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THE PHILLIPS CURVE IN ISRAEL

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In this study we estimate the short-term Phillips Curve for an international panel between 1993 and 2006 and for Israel between 1988 and 2006. The results of the estimation show that the lagged change in the unemployment rate affects the change in inflation. In the international panel the effect is stronger for countries which have achieved price stability. This result reinforced our motivation to examine the stability of the Phillips Curve in Israel. The relationship between the change in the inflation rate and the change in unemployment remained stable over the sample period, even though the lag of the effect became somewhat shorter in duration , and in some formulations the correlation even became stronger. The effect of the change in the exchange rate on the change in the inflation rate was found to be significant only in equations based on the Consumer Price Index (CPI); in equations based on the CPI excluding housing services the effect of the exchange rate was not significant. Finally, the forecasted inflation rate provided by the equation is good. An analysis of the findings indicates that during a period of price stability the short-term Phillips Curve prevails, so that if the Bank of Israel's credibility is based on attaining the inflation target, a counter-cyclical policy should be considered. In view of the fact that the exchange rate does not have an effect on the CPI excluding housing services, the Bank's reaction function should take into account an index of core prices that excludes housing services. This should be done in order to minimize the passthrough between exchange-rate shocks and changes in the Bank of Israel's key interest rate, which could cause real shocks via its effect on the real interest rate.

1. INTRODUCTION

For the last twenty years a long, slow disinflationary process has been taking place in Israel, culminating in 2003. Throughout this period tight monetary policy was implemented by

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means of various instruments—exchange-rate policy, an interest-rate policy combined with exchange-rate targets (the diagonal exchange-rate band) and, finally, an interest-rate policy without an explicit exchange-rate target. During this period many economic processes occurred—Israel was opened up to the free flow of capital, there was mass immigration from the former USSR, tight fiscal policy was imposed, the tax system was reformed, the high-tech sector grew, large numbers of foreign workers were employed, etc. In the political sphere, the Oslo Accords were signed, on the one hand, and there were two Intifadas (Palestinian uprisings), on the other. A process of disinflation was evident in most advanced economies as well as in some of the emerging ones, and an ever-increasing number of countries opened up to globalization, expressed *inter alia* in the liberalization of capital flows and the exchange rate.

The purpose of our study was to examine whether the short-term Phillips Curve, as it was estimated in our previous study (Lavi and Sussman, 1999) for the period between 1988 and 1996, has withstood the test of time and the many changes that have taken place in Israel. Because of the considerable influence of the exchange rate on inflation in Israel, and the effect of the exchange rate on the housing component, which accounts for approximately 22 percent of the CPI, we also estimated the model for the CPI excluding housing. The empirical results in several versions, show that despite Israel's economic and political vicissitudes it can be said that there was a stable relationship in the short term between the change in the unemployment rate and the change in the inflation rate throughout the period of the estimation. Moreover, according in some versions the effect of the change in the unemployment rate on the change in inflation became even stronger. Finally, we find that the original equation is a good predictor of inflation for a period of ten years beyond the original estimated sample.

The estimations of the change in the inflation rate excluding housing services show that the short-term Phillips Curve also holds for that index, especially since the influence of the exchange rate and immigration (which declined), which were found to be significant in the previous versions, has become weaker. It is therefore possible to recommend that in its reaction function the Bank of Israel, in common with other central banks (e.g., the US and Canada), should relate to the core index of prices that excludes the housing item.

In addition to estimating the equation for Israel, we also present findings from advanced economies demonstrating that in a regime where price stability has been attained, the estimated correlation between unemployment and inflation is stronger and more significant than in a period of disinflation, and hence the growing importance of this correlation in affecting policy today.

Since disinflationary process characterized by a unit root still existed in Israel in the estimated period,[1] in addition to the difference equations we estimated further to our previous study (Lavi and Sussman, 1999) we also estimated the derived Phillips equation as an error-correction equation from a cointegrative model of the level of inflation. In line with

[1] Although Israel is in a process of disinflation, there were two protracted departures from the trend during the estimated period, and they upset the process of convergence. These occurred in 1998 and in 2000-2003, and hence they are consistent with the finding regarding the unit root inflation level during the estimated period.

Woodford's (2007) criticism, we found that an estimation of this kind does not provide information that is superior to the information derived from the difference equations.

In conclusion, with the decline of the inflation rate in Israel and the world, and the adoption of an inflation-target monetary regime, the question remains whether the short-term Phillips Curve, which has always been in the background in managing monetary policy, still has any importance. In the period prior to the rational expectations revolution and the conceptual transformation regarding monetary policy, the Phillips Curve constituted a prescription, as it were, for policymakers, enabling them to conduct a counter-cyclical policy. During the period of disinflation there was widespread use of the Phillips Curve based on the difference equation in order to estimate the cost of disinflation in terms of output and/or employment. The short-term relation between inflation and unemployment today, at a time of price stability should, according to the contemporary inflation-target literature, affect the conduct of monetary policy, especially with regard to the importance ascribed to inflation vis-à-vis unemployment or the output gap in the reaction function. Our findings show that even in an inflation-target regime there is room for the short-term Phillips Curve, and once the inflation target is attained, it is advisable to include the deviations from the output gap in the central bank's reaction function—in contrast with the situation in the past (Sussman, 2004).

