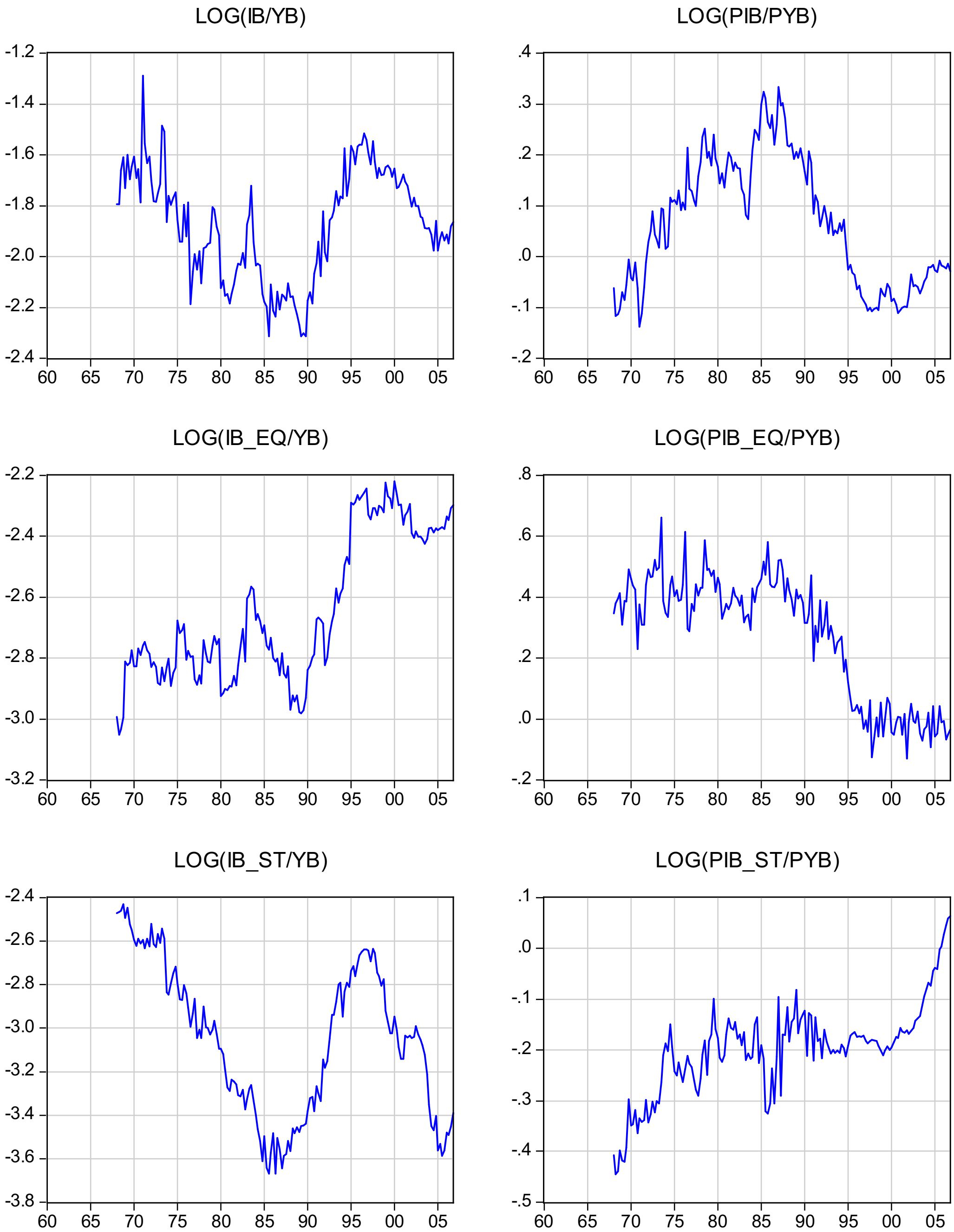
Appendix 1: Definitions and Characteristics of the Variables in the Study

