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**Measuring the Output Gap and
Its Influence on the Import Surplus**

Yigal Menashe and Yosef Mealem

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ABSTRACT

In this paper, we measure the output gap which is calculated both annually and quarterly for the period 1986-1999, and its influence on the import surplus. Analysis of the output gap's cyclical components - the deviation in private sector labor input and the deviation in productivity and capital utilization – shows that the output gap during the years 1997-1999 reflected both the increase in unemployment and low rates of productivity or capital utilization. The annual data indicate that potential output and actual private sector output grew at an average rate of 6-7 percent during the first half of the 90s. In following years, potential output grew at a more moderate rate of 4-5 percent. The results show a positive relationship between the output gap and the import surplus, which can be explained if we view the output gap as a proxy for surplus demand. Thus, a negative output gap reflects a negative demand surplus which can arise in the short run through a decrease in local demand, as occurred in the slowdown of 1997-1999. This decrease will result in a drop in the relative prices of local products which will, to a certain extent, lead to increased local production and a decrease in the import surplus. This positive relationship is maintained even when taking into account the positive influence of immigration on imports in the regression equation.

Measuring the Output Gap and its Influence on The Import Surplus¹

1. Introduction

Central banks usually estimate the output gap as an indicator of inflationary pressures. There are a number of ways to estimate potential output which either use technical methods or the relationships between economic variables. The approach used in this paper is an indirect one in which the output gap is estimated given actual output and potential output is then obtained as a remainder.² It is assumed that the production function is Cobb-Douglas such that output is dependent on general productivity and the two factors of production: labor and capital. Further, it is assumed that markets are competitive and that the production function therefore exhibits constant returns to scale.

In this paper, the output gap is calculated both annually and quarterly for the period 1986-1999. The annual calculations include both the output gap for each given year and the rate of change in potential output. The quarterly deviations correspond on average to the annual deviations although they exhibit higher variance. This is due to the fact that the quarterly deviations give greater weight to temporary shocks in output. In addition, the relationship between the quarterly import surplus (relative to output) and the quarterly output gap was analyzed. The results show a positive relationship which can be explained if we view the output gap as a proxy for surplus demand. Thus, a negative output gap (potential output greater than actual) reflects a negative demand surplus which can arise in the short run through a decrease in local demand, as occurred in the slowdown of

¹ Our thanks to Yaniv Vadai for his assistance.

² The calculations appearing below are based on a memo from Oshrit Bar Gil and Zvi Hercowitz (1997).

1997-1999. This decrease will result in a drop in the relative prices of local products (i.e. a real depreciation) which will, to a certain extent, lead to increased local production and a decrease in the import surplus.³ This positive relationship is maintained even when taking into account the positive influence of immigration on imports in the regression equation.

2. Alternative Approaches to Calculating Potential Output

i. HP (Hodrick-Prescott) Filter

This is a statistical approach in which potential output is derived from data on actual output. Potential output is a series of values, Y^P , which minimizes the following equation:

$$\frac{1}{T} \sum_{t=1}^T (\ln Y_t - \ln Y_t^P)^2 + \frac{\lambda}{T} \sum_{t=2}^{T-1} [(\ln Y_{t+1}^P - \ln Y_t^P) - (\ln Y_t^P - \ln Y_{t-1}^P)]^2$$

where Y is actual output, T is the number of observations and determines the degree of smoothing in the potential output trend.

This approach is applicable to a stable economy with a smoothly growing potential output. However, the Israeli economy has experienced significant structural changes during the past decade, especially as a result of the large wave of immigration, and therefore this approach is not applicable. The HP filter would show that the positive deviation is a result of the wave of immigration. In contrast, the production function approach discussed below would show that immigration increased output but at the same time increased potential output to an even greater degree, thus resulting in a negative deviation.

³ The results concerning the real exchange rate are contained in research done by Y. Djivre and S. Rivon (1999). The research analyzed a model for the years 1989-1998 in which the real exchange rate and other economic variables, including the quarterly output gap, are determined simultaneously. The research concluded that the positive relationship between an increase in the output gap and a real depreciation is due to demand shocks rather than supply shocks.

ii. **Structural Vector Autoregression**

This is a statistical approach which estimates a vector of variables, including the change in inflation and output, as a function of those same variables lagged with restrictions on the long term. This method was used in a model estimated by Quah and Blanchard (1989). The residuals from this system represent supply and demand shocks. This approach allows the changes in output to be analyzed as a function of supply and demand such that changes in demand, as opposed to supply, influence output only in the short run. To the extent that long run changes represent changes in potential output, the calculation of output deviations should only take demand deviations into account.

3. **Measuring Potential Output**

The method of measuring potential output used in this paper is indirect and utilizes the production function. The calculations that follow are carried out both on annual and quarterly seasonally adjusted data.

As stated earlier, the output gap is calculated directly in percentages and used to measure potential output. Therefore, possible errors in the measurement of the absolute size of the relevant labor force (inclusion of foreign laborers, etc.) have less influence on the results.