The paper is organized as follows: in the second section we present our methodological approach; in the third section we present the results of the estimation of the short-term Phillips Curve in the framework of an international panel; the fourth section contains the results of the estimation of the short-term Phillips Curve for Israel; the fifth section gives our examination of consistency by estimating the Phillips Curve derived as an error-correction equation of a cointegrative model of inflation; the sixth section describes an attempt to predict inflation for the period between 2003 and 2006 on the basis of the equation on which our previous study is based; and the seventh section concludes.

2. METHODOLOGICAL BACKGROUND AND ESTIMATION METHOD

In this paper we derive the short-term Phillips Curve from the simple neo-Keynesian model which is accepted in the inflation-target literature (Woodford, 2007). We then formulate an alternative estimation method that is similar to the one used by the European Central Bank (Gerlach, 2004).

a. The Short-Term Phillips Curve Derived from a New-Keynesian Model

The formulation accepted in the research literature today is a derivation of the following three equations of the Phillips Curve from a new-Keynesian macroeconomic model: an equation for the output gap, an equation for inflation, and an equation for the central bank's reaction function (the Taylor rule). In our previous study (Lavi and Sussman, 1999) we derived a difference equation of inflation based on a derivation of Taylor's (1994) model.

$$(1) \quad \Delta\pi_t = \Delta\pi_t^e - \alpha\beta\Delta\pi_{t-1} - \alpha^2\beta\Delta U_{t-2} - \alpha\beta\Delta r_{t-1}^f + \mu_t$$

In other formulations, e.g. Woodford (2007), the dependent variable is the difference between actual inflation and the inflation trend (or the inflation target).

b. The Short-Term Phillips Curve as Part of an Error-Correction Model of Long-Term Inflation

As stated, the accepted formulation in several central banks, and especially the European Central Bank (ECB), is based on Gerlach's (2004) approach, which combines an inflation equation derived from monetary anchors with the short-term Phillips equation (the difference equation).

Assume that long-term inflation, π, is derived from the changes in the values of the nominal anchors, X, that determine it:

$$(2) \quad \pi_t = \beta\dot{X}_t + \varepsilon_t$$

In another version, according to the rational expectations approach:

$$(3) \quad \pi_t = E\ \pi_{t+1}(\dot{X}_t) + \varepsilon_t$$

where expectations, $E_t\pi_{t+1}$, are a function of the expected values of the anchors, X. The traditional anchors include the change in the exchange rate, e_t, and the imported inflation rate, $\pi^{US}{}_t$ (PPP), as well as the change in the money supply *divided by* output (from money supply theory). According to the rational expectations theory, fiscal consolidation variables etc. may also be included.

The short-term equations derived from this model include first and foremost the lagged residual—the error-correction coefficient, shocks to the independent long-term variables, and additional variables, Z, which could affect inflation in the short term—variables representing shocks to the demand or supply of the economic aggregates.

$$(4) \quad \Delta\pi_t = \delta\varepsilon_{t-1} + \beta\Delta\dot{X} + \lambda Z + \nu_t$$

One of the potential dependent variables is the change in the unemployment rate (unexpected supply shocks), from which we obtain the short-term Phillips Curve which is consistent with long-term equilibrium.

The above model is estimated in the framework of the estimation of the cointegrative equation (equation 3). If we cannot reject the existence of a cointegrative relation we will go on to estimate a dynamic error-correction equation of the equation (4).

Note that Woodford disagrees with the estimation of the inflation equation that includes long-term anchors (derived from money supply theory) and the short-term output gap (unemployment), as Gerlich (2004) proposes. Woodford claims that the correlation between inflation anchors and inflation is not necessarily causal, and there is no additional information in an estimation of this kind. He suggests returning to the estimation of the Phillips curve derived from the new-Keynesian model. Our main findings also relate to the

estimation of the Phillips difference equation, as was the case in our previous study. In addition, we present the results of the estimation obtained from the cointegrative model, as these are consistent with the new-Keynesian model and consequently reinforce our findings about the fact that the short-term Phillips Curve prevails for Israel.

3. THE PHILLIPS CURVE IN AN INFLATION-TARGET REGIME: THE RESULTS OF AN INTERNATIONAL PANEL

As stated, in an environment of price stability and credible monetary policy we will expect individuals' expectations to be the same as the announced inflation target. In a situation of this kind, unexpected changes in the labor market, reflecting changes in the unemployment rate, will be expressed in unexpected changes in the inflation rate. In other words, we will obtain the short-term Phillips Curve. In this section we present findings from an international panel of 26 countries,[2] all of them open economies, some of them emerging economies, like Israel, others advanced. The regression estimated is a reduced form version of equation 1 which includes only the change in the unemployment rate as an independent variable, for quarterly data for the period between 1993 and 2006. The estimation method used is Feasible Generalized Least Squares (FGLS) with a correction for heteroskedacity[3]. In order to test the hypothesis we estimated the regressions with dummy variables which take into account the differential effect of the change in the unemployment rate on the change in the inflation rate for countries which have adopted an inflation target as well as for countries which have managed to attain their 'final' inflation target, defined as inflation of between one and three percent. In order to ensure the validity of the result we estimated the regression for sub-samples which included only countries with an inflation target and countries which had managed to attain the price-stability target.