Name of variable	Description	Period	Basis	
A_USA	Index of US productivity smoothed and annualized	1961-2006	Quarterly on annual basis	2005=100
AIL	Index of total Israeli business-sector	1963-2006	Quarterly on annual basis	2005=100
DEPB_ST	Depreciation – structures – business sector	1964-2006	Quarterly on annual basis, quarterly data from 19	
DEPGB	Depreciation – business sector	1964-2006	Quarterly on annual basis, quarterly data from 19	
DEPB_EQ	Depreciation of equipment	1964-2006	Quarterly on annual basis, quarterly data from 19	
DUM8085	Dummy variable for inflation period 1980-85	1961-2006	Quarterly	
GRTB	Scrap in business sector	1964-2006	Quarterly on annual basis, quarterly data from 19	
GRT_ST	Scrap in business sector – structures	1964-2006	Quarterly on annual basis, quarterly data from 19	
GRT_EQ	Scrap in business sector – equipment	1964-2006	Quarterly on annual basis, quarterly data from 19	
IB	Gross business-sector investment	1964-2008	Quarterly on annual basis, quarterly data from 19	
IBN	Gross business-sector investment – current	1964-2008	Quarterly on annual basis, quarterly data from 19	
IB_ST	Gross investment in structures – business sector	1964-2006	Quarterly on annual basis, quarterly data from 19	
IDN_O	Investment in residential construction – business sector	1964-2006	Quarterly on annual basis, quarterly data from 19	
IB_EQ	Gross investment in equipment – business sector	1964-2006	Quarterly on annual basis, quarterly data from 19	
IPN	Fixed investment in b.s. – current prices	1964-2006	Quarterly on annual basis	
ISUP_YB	Proportion of b.s. product invested in start-ups	1991-2006	Quarterly, investment was zero beforehand	
ISUP_YB_HP	Proportion of smoothed b.s. product invested in start-ups	1991-2006	Quarterly	
KB	Gross capital stock – b.s.	1964-2008	Quarterly on annual basis, quarterly data from 19	
KB_NET	Net capital stock – b.s.	1964-2006	Quarterly on annual basis, quarterly data from 19	
KB_EQ	Gross capital stock – equipment - b.s.	1964-2006	Quarterly on annual basis, quarterly data from 19	
KB_ST	Gross capital stock – structures - b.s.	1964-2006	Quarterly on annual basis, quarterly data from 19	
KB_ST_NET	Net capital stock - structures – b.s.	1964-2006	Quarterly on annual basis, quarterly data from 19	
NIZUL_O	Rate of utilization of machinery and equipment – manufacturing – b.s.	1984-2006	Quarterly	
NIZUL_OSA	Rate of utilization of machinery and equipment – manufacturing – seasonally adjusted – b.s.	1984-2006	Quarterly	
OLIM_AA	Proportion of immigrants in population – moving average over a year	1970-2006	Quarterly	
OLIM_SA	Proportion of immigrants in population	1970-2006	Quarterly	
PIB	Price of investment – b.s.	1964-2006	Quarterly	
PIB_EQ	Price of investment in equipment – b.s.	1964-2006	Quarterly	
PIB_PYB	Ratio of price of b.s. investment to GDP deflator	1964-2006	Quarterly	
PIB_PYB_US	Ratio of price of b.s. investment to GDP deflator in US	1964-2006	Quarterly	
PYB	Price of business-sector product	1964-2006	Quarterly	
RB10_GROSS	Gross rate of return on 10-year bonds	1987-2006	Quarterly	
RB10_NET_OLD	Real yield on long-term bonds	1960-2006	Quarterly	
RI	Real interest on development loans	1972-2006	Quarterly	
RS	Real overdraft and current account interest	1972-2006	Quarterly	
ER	Overdraft and current account interest – moveing average over a year	1972-2006	Quarterly	
TAX_STAT_HP	Smoothed corporate tax rate	1980-2006	Quarterly on annual basis	
TAX_STAT_O	Original corporate tax rate (on undistributed profits)	1980-2006	Quarterly on annual basis	
TAX_R	Share of tax in GDP	1960-2006	Quarterly on annual basis	
TEROR_IN	No. of incidents of terrorism	1960-2006	Quarterly	
V_MN	Variance of share-price index	1971-2006	Quarterly	
GDP_PER_C	Per capita GDP	1968-2008	Quarterly	
YB	Business-sector product	1964-2008	Quarterly	
PM_PX	Ratio of import to export prices	1968-2008	Quarterly	2005=100
YIND	Manufacturing product	1961-2008	Quarterly	