The production function is Cobb-Douglas which is characterized by constant returns to scale. According to this function, private sector production at time t , Y_t , is dependent on general productivity A_t and the factors of production - capital K_t and labor L_t .

$$Y_t = A_t (Z_t K_t)^\alpha L_t^{1-\alpha} \quad \text{where } Z_t \text{ represents capital utilization.}$$

Furthermore it is assumed that markets are competitive and therefore the elasticity of capital α and the elasticity of labor $1 - \alpha$ can be measured by the portions of capital and labor in output. We assume $\alpha = 0.32$ which is a widely used estimate of capital's portion in output and express the production function in logarithmic form:

$$\begin{aligned}\log Y_t &= \log A_t + 0.32 \log Z_t + 0.32 \log K_t + 0.68 \log L_t \\ y_t &= a_t + 0.32z_t + 0.32k_t + 0.68l_t\end{aligned}\quad (1)$$

Potential output is defined as follows:

$$\begin{aligned}\log Y_t^P &= \log A_t^P + 0.32 \log Z_t^P + 0.32 \log K_t^P + 0.68 \log L_t^P \\ y_t^P &= a_t^P + 0.32z_t^P + 0.32k_t^P + 0.68l_t^P\end{aligned}\quad (2)$$

The output gap (in logarithmic form) is given by the following equation:

$$y_t^C = y_t - y_t^P = a_t - a_t^P + 0.32(z_t - z_t^P) + 0.32(k_t - k_t^P) + 0.68(l_t - l_t^P)\quad (3)$$

It is assumed that firms can potentially utilize all of their capital stock (thus: $k_t = k_t^P$) and therefore that portion of the output gap originating from capital is due to underutilization.

Thus, this factor will be included in the cyclical component of productivity. Equation (3)

can therefore be rewritten in the following manner: $y_t^C = a_t^C + 0.32z_t^C + 0.68l_t^C$ (4)

We write $a_t^C + 0.32z_t^C$ as s_t^C (the Solow Residual): $y_t^C = s_t^C + 0.68l_t^C$ (5)

In order to calculate quarterly figures for the capital stock it was assumed that the annual increase was spread evenly over the year. Figures for domestic private sector output and gross capital stock are expressed in constant prices and are seasonally adjusted (millions of NIS, 1995 prices).

The cyclical component, s_t^C , is made up of:

- Underutilization of capital⁴ as explained above.
- The deviation in general productivity.

Actual labor input in the private sector is given by the following equation:

$$l_t = \text{Log}[(\text{pop} \cdot \text{part}_t)(1 - u_t)h_t] \quad (6)$$

where:

l_t – Labor input in the private sector (in hours).

pop - Working age population available to the private sector. This is basically the population of working age (both Israelis and foreign workers) minus workers in the public sector.

part_t – Participation rate of the working age population available to the private sector.

u_t – Unemployment rate.

h_t – The actual work week in hours per worker in the private sector.

Potential labor input is calculated in a similar manner using the long term trend in the length of the work week, participation rates in the civilian workforce and the natural rate of unemployment. Thus, potential labor input in the private sector is given by the following equation:

$$l_t^P = \text{Log}[(\text{pop} \cdot \text{partn}_t)(1 - \text{un}_t)hn_t] \quad (7)$$

where:

un_t – The natural rate of unemployment – 0.06.

hn_t – Long term trend in the private sector work week.

⁴ An analysis of the correlation between the net balance of the utilization rate of industrial equipment (according to quarterly data from a Bank of Israel survey) and the deviation in productivity, shows a significant positive relationship but only during recent years (see Chart 9).

$partn_t$ – Long term trend in the working age population available to the private sector.

From Equations 6 and 7, we can calculate the cyclical component of labor input which represents the deviation from its potential trend:

$$l_t^c = \text{Log}[(pop \cdot part_t)(1 - u_t)h_t] - \text{Log}[(pop \cdot partn_t)(1 - un_t)hn_t]$$

and following simplification:

$$l_t^c = \text{Log}\left(\frac{1 - u_t}{1 - un_t}\right) + \text{Log}\left(\frac{h_t}{hn_t}\right) + \text{Log}\left(\frac{part_t}{partn_t}\right) \quad (8)$$

As can be seen from the equation, the population available to the private sector does not appear in the calculation of the labor input deviation. It would have been optimal for the variables in equation 8 to be averages of all workers including foreign ones; however, due to the lack of data on foreign workers (unemployment and participation rates) only data on the labor input of Israeli workers in the private sector was used. At the same time, taking into account foreign workers in the private sector would have had only a small effect on the output gap.⁵

In order to calculate the deviation of actual from potential output, we substitute equation 8 into equation 5 as follows:

$$y_t^c = s_t^c + 0.68 \cdot l_t^c = s_t^c + 0.68 \cdot \left[\text{Log}\left(\frac{1 - u_t}{1 - un_t}\right) + \text{Log}\left(\frac{h_t}{hn_t}\right) + \text{Log}\left(\frac{part_t}{partn_t}\right) \right] \quad (9)$$

and by subtracting equation 9 from equation 1, we obtain the estimate of potential output:

$$y_t^p = y_t - y_t^c \quad (10)$$

⁵ See Table 3 below.

Table 1
Estimates of Potential Output and the Output Gap

The output gap and its components: the deviations in productivity, capital utilization and labor input

	<u>Deviation of labor input</u>	<u>Deviation in productivity and capital utilization</u>	<u>Total output gap</u>
1987	-0.7	1.4	0.7
1988	-0.6	1.6	1.0
1989	-1.0	-1.2	-2.2
1990	-3.4	2.1	-1.3
1991	-5.2	4.0	-1.2
1992	-4.3	3.5	-0.8
1993	-2.9	0.9	-2.0
1994	-0.2	-0.5	-0.7
1995	0.8	1.3	2.1
1996	-0.4	0.3	-0.1
1997	-0.5	-1.1	-1.6
1998	-2.8	-1.0	-3.8
1999*	-2.7	-3.1	-5.8

Rates of Change in Private Sector Output and Potential Output

	<u>Potential Output</u> (according to production function)	<u>Actual Private Sector Output</u>
1987	6.2	8.1
1988	3.2	3.6
1989	4.3	1.0
1990	6.4	7.4
1991	7.3	7.3
1992	7.4	7.9
1993	4.9	3.7
1994	6.3	7.6
1995	7.1	9.8
1996	7.3	5.1
1997	4.2	2.8
1998	4.4	2.2
1999*	3.7	1.6

* The data for 1999 are not final and are based on the forecast of the Central Bureau of Statistics which used 9 months of data.