The results of the estimation, which are presented in Table 1, show that the coefficient for unemployment with a lag is larger in absolute terms in the Phillips equation for countries which have attained price stability under an inflation-target regime[4]. For these countries the slope of the Phillips Curve is steeper, and the substitution between inflation and unemployment is greater. Thus, in a situation of price stability the central bank should include macroeconomic shocks which affect employment and/or output in its reaction function. If in the disinflationary period many central banks tended to ascribe considerable—and sometimes even exclusive—weight to deviations of inflation from the target, in comparison with deviations of output from its potential, in a situation of price

[2] Argentina, Australia, Ecuador, Bulgaria, Brazil, South Africa, the Netherlands, Hungary, Venezuela, Israel, Mexico, Morocco, Norway, Nigeria, New Zealand, Poland, the Philippines, Panama, Peru, Chile, the Czech Republic, Korea, Canada, Russia, Sweden, Turkey, and Thailand. The countries that obtained a final inflation target status are: Australia (1993), Brazil (2004), Canada (1995), Chile (2001), Czech Republic, (2006) Hungary (2004), Israel (2003), Korea (2004), Mexico (2003) New Zealand,(1993) ,Poland (2004) and Sweden (1995).

[3] We estimated the regressions correcting for the unbalanced panel.

[4] For countries with high inflation,the slope of the Philips curve is positive., suggesting an unstable short term Philips curve that may be shifting over time.

stability greater weight than in the past should be attributed to deviations of output and employment.

Table 1
The Short-term Phillips Equation: An International Panel, 1993-2006

Dependent variable: annual change in inflation rate			
Sample	All countries with annual inflation rate less than 50%	Countries with non-final inflation target	Countries with final inflation target
Rate of change of unemployment	0.168 (0.083)	-0.180 (0.089)	-0.300 (0.076)
Rate of change of unemployment multiplied by a dummy for countries with a final inflation target	-0.364 (0.152)		
Rate of change in unemployment multipled by a dummy for countries with a non-final inflation target	-0.266 (0.180)		
No. of observations	999	172	281
Likelihood log	-2430	-343	-396

4. THE ESTIMATION FOR ISRAEL

In this study we estimate the Phillips Curve equation for the 1988 to 2006 period. The year 1988 was chosen as the point of departure because we wanted to estimate the Curve for the disinflationary period following the Economic Stabilization Program (ESP) of 1985. We estimate the equation for the entire period and for sub- periods of 1988 to 1996, the point at which our previous study ended, and 1996 to 2006. The variables were measured on a quarterly basis.

The variables used were:

PIP = annual rate of change of CPI

PIP_H = annual rate of change of CPI adjusted for housing services

$\Delta U24$ = rate of change of unemployment over six months with a six-month lag (seasonally-adjusted)

Inflation anchors

DEX = rate of change of NIS/$ exchange rate

π^{US} = annual rate of change of CPI in US

PIPUS_DEX = imported inflation according to PPP equation: annual rate of change of CPI in US *less* rate of change of the NIS/$ exchange rate.

M_YRDP = rate of change of money supply as percent of GDP

PM/PX_SA = Israel's terms of trade: import prices *divided by* export prices, a proxy of imported inflation (seasonally adjusted figures)

Policy variables

DRP = rate of change of lending rate and interest on unindexed demand deposits, effective rate

DEBT = public sector debt as proportion of GDP—fiscal policy variable

DUM_9802 = dummy variable for 1998:IV and first half of 2002. This variable expresses policy shocks which arose from the sharp interest-rate cut and its steep hike in those quarters

Labor market variables

OLIM = proportion of immigrants in population; this variable expresses the large shock to the labor market and aggregate demand resulting from the influx of immigrants from the former USSR in the 1990s

Instrumental variables

DEX_EU = rate of change of $/€ exchange rate

DWB_YBLB35 = rate of change of wages above labor productivity

The evolution of the independent variables over time is described in Figures 1 and 2. For the variables used in the estimation of the short-term equations (cointegration) we also give a series divided on the basis of the HP (Hodrick-Prescott) filter.

5. RESULTS OF THE ESTIMATION

a. Estimation of the New-Keynesian Phillips equation

In this section we estimate various versions of equation 1. What distinguishes this estimation from the one in our previous study is the inclusion of the rate of change of the exchange rate in the short-term equation.[5] The inclusion of the exchange rate should represent the effect of indexation to the US dollar of rental contracts, and the prices of housing and other services. This allows us to better understand the transmission channels of the changes in the various variables on the change in the inflation rate. However, the change in the exchange rate may occur simultaneously with the change in the inflation rate, and we therefore estimated the equations using the (Two Stage Least Sqaures) 2SLS method. Furthermore, technically, a lagged variable is not determined simultaneously with the dependent variable. However, because inflation and unemployment are determined simultaneously lagged unemployment may be a result of expectations of future inflation. Consequently, we estimated equations (using the 2SLS method) in which the lagged unemployment rate was also assumed to be endogenous. In addition, we increased the lags in the equation by one quarter, compared with the estimation in our previous study.

[5] We thank the participants in the Research Department conference for their comments about the inclusion of the exchange rate in the estimation equation. This may resolve an omitted variable problem we had in our previous estimations.

Table 2 shows the equations we estimated by sub-periods, equations which are similar to those we estimated in the past. Inspection of the table shows that the equations are fairly stable throughout the main period and the sub-periods; this applies in particular to the effect of lagged unemployment, the core of the short-term Phillips Curve.