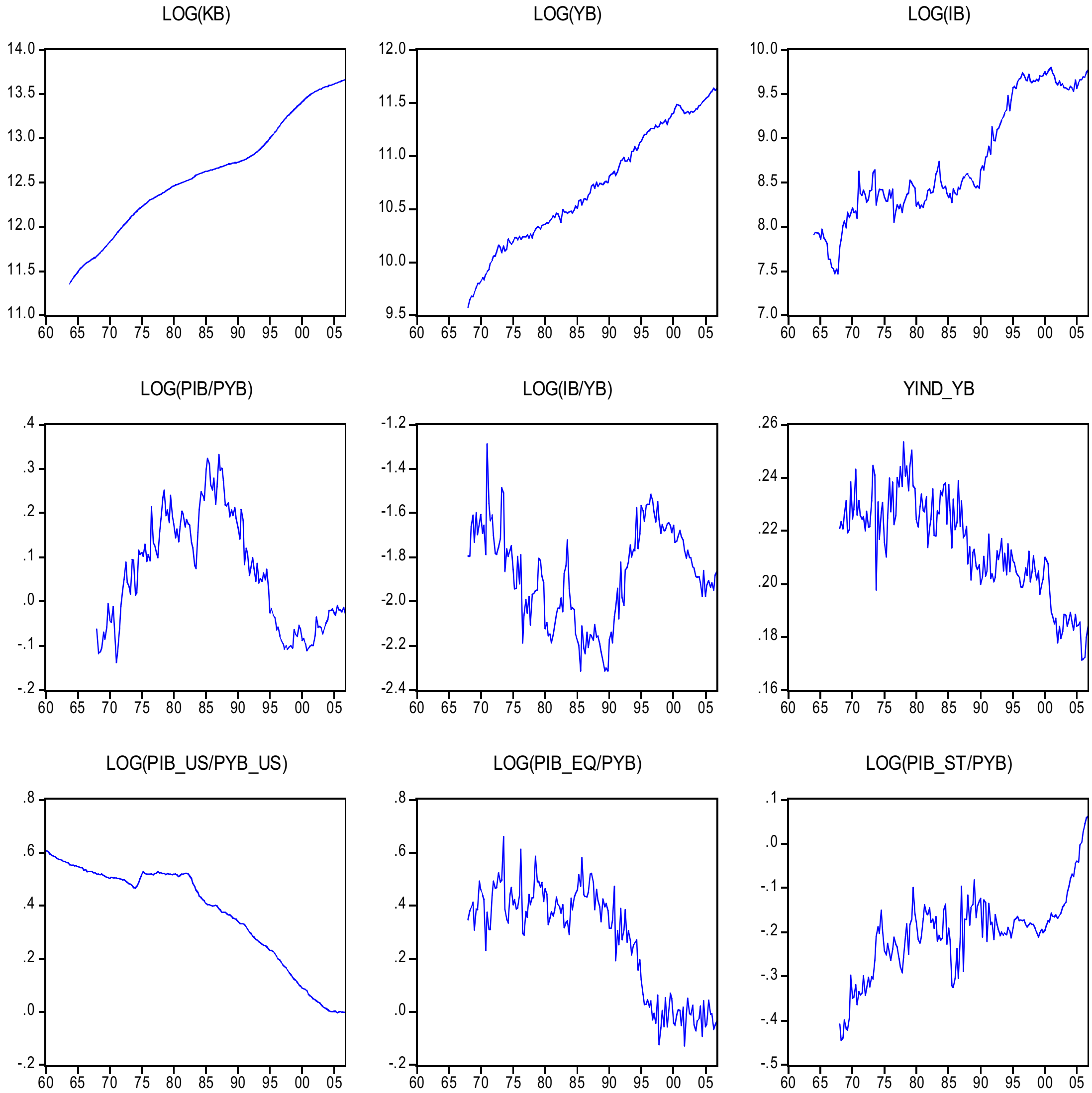
Appendix 2a: The Relative Price of Investment in Equipment and in Structures, and the Ratio Between the Prices of Investment in Them



Appendix 2b: Rate of Investment in GDP and Relative Price of Investment (Total Equipment and Structures)



Appendix 2c: Graphs of the Main Variables in the Study



Appendix 3: Log Regressions of Investment, Annual Frequency Including Adjustment of Capital Stock, and Total Productivity

Sample Period: 1963-2006, (Figures in parentheses are SD of coefficients)