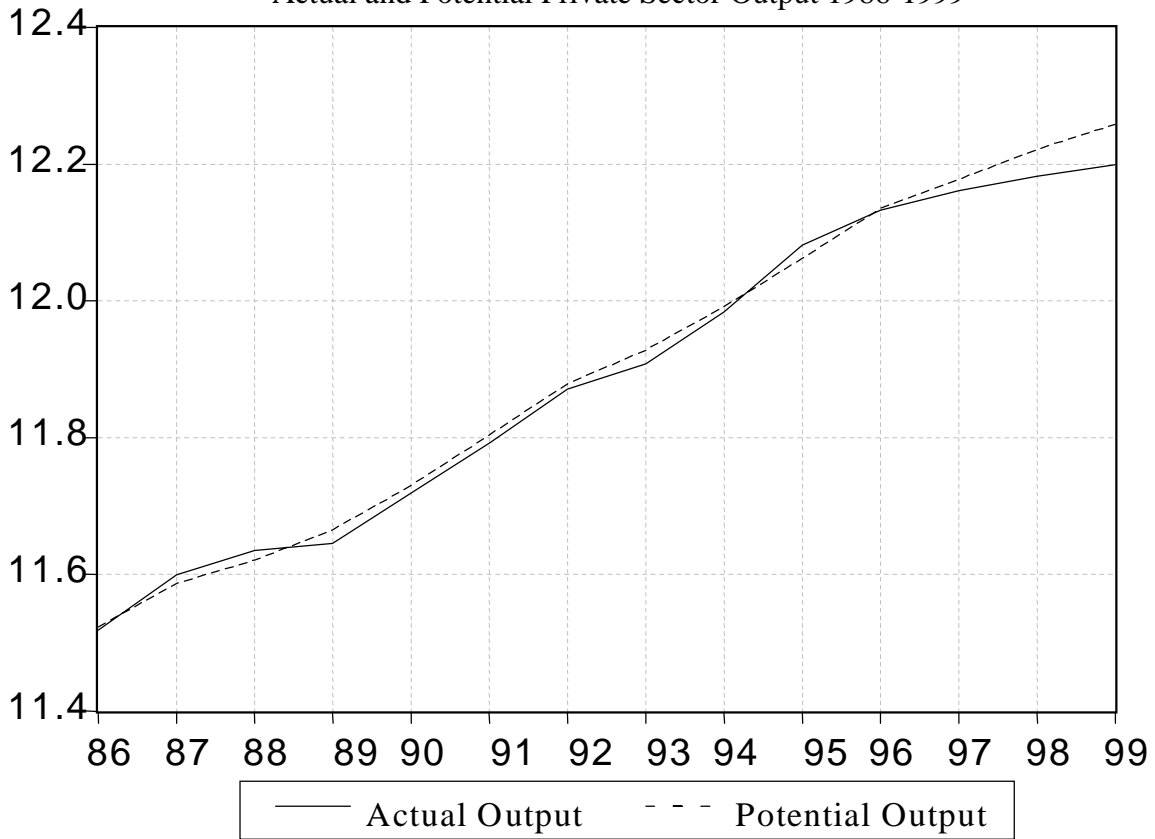
4. Application of the Equations

In the first stage, we calculate the output gap using equation 9 with annual data for 1986-1999. Charts 1 and 2 show that actual private sector output has been below potential output (a negative output gap) since 1989, with the exception of 1995. The output gap has continued to grow during the last three years and reached a peak of 6 percent in 1999. This is a much larger output gap than existed in 1989 (2 percent).

Chart 1
Output Gap 1986-1999
(percentages of output)



Chart 2
Actual and Potential Private Sector Output 1986-1999



Analysis of the output gap's cyclical components - the deviation of private sector labor input and the deviation in productivity and capital utilization - shows that the output gap during the years 1997-1999 reflected both an increase in unemployment and low rates of productivity or capital utilization during those years.⁶

We also examined the possibility that the natural rate of unemployment had increased in recent years which would affect the calculation of the output gap. To do this, it was assumed that the natural rate of unemployment had been fixed at 6 percent during the period 1986-1995 and that during the years 1996-1999, it had increased by

⁶ In the estimation of potential output, the effect of capital utilization cannot be separated from temporary changes in overall productivity.

0.15 percent per year to a rate of 6.6 percent in 1999.⁷ The analysis of the results in Table 2 shows that there is still an increasing trend in the output gap during the last three years. This is similar to what would be predicted if it was assumed that the natural rate of unemployment was fixed, although in this case the deviation would only have reached 5.4 percent in 1999.

Table 2

The Output Gap

(in percentages of output)

Year	Output gap (fixed rate of natural unemployment)	Deviation from Potential Output (increasing rate of natural unemployment)
1987	0.7	1.2
1988	1.0	1.4
1989	-2.2	-2.0
1990	-1.3	-1.1
1991	-1.2	-1.1
1992	-0.8	-0.7
1993	-2.0	-2.0
1994	-0.7	-0.7
1995	2.1	2.1
1996	-0.1	0.0
1997	-1.6	-1.4
1998	-3.8	-3.5
1999	-5.8	-5.4

⁷This result was obtained by calculating the average rate of unemployment during the years 1973-1999. Eran Yashiv (2000) made a similar calculation for the years 1980-1995.