Figure 1
The Long-Term Variables, 1988 to 2006

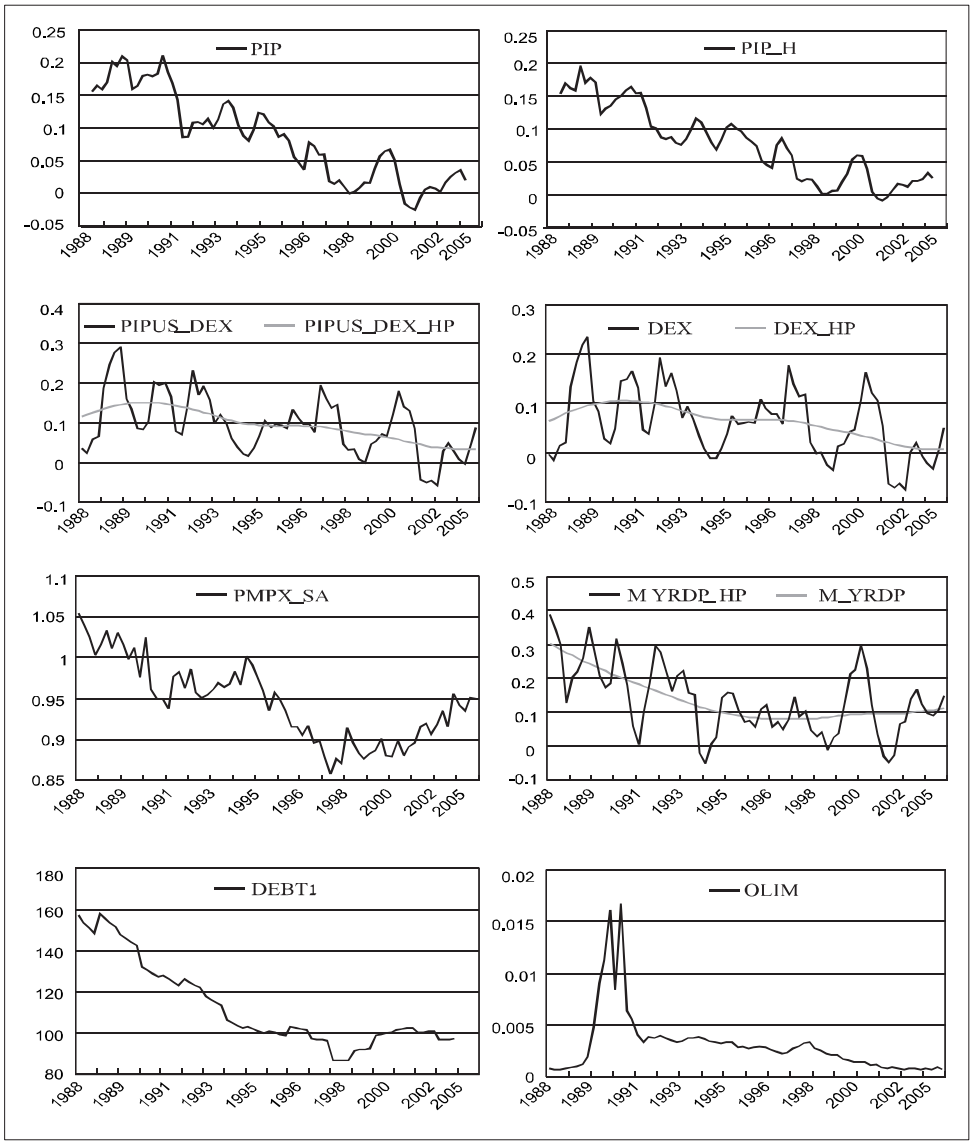
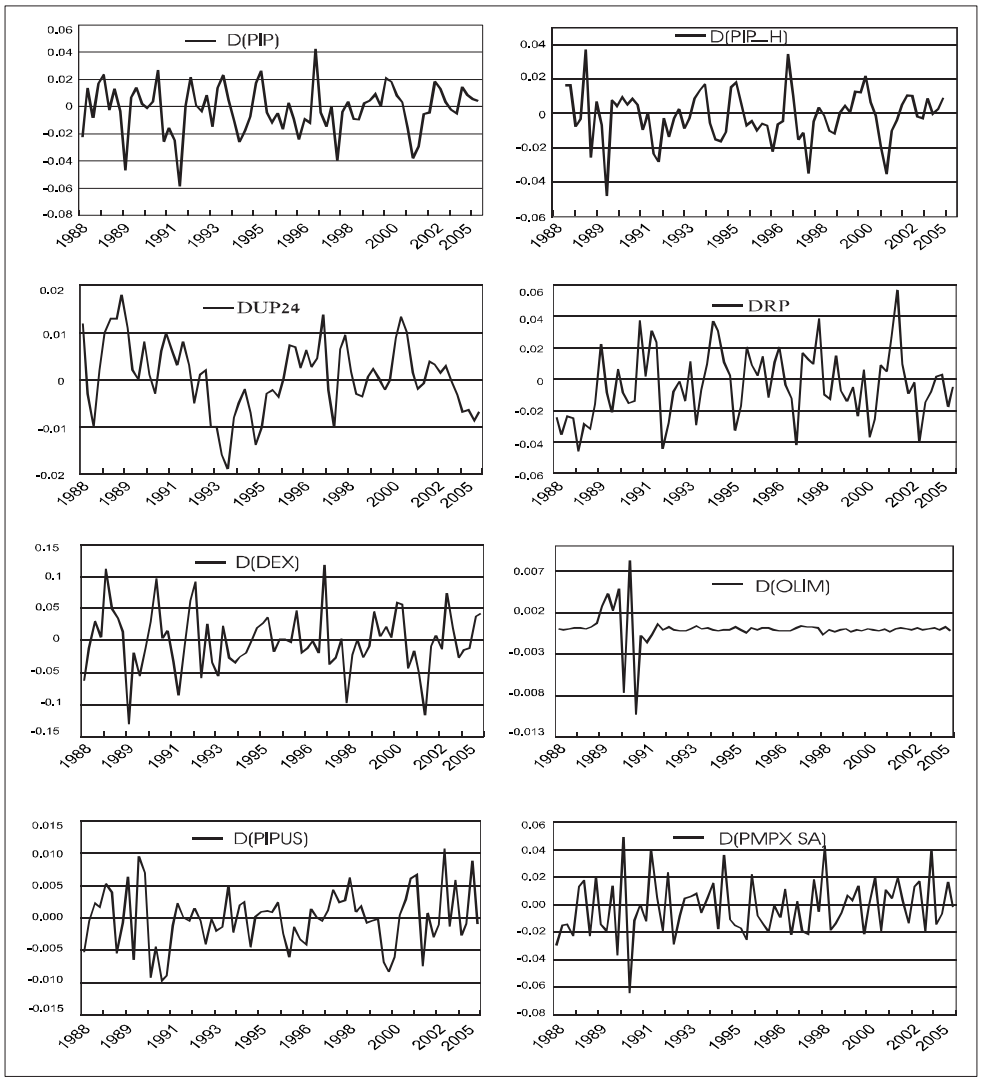