Equation	*Independent variables*									*Statistics*		*Examination of residuals*
	C	*LOG(AIL)*	*RS*	*ER*	*RI*	*PIB/PYB*	*LOG(BLAI)*	*LOG(KB-1)*	*YIND_YB*	R^2 *adj*	*D.W.*	*A.D.F* [1]
1.	11.696	1.560	-0.002			-1.014	2.068	-1.795	2.328	0.965	1.33	-4.866
	(2.97)	(0.29)	(0.00)			(0.27)	(0.54)	(0.59)	(1.29)			
2.	11.766	1.545	-0.002		0.000	-0.992	2.094	-1.819	2.403	0.964	1.34	-4.830
	(3.06)	(0.31)	(0.00)		(0.00)	(0.32)	(0.58)	(0.62)	(1.42)			
3.	10.705	1.633				-1.199	1.859	-1.578	2.540	0.964	1.30	*-5.211
	(2.97)	(0.29)				(0.25)	(0.53)	(0.58)	(1.31)			
4.	11.107	1.640		-0.002		-1.063	1.938	-1.668	2.224	0.964	1.34	*-5.418
	(2.96)	(0.29)		(0.00)		(0.27)	(0.53)	(0.58)	(1.32)			
5.	11.128	1.635		-0.002	0.000	-1.050	1.948	-1.678	2.257	0.963	1.35	**-5.417107
	(3.02)	(0.30)		(0.00)	(0.00)	(0.34)	(0.56)	(0.61)	(1.43)			

Significance level of A.D.F. is consistent with the number of variables and the number of observations:
* Significant at the 5 percent level
** Significant at the 10 percent level

Sample Period: 1963-2006, (Figures in parentheses are SD of coefficients)

Equation	*Independent variables*									*Statistics*		*Examination of residuals*
	C	*LOG(AIL)*	*RS*	*ER*	*RI*	*PIB/PYB*	*LOG(BLAI)*	*LOG(KB-3)*	*YIND_YB*	R^2 *adj*	*D.W.*	*A.D.F* [1]
1.	6.299	1.797	-0.002			-1.130	1.143	-0.785	2.044	0.962	1.17	**-5.016
	(1.60)	(0.29)	(0.00)			(0.28)	(0.29)	(0.32)	(1.35)			
2.	6.321	1.783	-0.002		0.001	-1.101	1.165	-0.804	2.126	0.961	1.18	-4.971
	(1.63)	(0.30)	(0.00)		(0.00)	(0.34)	(0.33)	(0.35)	(1.47)			
3.	6.122	1.833				-1.254	1.084	-0.731	2.228	0.962	1.19	*-5.324
	(1.61)	(0.29)				(0.26)	(0.29)	(0.32)	(1.35)			
4.	6.176	1.848		-0.002		-1.150	1.100	-0.752	1.953	0.962	1.20	*-5.430
	(1.60)	(0.29)		(0.00)		(0.28)	(0.29)	(0.32)	(1.37)			
5.	6.192	1.837		-0.002	0.001	-1.099	1.129	-0.778	2.055	0.961	1.21	**-5.423
	(1.63)	(0.30)		(0.00)	(0.005)	(0.37)	(0.33)	(0.35)	(1.47)			

Significance level of A.D.F. is consistent with the number of variables and the number of observations:
* Significant at the 5 percent level
** Significant at the 10 percent level
1. Examination of residuals with intercept
2. Capital stock variable with 3-year lag

Appendix 4: Log Regressions of Investment, Annual Frequency Including Adjustment of Capital Stock, and Business-Sector Product

Sample Period: 1963-2006, (Figures in parentheses are SD of coefficients)