5. Sensitivity Analysis

We also analyzed the extent of the influence of foreign workers (including those from the territories) on the output gap. Foreign workers have unique characteristics: a high participation rate and low unemployment rate. In the present context, which focuses on the deviations of actual from potential output, it would appear that the variation in unemployment and participation rates among foreign workers is smaller than among Israeli workers. Therefore, we examined their influence on the deviation of actual from potential labor input (herein the labor input deviation) and on the deviation of actual from potential output (herein the output deviation) as calculated in equation 8:

$$i_t^c = \text{Log}\left(\frac{1-u_t}{1-un_t}\right) + \text{Log}\left(\frac{h_t}{hn_t}\right) + \text{Log}\left(\frac{\text{part}_t}{\text{partn}_t}\right) \quad (8)$$

Since there are no data on participation rates and unemployment among foreign workers, we made the following simplified assumptions:

- Participation rate of 100%.
- No unemployment among foreign workers.

It can be seen from equation 8 that less extreme assumptions (less than full participation and some unemployment) would only marginally affect the labor input deviation.

Table 3 presents the labor input deviation (multiplied by its share in output – 0.68) not including foreign workers; the labor input deviation including foreign workers (under

the above two assumptions); and the proportion of foreign workers in the total number of workers employed in the private sector.

The table shows that if we take into account foreign workers, the cumulative influence of the participation and unemployment rates results in a reduction, although only marginal, of the labor input deviation in absolute terms relative to the case in which foreign workers are not included. With regard to productivity, the inclusion of foreign workers increases the deviation in productivity and capital utilization in absolute terms which leads to an increase in the output deviation. Thus, the inclusion of foreign workers has the following influences:

- The participation and unemployment rates only marginally affect the labor input deviation (and therefore the output deviation) in absolute terms.
- There is an increase in the deviation of productivity and capital utilization in absolute terms which leads to an increase in the output deviation in absolute terms.

We conclude that by not including foreign workers, our approach becomes more conservative. In other words, the absolute output deviation is reduced by not including foreign workers.

While the deviation in output applies to the private sector only, the rate of unemployment applies to the economy as a whole. Since the public sector endeavors to influence the labor market in an anti-cyclical manner, it can be assumed that the variance of general unemployment is less than that of private sector unemployment. Therefore, the use of general unemployment leads to a decrease in the absolute output deviation.

Alternatively, the replacement of the overall rate of unemployment with the private sector rate would lead to an increase in the output deviation. Thus, the approach is more conservative when the overall rate of unemployment is used.

Table 1 presents, in addition to absolute deviations, annual rates of change in actual private sector output and potential output during the years 1987-1999. The data show that both potential and actual output grew at average rates of 6-7 percent. In following years, potential output grew at more moderate rates of 4-5 percent on average. A similar analysis done on seasonally adjusted quarterly data during the period Q1 1986 to Q2 1999, shows a similar picture on average, both with regard to the output gap and its rate of change. However, an examination of the output gap in quarterly terms (Charts 3 and 4) shows a higher variance than the output gap in annual terms. This difference is a result of the sensitivity of the output gap to temporary shocks which influence quarterly private sector output. Examples include the sharp drop in private sector output in the first quarter of 1991 as a result of the Gulf War and the decrease during the first half of 1993 caused by the reduction in the number of workers from the territories who were permitted to work in Israel which lead to a significant decline in productivity.⁸

⁸ See the analysis of the quarterly output gap's cyclical components in Charts 6-8 below.

Table 3

Sensitivity Analysis of Labor Input Deviation to Inclusion of Foreign Workers

Year	Labor Input Deviation (excluding foreign workers) *	Labor Input Deviation (including foreign workers) *	Proportion of Foreign Workers in Private Sector Labor Force (in percent)
1987	-0.7	-0.7	8.6
1988	-0.6	-0.5	8.4
1989	-1.0	-0.8	7.8
1990	-3.4	-3.4	7.9
1991	-5.2	-5.2	7.1
1992	-4.3	-4.2	8.4
1993	-2.9	-2.8	7.0
1994	-0.2	0.0	7.2
1995	0.8	1.1	8.8
1996	-0.4	-0.3	10.0
1997	-0.5	-0.4	10.5
1998	-2.8	-2.8	10.4
1999*	-2.7	-2.7	10.2

* Labor input deviation weighted by its share in private sector output.

** The data for 1999 are not final and are based on the forecast of the Central Bureau of Statistics using nine months of data.

Chart 3

The Output Gap using Quarterly Data 1986:1-1999:2
(percentage of output in annual terms)