Figure 2
The Short-Term Variables, 1988 to 2006



The phillips equation, which is significant and stable in all the versions, is even stronger in some formulations for which we assumed endogeneity, in the 1996-2006 period. This finding indicates, as is the case with the international findings, that not only has the relation between unemployment and inflation not become weaker with the stabilization of inflation at low levels, but it may even have become stronger. Another finding is that the constant in the equation is significantly different to zero, and in effect is also negative for the 1996-2006 period. This finding indicates that the level of inflation in Israel has not yet stabilized,

and that forces for its continued decline, even to below the target (as of 1996), are still at work. These forces may be related to the interest-rate policy, which was fairly inflexible and did not take the output gap and unemployment into account. The result may also stem from the unemployment rate, which is still high by western standards, exerting downward pressure on inflation, and to which the Bank of Israel has not attributed great importance in its policy. The effect of the exchange rate was found to be significant to the extent of 25 percent, equal to the weight of housing services in the CPI. As was the case in our previous study, we found that the mass immigration of the 1990s was a demand factor which contributed to inflationary pressures. The effect of the real interest rate with a lag, representing the Bank of Israel's reaction function, was also found to be significant.

Table 2
Differential Equations of Inflation for 1988:III to 2006:I and Subsidiary Periods

	Period	Independent variables						Statistics		
		C	$\Delta(U_{-2-4})$	DRP_{-1}	$\Delta(OLIM_{-1})$	ΔDEX	*DUM_9802*	R^2 adj	obs.	D.W.
1.	1988:3–1996:4	-0.005 (-2.004)	-0.760 (-2.961)	-0.349 (-3.404)	2.774 (3.526)	0.193 (2.718)		0.574	34	2.173
1.a*		-0.005 (-1.997)	-0.759 (-1.994)	-0.352 (-3.300)	2.756 (3.499)	0.187 (2.566)		0.575	34	2.184
2.	1996:1–2006:2	-0.002 (-1.734)	-0.508 (-1.973)	-0.282 (-4.364)		0.226 (2.566)	0.014 (1.443)	0.781	42	2.125
2.a*		-0.002 (-1.702)	-1.111 (-2.131)	-0.262 (-3.601)		0.219 (2.295)	0.022 (1.978)	0.743	42	2.067
3.	1988:3–2006:1	-0.004 (-2.756)	-0.642 (-3.652)	-0.292 (-4.711)	2.767 (4.389)	0.206 (3.341)	0.019 (2.318)	0.666	71	2.183

t-values in parenthesis
The equations were estimated by 2SLS method: the exchange rate is endogenous in all the equations. The instrumental variables are *D(DEX_EU)*, and the explanatory variables are exogenous.
*In equations 1a and 2a the unemployment rate is also endogenous. The instrumental variables are *DWB_YBLB35* and *DUP24* with a lag, and the independent variables are exogenous.

The significant effect of the exchange rate on the change in the inflation rate we found above could be a result of a pass-through from import prices to the general price level or could be confined to a direct effect on housing prices which owing to the legacy of the high inflation period, are still quoted in U.S Dollars. To clarify the transmission mechanism of the change in the exchange rate to the change in inflation we re-estimate the short-term Phillips equation with the change in the CPI excluding housing services as the dependent variable. Table 3 presents the results of the estimation for the CPI excluding housing services. The most prominent finding is that the effect of the change in the dollar exchange rate on the change in inflation is no longer significant in any version. In the first period, its effect is on the margin of significance, but from 1996 onwards its effect is not significant at all. This result shows that the pass-through of changes in the exchange rate to the change in the inflation rate is limited to the housing sector. This finding suggests that the reaction function of the Bank of Israel, which relates to the general CPI, is unduly influenced by the

effects of the exchange rate on asset (housing) prices as these are measured by the Central Bureau of Statistics (CBS).