Equation	Independent variables									Statistics		Examination of residuals
	C	*LOG(YB)*	*RS*	*ER*	*RI*	*PIB/PYB*	*LOG(BLAI)*	*LOG(KB-1)*	*YIND_YB*	R^2 *adj*	*D.W.*	*A.D.F* [1]
1.	6.525	1.487	-0.002			-0.680	1.348	-2.025	1.566	0.980	1.57	*-5.183
	(2.44)	(0.17)	(0.00)			(0.19)	(0.43)	(0.44)	(0.98)			
2.	6.357	1.505	-0.001		-0.001	-0.712	1.298	-1.989	1.427	0.979	1.56	**-5.147
	(2.53)	(0.18)	(0.00)		(0.00)	(0.22)	(0.47)	(0.46)	(1.09)			
3.	5.520	1.536				-0.825	1.149	-1.849	1.724	0.978	1.52	*-5.238
	(2.45)	(0.17)				(0.18)	(0.43)	(0.44)	(1.01)			
4.	5.907	1.536		-0.002		-0.698	1.226	-1.935	1.434	0.979	1.61	*-5.530
	(2.42)	(0.17)		(0.00)		(0.19)	(0.43)	(0.43)	(1.01)			
5.	5.769	1.552		-0.001	-0.001	-0.752	1.174	-1.895	1.284	0.979	1.58	*-5.503
	(2.48)	(0.18)		(0.00)	(0.00)	(0.24)	(0.45)	(0.45)	(1.10)			

Significance level of A.D.F. is consistent with the number of variables and the number of observations:
* Significant at the 5 percent level
** Significant at the 10 percent level

Sample Period: 1963-2006, (Figures in parentheses are SD of coefficients)

Equation	Independent variables									Statistics		Examination of residuals
	C	*LOG(YB)*	*RS*	*ER*	*RI*	*PIB/PYB*	*LOG(BLAI)*	*LOG(KB-3)*	*YIND_YB*	R^2 *adj*	*D.W.*	*A.D.F* [1]
1.	0.247	1.696	-0.001			-0.665	0.327	-1.045	1.034	0.979	1.32	-4.870
	(1.38)	(0.17)	(0.00)			(0.20)	(0.25)	(0.24)	(1.02)			
2.	0.234	1.698	-0.001		0.000	-0.671	0.321	-1.041	1.014	0.978	1.32	-4.882
	(1.42)	(0.18)	(0.00)		(0.00)	(0.24)	(0.28)	(0.26)	(1.12)			
3.	0.004	1.723				-0.762	0.266	-1.004	1.173	0.978	1.35	*-5.323
	(1.38)	(0.17)				(0.19)	(0.25)	(0.24)	(1.03)			
4.	0.036	1.727		-0.002		-0.668	0.279	-1.023	0.930	0.978	1.37	*-5.376
	(1.37)	(0.17)		(0.00)		(0.20)	(0.25)	(0.24)	(1.04)			
5.	0.042	1.726		-0.002	0.000	-0.661	0.284	-1.026	0.945	0.978	1.38	**-5.378
	(1.40)	(0.18)		(0.00)	(0.00)	(0.27)	(0.28)	(0.26)	(1.12)			

Significance level of A.D.F. is consistent with the number of variables and the number of observations:
* Significant at the 5 percent level,
** Significant at the 10 percent level

Appendix 5: The Different Methods of Calculating Dependent Variances as an Index of Uncertainty Affecting Investment in the Short Term

In the investment regressions of the short run we used the uncertainty of the dependent variance obtained from estimating an ARCH model for the rates of change of several variables (business-sector product, total productivity in the business sector, the real short-term interest rate, the general share-price index, the relative price of investment, and the terms of trade derived from the ratio of import to export prices). The dependent variance h_t was calculated as follows:

The rate of change of variable X was run in an autoregressive process relative to its lags (in this case, quarterly data and hence a relative small number of lags – up to two).

$$(1)\ \mathrm{dX_t} = \beta_0 + \beta_1 dX_{t-1} + \beta_2 dX_{t-2} + \varepsilon_t \qquad \varepsilon_{\mathrm{t}} \sim N(0, h_t)$$

where the variance of the random disturbance of the equation is the dependent variance, h_t which we want to calculate in relation to the variance of the random disturbance, which is the random disturbance squared of equation $(1)\,\varepsilon_t^2$, the assumption here being that the variance also maintains an autoregressive process (of up to two lags), so that the dependent variance is obtained by the following calculation:

$$(2)\ \mathrm{h_t} = \gamma_0 + \gamma_1 \varepsilon_{t-1}^2 + \gamma_2 \varepsilon_{t-2}^2$$

Appendix 6: Regressions For the Rate of Investment According to the Neo-Classical Model, Quarterly Frequency

Cointegrative Correlation Between Rate of Business-Sector Investment and Components of Capital Use Costs
(Sample period: 1968:I to 2006:IV; figures in parentheses are SD of coefficients)