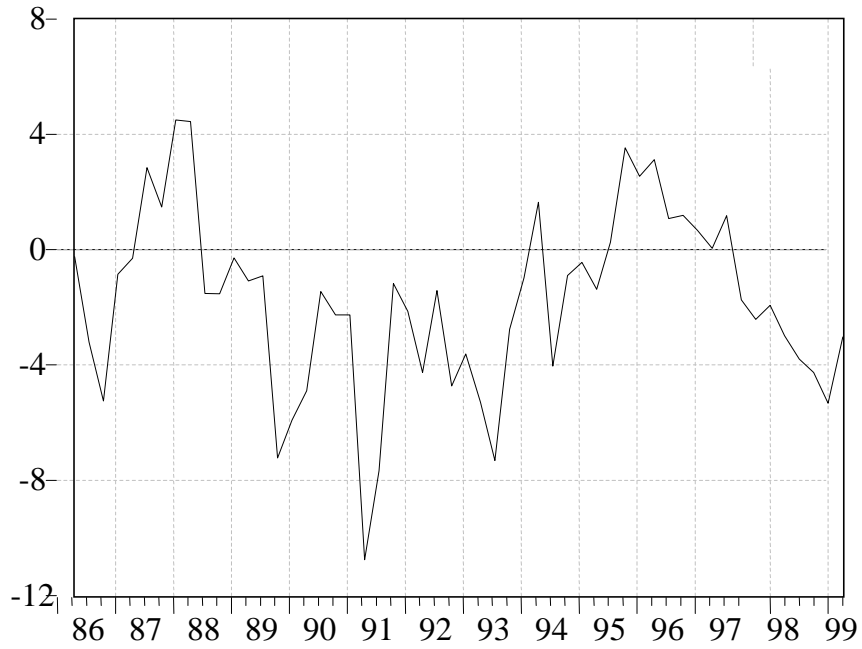
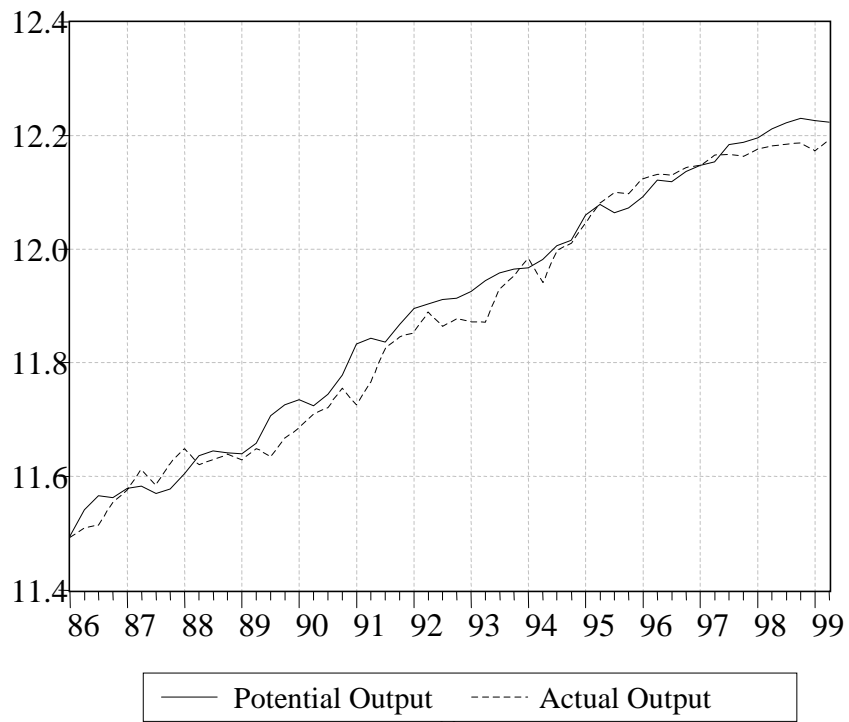


Chart 4

Potential and Actual Private Sector Output
Quarterly Data 1986:1-1999:2



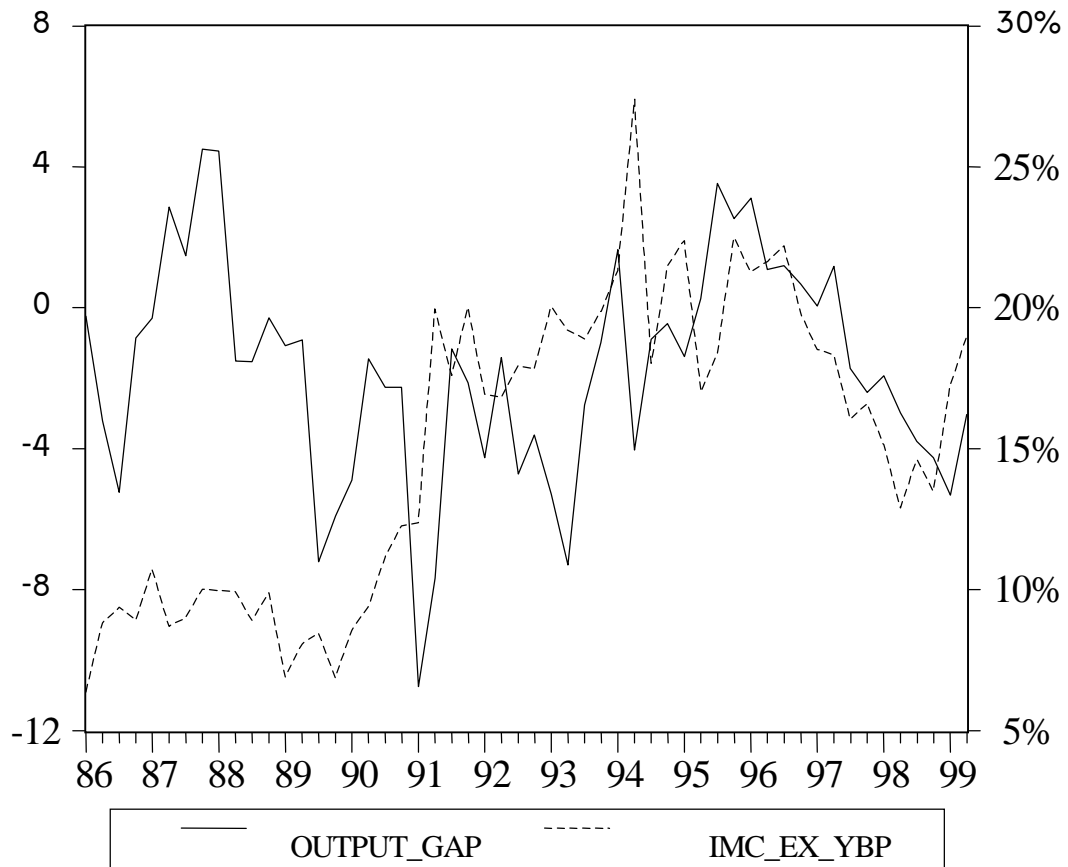
6. The Output Gap and the Import Surplus