Table 3
Differential Equations of Inflation, adjusted for housing services for 1988:III to 2006:I and Subsidiary Periods

	Period	Independent variables						Statistics		
		C	$\Delta(U_{-2-4})$ או $\Delta(U-3-5)$	DRP_{-1} או $DRP-2$	$\Delta(OLIM_{-1})$	ΔDEX	*DUM_9802*	R^2 adj	obs.	D.W.
1	1988:3 - 1996:4	-0.003 (-1.169)	-0.442 (-1.580)	-0.065 (-0.581)	1.142 (1.334)	0.137 (1.775)		0.205	34	2.066
2*		-0.004 (-1.686)	-0.817 (-3.352)	-0.157 (-1.670)	1.011 (1.356)	0.127 (1.969)		0.393	34	2.231
2***		-0.004 (-1.694)	-0.916 (-1.819)	-0.163 (-1.664)	0.997 (1.330)	0.125 (1.959)		0.388	34	2.223
3	1996:1 - 2006:2	-0.003 (-1.747)	-0.672 (-2.041)	-0.386 (-4.680)		-0.027 (-0.237)	0.027 (2.213)	0.495	42	2.202
4		-0.003 (-1.892)	-0.648 (2.181)	-0.379 (-5.181)			0.025 (3.728)	0.546	42	2.168
4**		-0.003 (-1.859)	-1.443 (2.127)	-0.348 (-4.186)			0.035 (-3.352)	0.456	42	2.054
5	1988:3 - 2006:1	-0.003 (-2.320)	-0.488 (-2.352)	-0.214 (-2.930)	0.795 (1.071)	0.048 (0.674)	0.023 (2.398)	0.304	71	2.221
6*		-0.003 (-2.168)	-0.438 (-2.140)	-0.171 (-2.520)	0.751 (0.993)	0.061 (0.827)	0.019 (2.021)	0.279	4	1.970

t-values in parenthesis
The equations were estimated by the 2SLS system: the exchange rate is endogenous in all the equations, except for equation 4, which was estimated by the OLS system, because the exchange rate is not in it as an independent variable. The instrumental variables are: *D(DEX_EU)*, and the explanatory variables are exogenous.
* In equations 2 ,2a and 6 the unemployment rate and the interest-rate are with a further lag, meaning $\Delta(U_{-3-5})$ and DRP_{-2} .
** In equations 2a and 4a the unemployment rate is also endogenous. The instrumental variables are: *DWB_YBLB35* and *DUP24* with a lag, and the independent variables are exogenous. In equation 4a there is an additional instrumental variable: *D(DEX_EU)*, and there is no immigrants.

An additional difference between the estimations with and excluding housing services is the lack of significance of the immigration variable. It would seem that the effect of immigration on aggregate demand was expressed primarily in the prices of housing services: the well-known inflation step of 1992, which constituted the basis of the inflation steps theory regarding Israel's economy (Liviatan and Melnick, 1998), was influenced by the part played by housing services in the CPI, which in turn was affected that year by the influx of immigrants from the former USSR. The real interest-rate variable was not significant in the 1986-1996 period, when the use of the interest rate in order to fight inflation had not yet been established (Sussman, 2004). Here, too, it seems that the effect of the interest rate on the CPI, which we found for the general CPI, appears to have worked through housing prices (the effect of the cost of capital on investment in the (housing) capital stock). In contrast, in the 1996-2006 period, when the Bank of Israel employed a

more aggressive real interest-rate policy, its effect even on the CPI excluding for housing services is notable. We also found that the lag structure of the independent variables differs between the two sample periods; for the 1988-1996 period the addition of a lag improves the estimation results, while in the estimation of the overall inflation equation (Table 2) no significant difference was found in the lag structure.

To conclude, the results of the estimation show that the short-term Phillips Curve continues to obtain for the Israeli economy even at a time of low inflation. It would appear, however, that in the short-term inflation equation (the change in the inflation rate) there are significant differences between the use of the CPI with and without housing services: the effect of the exchange rate on the CPI in recent years is expressed solely in the price of housing services. On the other hand, in the last few years the effect of the interest-rate policy on inflation has increased, and its influence on the CPI adjusted for housing services is even stronger than its effect on the general CPI. Hence, the Bank of Israel's reaction function may have over-reacted to changes in the index of housing prices, thereby exerting considerable influence on the CPI excluding housing services. Therefore, at a time when housing prices are rising because of exchange-rate shocks, the Bank of Israel's reaction could lead to sharper deflation than is required in relation to the core CPI (excluding housing). Conversely, at a time of local-currency appreciation the Bank of Israel will adopt an expansionary interest-rate policy, which will serve to raise the core CPI excessively.

b. Estimation in the framework of a cointegrative model

We could not reject the hypothesis that the main variables we used in our estimation of the short-term Phillips curve exhibit unit root properties. Therfore, our results are subject to a potential criticism of a spurious relationship[6]. Therefore, as a robustness check, we proceeded to re-estimate the short-term Phillips equation taking into account the presence of unit roots in the variables we used above. At the first stage, we estimated several cointegrative (long term) equations of the level of inflation on the various anchors, using the Engle-Granger method. The results of the estimations are presented in Table 4. The results show that from 1998 to 2006 the existence of a cointegrative relation between inflation and its various anchors cannot be rejected—and in particular equation 3 is consistent with the relative PPP approach, where the PPP coefficient is not significantly different from 1. A consistent effect of the terms of trade was also found. The effect of immigration was not significant in all the versions, while the effect of the money supply was significant, albeit with a lower coefficient than that found for the exchange rate. In equation 2 we added the effect of fiscal policy, and this was found to be significant. The fiscal consolidation process had an effect on inflation in Israel in that period. When we estimate the cointegrative equations for the CPI excluding housing services (columns 4-6 in Table 4) we get results that are almost identical with those of the estimation for the general CPI. This represents an important finding that most of the differential effect of the price of housing services is