Cointegrative correlation estimated = $LOG\left(\frac{IB}{YB}\right)_t - \gamma_0 - \sum_{i=1}^{m} \gamma_i ' X_{it} + \varepsilon_t = 0$

No. of equation	Variables: LOG(IB/YB)	C	LOG(PIB/PYB)	LOG(DEPGB/KB)	LOG(GRTB/KB)	ER	Statistics: R^2 Adj	D.W.	Examination of residual: A.D.F	D.W.[1]
1.	1.000	1.785 (0.01)	1.378 (0.08)				0.650	0.55	-3.344**	2.00
2.	1.000	4.169 (0.42)	1.562 (0.08)	0.528 (0.09)			0.709	0.66	-4.226*	1.99
3.	1.000	2.846 (0.17)	1.364 (0.07)		0.220 (0.04)		0.719	0.69	-4.253*	1.99
4. [2]	1.000	1.732 (0.03)	1.329 (0.09)			0.0015 (0.00)	0.640	0.49	-3.148***	2.01

1)Belongs to equation estimating the A.D.F.
2) Sample period in equation is 1972:III to 2006:IV.
Significance level of A.D.F. is consistent with the number of variables and the number of observations:
* Significant at the 5 percent level
** Significant at the 10 percent level
*** Not significant even at the 10 percent level

Cointegrative Correlation Between Rate of Business-Sector Investment and Components of Capital Use Costs
(Sample period: 1995:I to 2008:IV; figures in parentheses are SD of coefficients)

Cointegrative correlation estimated = $LOG(IB/YB)_t - \gamma_0 - \sum_{i=1}^{m} \gamma_i ' X_{it} + \varepsilon_t = 0$

No. of equation	Variables: LOG(IB/YB)	C	LOG(PIB/PYB)	LOG(DEPGB/KB)	YIND_YB	Statistics: R^2 Adj	D.W.	Examination of residual: A.D.F	D.W.[1]
1.	1.000	18.59 (2.24)	1.709 (0.23)	1.914 (0.26)		0.66947	1.25	-4.85*	2.21
2.	1.000	15.03 (2.39)	1.256 (0.26)	1.414 (0.29)	-4.322 (1.42)	0.71467	1.21	-4.74*	2.17

1)Belongs to equation estimating the A.D.F.
2) The sample period in the equation is 1972:III to 2006:IV
Significance level of A.D.F. is consistent with the number of variables and the number of observations:
* Significant at the 1 percent level
** Significant at the 5 percent level
*** Significant at the 10 percent level

Appendix 7: Extent of Substitutability Between the Components of Equipment and Structures in Capital Stock in the Long Run

Appendix Table 3.3
Long-Term Substitutability Between the Components of Equipment and Structures in Capital Stock as Represented in the Prices of these Components
(figures in parentheses are SDs of the coefficients)

Table 3.3a
Substitution in the Long Run Between Components of Capital Stock, Equipment and Structures, as Reflected in Their Prices
(figures in parentheses are SDs of coefficients)

Cointegrative correlation estimated = $KB\_EQ/KB\_ST_t - \gamma_0 - \gamma_1 PIB\_EQ/PIB\_ST_t + \varepsilon_t =$

	Sample period	*KB_EQ/KB_ST*	*C*	*PIB_EQ/PYB_ST*	*R^2 Adj*	*A.D.F*
1.	1968: 1 - 2006: 4	1.000	-1.317 (0.03)	**0.400** **(0.02)**	0.807	-5.096*
2.	1970: 1 - 2006: 4	1.000	-1.309 (0.03)	**0.394** **(0.02)**	0.788	-4.80*
3.	1975: 13-2006:4	1.000	-1.318 (0.05)	**0.380** **(0.02)**	0.778	-3.36**
4.	1990: 1- 2006:4	1.000	-1.310 (0.03)	**0.379** **(0.02)**	0.731	-3.954**

Significance level of A.D.F. is consistent with the number of variables and the number of observations:
* Significant at the 5 percent level
** Significant at the 10 percent level