In this section we analyze the connection between the output gap and the civilian import surplus relative to private sector output. Chart 5 shows that during the massive wave of immigration from the Soviet Union during the early 90s, the import surplus (IMC_EX_YBP) rose sharply; during the same period there was a small (negative) output gap (OUTPUT_GAP). Although the gap was to some extent the result of an increase in actual output, it was particularly due to a sharp increase in potential output. It appears that the increase in the import surplus during the early 90s was due to both the increased purchase of basic goods required by the new immigrants during their initial absorption and the exposure of the economy to competing imports which began during this period. During the years 1997-8, which were characterized by a decline in domestic demand and actual private sector output, there was a decline in the civilian import surplus (relative to output) together with an increase in the (negative) output gap. One possible explanation of this connection is that the output gap is acting as a proxy for the import surplus; a negative output gap (potential output higher than actual private sector output) reflects a negative demand surplus which can exist in the short run as a result of a decline in domestic demand, e.g. as occurred during the recession of 1997-1999. Such a decline is accompanied by a decrease in relative prices in the domestic market, i.e. a real depreciation,⁹ which to some extent results in increased domestic output at the expense of the import surplus.

⁹An examination of the connection between the deviations in the real depreciation (export prices relative to output prices) from its (appreciating) trend and the import surplus relative to output, shows a negative relationship which is not significant. A similar conclusion was reached in a paper by Y. Lavi which examined

Chart 5

The Output Gap and the Proportion of the Civilian Import Surplus in Output
Quarterly Data 1986:1-1992:2
As a Percentage of the Potential Output



Empirical estimation of the relationship between these variables (Table 4) using instrumental variables (TSLS) shows a positive correlation between the output gap (OUTPUT_GAP) and the civilian import surplus relative to potential output.¹⁰ An alternative formulation, in which the dependent variable is the import surplus relative to private sector output (IMC_EX_YB), yields a similar result. The control variable for

the short and long run connection between a real depreciation and the import surplus in a model with two sectors - tradable goods and non-tradable goods.

immigration, LOG(STOLIM/POP), is the cumulative proportion of immigrants in the population during the four years which preceded the quarter.¹¹ Furthermore, splitting the output gap into actual private sector output and potential output as separate explanatory variables yields estimated coefficients of similar magnitude and expected signs, i.e. a positive coefficient for actual private sector output and a negative coefficient for potential output. The hypothesis that the coefficients are equal cannot be rejected and therefore it is acceptable to estimate the basic regression with output gap as the explanatory variable.

Table 4

Results of 2SLS Estimation

Regression to Explain the Proportion of the Import Surplus in Output*

Explanatory Variable	Dependent Variable				
	IMC_EX_YBP	IMC_EX_YBP	IMC_EX_YB	IMC_EX_YB	IMC_EX_YB
Constant	-0.041 (0.017)	-0.356 (0.241)	-0.044 (0.017)	-0.338 (0.246)	-0.567 (0.262)
OUTPUT_GAP	0.79 (0.21)		0.652 (0.211)		
LOG_YB		0.719 (0.206)		0.577 (0.211)	0.667 (0.246)
LOG_YB_P1		-0.687 (0.215)		-0.547 (0.219)	-0.612 (0.257)
LOG(STOLIM4/POP)	0.058 (0.005)	0.051 (0.006)	0.058 (0.005)	0.052 (0.007)	
LOG(STOLIM3/POP)					0.046 (0.007)
R ² adjusted	0.70	0.73	0.70	0.73	0.66
D.W	1.70	1.75	1.75	1.79	1.61
N	53	53	53	53	53

* Instrumental variables: LOG_YB(-1) ,LOG_YB_P1(-1) ,LOG(STOLIM4/POP)(-1).

* The figures in parentheses are standard deviations.

¹⁰ The civilian import surplus is calculated from national account data; the data is seasonally adjusted and expressed in millions of NIS in 1995 prices.

¹¹ Similar results were obtained for a period of three years preceding the quarter.

7. Conclusion

The output gap has grown steadily over the past three years and reached a high of approximately 6 percent in 1999. This compares to an output gap of only 2 percent in 1989. Analysis of the output gap's cyclical components - the deviation in private sector labor input and the deviation in productivity and capital utilization – shows that the output gap during the years 1997-1999 reflected both the increase in unemployment and low rates of productivity or capital utilization. The annual data indicate that potential output and actual private sector output grew at an average rate of 6-7 percent during the first half of the 90s. In following years, potential output grew at a more moderate rate of 4-5 percent.

In this paper, the output gap was also calculated in quarterly terms. A positive relation was found between the output gap and the civilian import surplus (relative to output) during the years 1986-1999. One possible explanation is that the output gap is acting as a proxy for demand surpluses. Thus, a negative output gap indicates a negative demand surplus which can arise in the short run as a result of a decline in domestic demand (e.g. as occurred during the recession of 1997-1999). This decline is accompanied by a decrease in the relative prices of domestic goods which to a certain extent leads to a decline in the import surplus. This positive relation persists even when the positive influence of immigration on imports is taken into account in the regression equation.

The output gap was split into two separate explanatory variables – actual private sector output and potential output – in the regression of the import surplus relative to output. The hypothesis that the coefficients were equal could not be rejected. Thus, the basic regression in which the output gap is the explanatory variable is acceptable.