[6] We do not wish to enter the debate between structuralists and no-structuralists on the appropriateness of accepting the rejection of the null-hypothesis of unit-roots in time series data. The structrualist approach argues that dis-inflation is *fundamentally* not a unit root (random or Markov) process even though it exhibits the *statistical* proprties of a unit root process.

expressed in the short term; in the long term the effects of the short-run, mechanical, transmission of exchange rate changes to housing prices is eroded by the fundamental forces of the economy that affect housing prices. This conclusion reinforces the criticism against the reaction by the central bank to the effect of short-term housing price changes caused by changes in the exchange rate.

At the second stage we estimated dynamic short-term equations that include an error-correction variable derived from the above estimations. As Table 5 shows, for each cointegrative equation we found that in the dynamic process there is a significant convergence process which includes the direct and consistent effect of the change in the unemployment rate (Phillips Curve). The error-correction coefficient, 0.14, indicates a convergence process of about two years, i.e., the deviations of inflation from long-term equilibrium are corrected within approximately two years. Similar results (not shown), albeit less significant ones, were obtained for the estimation with the CPI excluding housing services.

Table 4
Inflation Equations: Israel, 1988-2006

	(1)	(2)	(3)	(4)	(5)	(6)
Inflation excluding housing	1.000	1.000	1.000	1.000	1.000	1.000
Rate of depreciation - HP filter	-1.183 (0.16)	-1.038 (0.16)		-0.978 (0.13)	-0.850 (0.14)	
Imported inflation – HP filter			-1.252 (0.14)			-1.083 (0.12)
Terms of trade	-0.283 (0.16)	-0.22 (0.11)	-0.392 (0.09)	-0.197 (0.10)	-0.162 (0.10)	-0.344 (0.08)
Immigration	-0.848 (1.35)	-0.996 (1.31)	-0.188 (1.37)	-0.721 (1.16)	-0.588 (1.14)	-1.413 (1.21)
Foreign debt as proportion of GDP		-0.001 (0.00)			-0.001 (0.00)	
Change in money supply divided by GDP	-0.302 (0.09)			-0.323 (0.08)		
R^2Adj	0.839	0.847	0.835	0.841	0.845	0.826
D.W.	0.51	0.51	0.54	0.49	0.473	0.553
A.D.F	*-4.810	*-4.756	*-4.887	*-4.540	-4.480	*-4.472
D.W.	2.04	2.08	2.05	2.057	2.14	2.067

*Significant at 5%.

It is interesting to note that when the change in the exchange rate was included in the error-correction equation reported in Table 5, the error-correction variable lost its significance. We also estimated the dynamic equations including the rate of change in the exchange rate, using the 2SLS (two stage least squares) method. Although this is not the main focus of this study, it can be said that the error-correction process is consistent with changes in the rate of change of the exchange rate which operates, via CPI components that are affected by the exchange rate, to restore the inflation rate to the level derived from the long-term equation. When inflation is below the level derived from its anchors, a process of accelerated local-currency depreciation takes place, restoring inflation to its equilibrium

level. This is apparently because when inflation is below equilibrium the likelihood that the Bank of Israel will not raise, and may even lower, the interest rate is greater. It is then that local-currency depreciation occurs, causing the CPI to rise until inflation returns to its equilibrium level. This interpretation reinforces our assertion above that the exchange rate is endogenous to changes in the rate of inflation. This conclusion is consistent with the assumption of the New-Classical model which asserts that in the long-run, under a flexible exchange rate regime, the exchange rate is an endogenous variable.

Table 5
Dynamic Phillips Equations, Including an Error-Correction Variable

	(1)	(2)	(3)
Constant	-0.004 (-2.51)	-0.004 (-2.49)	-0.004 (-2.52)
Error correction	-0.148 (-2.37)	-0.142 (-2.19)	-0.136 (-2.19)
Change in unemployment	-0.554 (-2.41)	-0.58 (-2.52)	-0.535 (-2.28)
Change in real interest rate, lagged	-0.367 (-5.04)	-0.367 (-5.02)	-0.376 (-5.15)
Change in proportion of immigrants in population, lagged	1.824 -2.35	1.752 -2.22	1.908 -2.46
Dummy variable for 1998-2002	0.032 -3.83	0.032 -3.83	0.032 -3.83
R^2Adj	0.449	0.443	0.443
No .of observations	72	72	72
D.W.	2.23	2.24	2.26