Appendix 8: Results of the ADF Tests for the Main Series in the Study

	Level P-VALUE percent	Differences P-VALUE percent	Conclusion
IB	98.4	0.0	I(1)
EQ_IB	99.7	0.0	I(1)
ST_IB	85.2	0.0	I(1)
YB	99.0	0.0	I(1)
KB	92.2	78.8	Brake in the series
KB_EQ	97.4	57.4	Brake in the series
ST_KB	92.7	80.9	Brake in the series
AIL	64.5	0.0	I(1)
AIND	18.3	0.0	I(1)
US_A	68.2	0.0	I(1)
US_AIND	99.0	3.0	I(1)
PYB_PIB	36.4	0.0	I(1)
EQ_PIB_PYB	71.9	0.0	I(1)
ST_PIB_PYB	67.2	0.0	I(1)
US_PIB_PYB	98.8	0.0	I(1)
YIND_YB	75.7	0.0	I(1)
DEPB	96.6	53.6	Brake in the series

Appendix 9: LM Test for the Existence of a Cointegrative Relation Including a Break: The Case of the Long-Term Equation for Investment According to the Neo-Classical Model Including Dummy Variables for the Existence of a Break in the Investment Series

The test for examining the null hypothesis of the existence of integration given a break in the investment series (which occurred with the arrival in Israel of the massive influx of immigrants from the former USSR in the 1990s) is based on the following equation:

$$(1)\ \log(\mathrm{IB_t}) = \beta_0 + \theta DUM91END_t + X_t'\ \beta_1 + X_t'\ \beta_2 DUM91END_t + \varepsilon_t$$

where, as will be recalled,

$$DUM91END_t = \begin{cases} 1 & t \geq 1991:1 \\ 0 & otherwise \end{cases}$$

X represents the vector of the explanatory variables (right-hand side) of the long-term equation examined. The SC statistic needed for the test is in fact the following Lagrange multiplier (LM):

$$SC(\lambda) = T^{-2}\hat{\omega}_1^2 \sum_{\mathrm{t=1}}^{\mathrm{T}} \mathrm{S_t^2}\ ,\lambda = \mathrm{T_B/T}$$

where $T_{B.}$ represents the number of observations which take the value 0 as a dummy variable up to the time of the break in the investment series in 1991:I. The estimator which follows the variance of the random disturbance ε_t is represented by $\hat{\omega}_1^2$, and the sum of the residuals squared obtained from estimating the open squares of equation (1) above is S_t^2.

Carrion-i-Silvestre and Sanso (2006) present the critical values for several values of the λ ratio as well as for the number of explanatory variables in the original equation (which does not include the dummy variables).

The results of the test in the various investment equations of both the neo-classical and the capital-adjustment adjustment models indicate that at every significance level the SC statistic is lower than the critical values of the distribution, meaning that the null hypothesis of the existence of a cointegrative relation in the long run in the investment equations cannot be rejected, even taking into account the possible existence of a break in this relation.

Table 3.1b

Cointegrative Relation (Including Structural Break) Between Level of Business-Sector Investment and Cost Components of Capital Use

(sample period: 1968:I to 2008:IV)

Cointegrative correlation estimated = $$LOG(IB)_t - \gamma_0 - \sum_{i=1}^{m} \gamma_i ' X_{it} + \varepsilon_t = 0$$

	Variables									Statistics		LM Test	
No. of equation	*LOG(IB)*	*C*	*LOG(YB)*	*LOG(PIB/PYB)*	*LOG(DEPGB)*	*LOG(GRTB/KB)*	*LOG(REER)*	*LOG(FDI_R_MA)*	*ER*	$R^2 Adj$	*D.W.*	*S.C*	
1.	1.000	-1.252	-0.701	0.913						0.969	0.83	0.00608*	1.99
2.	1.000	-0.680	-0.968	0.730	0.284					0.972	0.95	0.00604*	2.00
3.	1.000	2.423	-0.930	1.071		0.270				0.973	0.98	0.00604*	1.99
4. [2]	1.000	-2.548	-0.577	0.762					0.090	0.975	0.95	0.00674*	1.98
5.	1.000	-4.616	-0.681		0.404		1.196			0.972	0.92	0.00857*	
6.	1.000	-2.233	-0.902	0.879	0.426			-0.055		0.9803	0.99	0.00901*	

1. The equation includes the dummy variables DUM91END and its interaction variables with all the independent variables.
2. The sample period in the equation is 1972:III to 2006:IV.

The level of significance of SC is consistent with the number of variables and the ratio of the number of observations before the break to the total size of the sample.

- Significant at the five percent level.

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