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Chart 6

The Cyclical Component of Productivity and Capital Utilization

Quarterly Data: 1986:1-1999:2

(percentages of output)

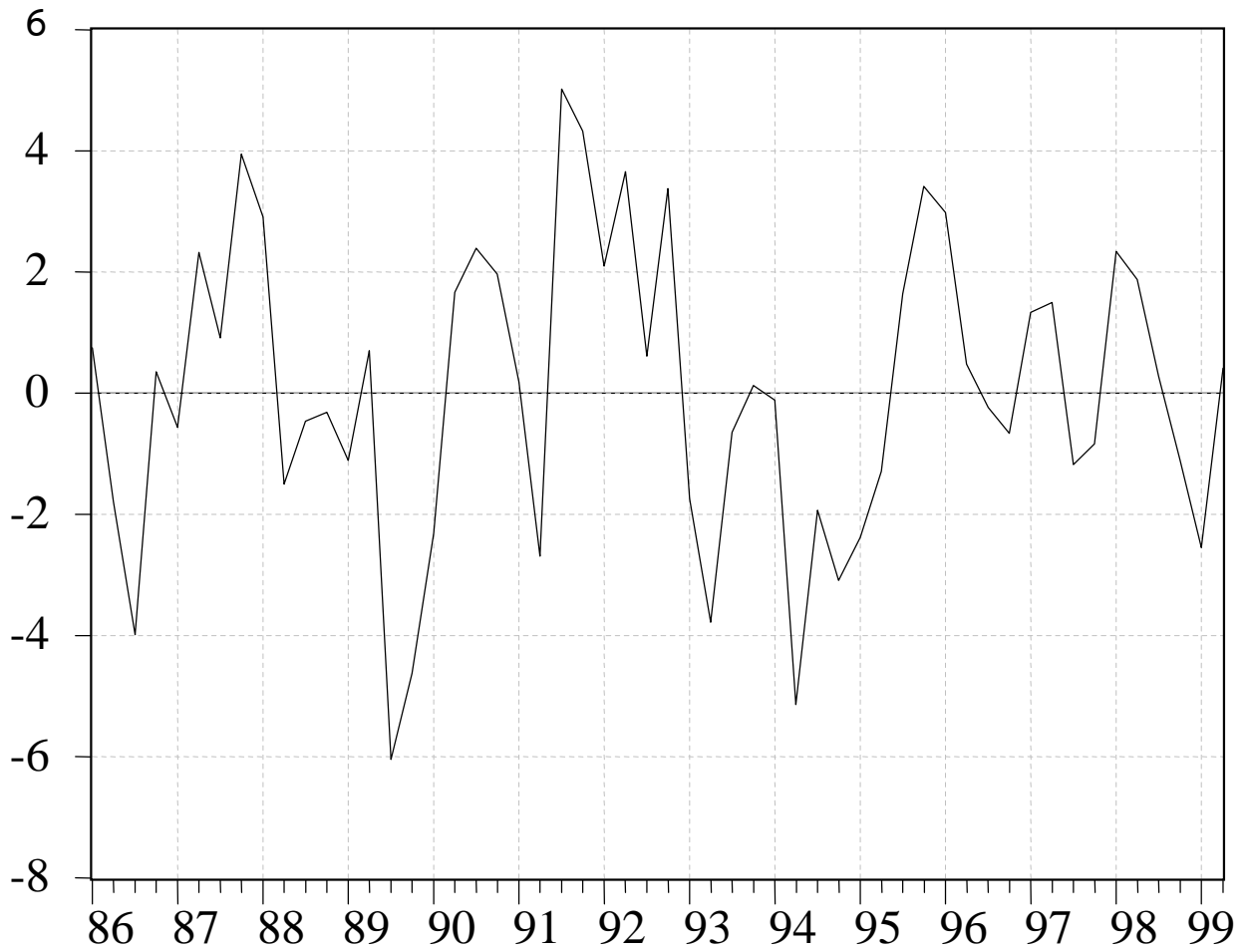
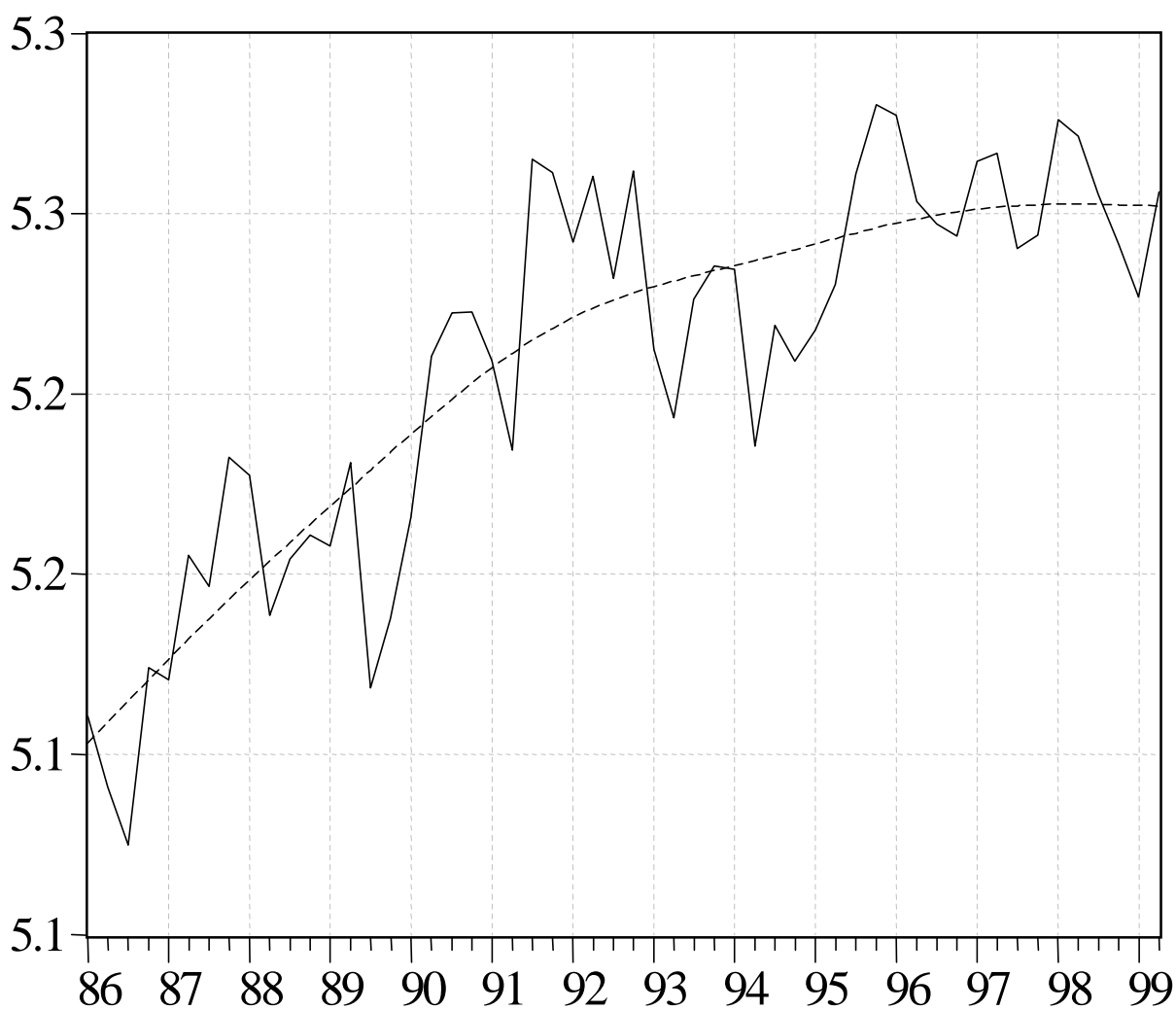