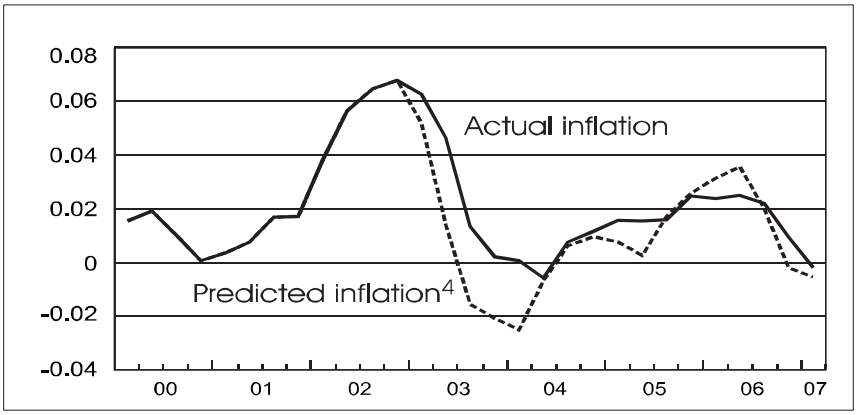
t-values in parentheses

The overall finding that the error correction coefficient is not very significant can also lead to the conclusion that the traditional version of the Phillips Curve estimated in section 5.a. (as a dynamic equation) is in fact a reduced version of the long-term convergence equation. This finding reinforces Woodford's criticism of the ECB's method of estimating the Phillips Curve. As stated, Woodford claims that the long-term equation does not provide any additional information over that which can be inferred from a short-term Phillips Curve specification. The equivalence between the short-term equations derived from the New-Keynesian model and the equations derived from the error-correction model illustrate this clearly. Despite these reservations, it worthwhile to reiterate that the effect of the change in unemployment on inflation (the Phillips Curve), in any specification, remains intact as regards both the significance and the size of the coefficient.

6. THE DURABILITY OF THE SHORT-TERM PHILLIPS CURVE

In this section we evaluate the the time-consistency of the forecast provided by the model's original (Lavi-Sussman, 1999) equation as estimated for the 1988-1996 period. Of course, the equation estimated cannot predict the events which occurred in 1998 or those surrounding the interest-rate cut at the end of 2001; the latter were expressed through the addition of a dummy variable in the equations estimated for the entire period. We consequently estimated the original equation up to the end of 1996, and then generate a dynamic forecast for the 2003-2007[7] period. The results of the exercise are presented in Figure 3.

Figure 3
Actual Inflation and a Forecast Based on the Original (Lavi-Sussman1999) Model, 2000-2007



Although, almost ten years have passed since it was estimated, the original equation estimated has succeeded in generating an out of sample forecast that any inflation predictor would be happy with.

7. CONCLUSION

In this study we estimated difference equations of the short-term Phillips Curve for a panel of 26 countries, and obtained the result that a new-Keynesian Phillips Curve holds for countries with an inflation target. In countries which attained price stability (an inflation target between 1 and 3 percent) we found that the slope of the Phillips Curve was steeper, and this result indicates that the short term substitution rate between inflation and unemployment is greater in this environment.

For Israel, we estimated difference equations which are derived from a new-Keynesian model, and from a dynamic error-correction specification derived from a cointegrative

[7] The forecast is calculated using a dynamic method

relation between inflation and its anchors. An examination of the results of these two types of estimation bears out Woodford's criticism regarding the ineffectiveness of using an estimation of the level of inflation (cointegration). In Israel, in spite of the extensive policy changes and the various political and economic disruptions, a stable and significant relationship has been maintained in the short term between changes in unemployment and changes in the inflation rate. In other specifications it is possible to show that the effect of unemployment has even grown stronger, as we found for the international panel. Although the equations estimated are not identical, the slope of the short-term Phillips Curve in Israel would appear to be steeper than the average of the international sample. This may constitute a partial explanation of the relatively high unemployment rates in Israel associated with the management of monetary policy (Sussman, 2004).

We also estimated the model for the CPI excluding housing services. In these estimations, the effect of the exchange rate is not significant in recent years. Hence, the Bank of Israel seems to responds to inflation that stems partly from exchange-rate changes, which affect the prices of housing services and this response affects employment and inflation via changes in the real exchange rate. Thus, hort-term exchange-rate changes cause fluctuations in the rates of inflation and employment (via the central bank's reaction to their effect on the price index of housing services). We consequently recommend that especially at a time of price (inflation) stability the Bank of Israel adopt a 'core' index which does not include housing services.

Since we found that the change in unemployment has a significant and consistent effect on the change in inflation, the possibility exists that monetary policy ought to have taken this effect into account. Sussman (2004) found that in the period from 1990 to 2000 – the Bank of Israel did not respond either to deviations in output or to changes in the unemployment rate. Apart from the change in unemployment, the effect of policy was found to be significant and the changes in the real interest rate influenced inflation as expected. Positive deviations in the real interest rate, i.e., tougher counter-cyclical policy, brought about a decline in the inflation rate in the short term. The effect of the immigration shock of the 1990s on Israel's economy was also significant. The positive coefficient of this variable attests to the exceptional demand effect of the influx of immigrants. By comparing the regression coefficient of immigration and the estimation of the CPI equation, on the one hand, and the estimation of the CPI excluding housing services, on the other, it is possible to ascribe the effect of immigration to the housing item. As expected, the dummy variable for the large swings in monetary policy (Sussman, 2004) also had a significant effect on the dynamic process of inflation. The unexpected interest-rate cuts of July 1998 and December 2001 caused shocks to the short-term Phillips Curve which, once adjusted for these shocks, was stable in those years.

Our conclusion is that central banks in general, and the Bank of Israel in particular, should assign appropriate weight to business cycle variables in their reaction function, because in the short term, the ability of the central bank to influence employment seems to have increased with its credibility. As Phillips showed in his original article, which focused on the period when the UK adhered to the gold standard (1860-1914), at a time when price stability prevails and the central bank's credibility is high there is a stable, long-term relation between inflation and unemployment.

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