Chart 7

Productivity (and Capital Utilization) with a Time Trend

Quarterly Data 1986:1-1999:2

(Trend calculated using an HP-Filter)



— S - - - - S_P

Chart 8

The Deviation in Actual from Potential Labor Input

Quarterly Data 1986:1-1999:2

(percentages of output)

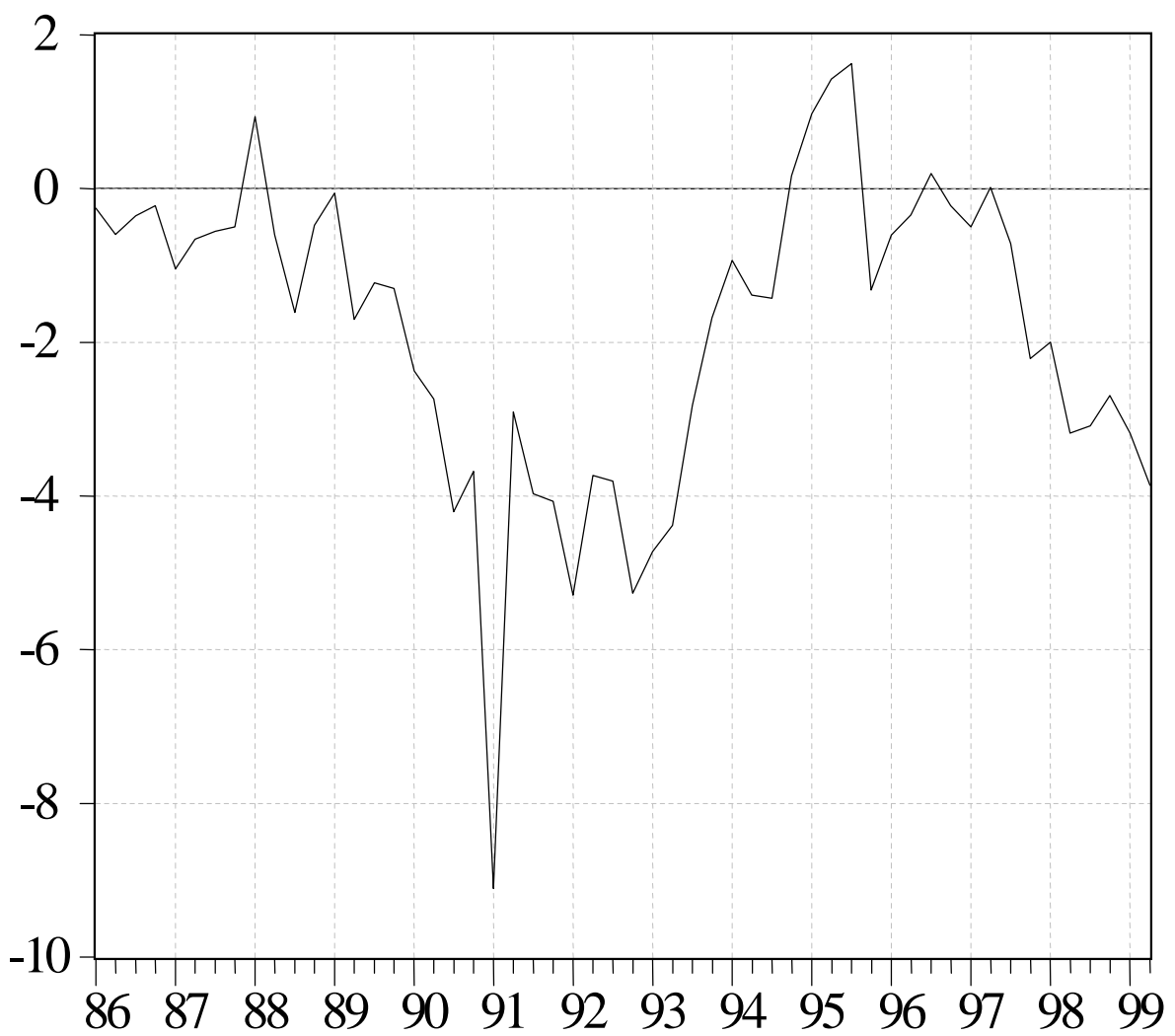


Chart 9

Net Rate of Equipment Utilization Derived from Survey Data

Quarterly Data: 1986:1-1999:2

