

# The equilibrium real exchange rate for Israel

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## 1. Introduction

This paper analyses the equilibrium real exchange rate (ERER) for Israel. In a small open economy such as Israel, in which export flows account for 40% of GDP, the real exchange rate (RER) has an important impact on growth and stability.<sup>4</sup> RER misalignments that are due to medium-term deviations of the actual exchange rate from the ERER could cause output loss and cyclical, inefficient allocation of resources, including low utilisation of factors of production. The fact that a large share of exports is based on the high-tech industry and high investment in human capital makes this concern an important policy factor.

On the eve of the crisis in 2008 the Israeli currency (New Israeli Shekel, NIS) appreciated by about 20%. This raised concern that the RER was overvalued due to short-run capital flows. This, and the low level of foreign currency reserves, prompted the BOI to intervene in the foreign exchange (FX) market after 10 years during which the exchange rate was free-floating. The policy during the stress period of the crisis was that of buying \$100 million a day. Since August 2009, the Bank of Israel has adopted a policy of FX market intervention in case of sharp exchange rate movements that do not reflect fundamental forces, and in cases of market anomalies. Thus, the question of whether the RER is aligned with economic fundamentals has become central to active policy.<sup>5</sup>

Currently, the low rate of growth in the developed economies and the interest rate differential between Israel and these economies, that maintain historically low key rates, have created massive capital inflows into Israel, and similarly into other growing economies.<sup>6</sup> These flows have resulted in episodes of RER overvaluation; consequently, some central banks have started to defend their exchange rates either by purchasing foreign currency or by restricting capital flows.

The case of Israel illustrates the above: cumulative per capita growth in Israel in 2008–10 was higher than in the main developed economies. The rapid recovery after a mild recession and growing inflationary pressures induced the BOI to raise the key interest rate from 0.5% in April 2009 to 2% by the end of 2010, while the key rates in the US and the euro zone are at historical lows and are expected to stay there for most of this year. The interest rate differential led to a substantial increase in carry-trade capital inflows towards Israeli short-run zero-coupon debt instruments issued by the BOI (*makam* – short-term borrowing), putting additional pressure on the exchange rate. The BOI's policy response was to purchase

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<sup>4</sup> Flug and Strawczynski (2007).

<sup>5</sup> Usually, the exchange rate analyses are used internally and are not reported to the public. The exceptions are the BOI Annual Report 2004, which presented the ERER methodology and reported that the RER was aligned, and the Annual Report 2008, which reported that the RER was overvalued.

<sup>6</sup> IMF (2010).

foreign currency in order to moderate the shekel appreciation trend. Total reserves increased from \$28 billion in 2008 to \$71 billion at the end of 2010.

The justifications for the foreign currency purchases by the BOI are either an overvalued currency relative its equilibrium level, or a non-gradual appreciation towards equilibrium. Our analysis is divided into two methods: (i) a direct method based on an economic model that is derived by long-term fundamental economic indicators; and (ii) an indirect methodology based on the analysis of the current account. According to this latter methodology, the difference between the actual and the fundamental current account indicates RER misalignment, which may be caused by transitory capital flows or other factors. The magnitude of the misalignment depends on the elasticities of exports and imports with respect to the RER.

Our analysis includes two measures of the RER: (i) the real effective exchange rate (REER), that is, the nominal effective exchange rate (NEER) divided by the relative price levels; and (ii) purchasing power parity (PPP) indices, which include both low-frequency panel data and high-frequency time-series data. We follow the vast literature on this subject and use several economic fundamental variables: relative per capita GDP, the terms of trade, the dependency ratio, government size, foreign direct investment (FDI) flows, interest rate differentials and others that help to explain RER fluctuations and trends. We find the first two variables to be the most important and robust.

Our main findings are as follows. In 2006, a year during which the RER reached a historical low (that is, when the shekel depreciated the most), the RER was undervalued. This conclusion holds for both the direct and indirect methods, as there was an unprecedented current account surplus in the same period. This is also in line with the claim that the earlier financial liberalisation was the main cause of the massive capital outflows that were one of the main forces behind the undervaluation of the NIS in 2006.<sup>7</sup> Thus, the rapid appreciation of the shekel in 2008 was to some extent an equilibrium-reverting movement. However, the RER assessment for 2008 depends on the RER measure in the sample period: on the one hand, inferences based on long samples and on the REER point to convergence with no “overshooting”. On the other hand, inferences based on PPPs, or those based on short-sample REER, point to evidence of overvaluation in 2008.

In 2009, however, all models point to undervaluation, which could be a result of the BOI’s policy of foreign exchange intervention, which supported the NIS and seems to have had a sizeable influence on the nominal effective exchange rate.<sup>8</sup> An indirect RER assessment based on current account analyses provides evidence that the RER was considerably undervalued in 2006 and in 2009, thus providing further support for the conclusions based on the direct ERER analysis. In 2010 the RER continued to appreciate, and the latest assessment, based on the direct method and quarterly data, indicates that the RER was back to its equilibrium level by the end of the year or even slightly overvalued. An indirect assessment based on the current account points to undervaluation of about 10%, even at the end of 2010.

The paper is organised as follows. The next section presents the main trends of the RER and the current account during the last decade. The third section presents the main econometric results of the RER equations based on both panel and time-series data. The fourth section briefly discusses the fundamental equilibrium exchange rate that balances the current account, and concluding remarks are given in Section 5.

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<sup>7</sup> Friedman and Liviatan (2009).

<sup>8</sup> Sorezcky (2010).

## 2. The real exchange rate and the current account

Israel is an advanced, small open economy. With a relatively large segment of highly trained workforce and innovative engineering, exports are concentrated in several human capital-intensive industries. To a large extent, economic growth in recent decades has been led by the export sector, which is directly affected by RER fluctuations.

The REER and the NEER are presented in Figure 1. Not surprisingly, the two are highly correlated, as the shekel is a free-floating currency and inflation in Israel in the 2000s was on a par with that in its trading partners, so that the changes in the NEER directly affect the REER both in the short run and in the long run. The Israeli economy has been characterised by a current account surplus since 2003, as presented in Figure 2.

After a relatively depreciated level in the mid-2000s, the REER appreciated rapidly between mid-2007 and mid-2008. During a short period, of less than a year, it appreciated by about 20%. This incident raised great concern at the BOI about the competitiveness and resilience of the Israeli export sector. This situation, and the low level of the foreign exchange reserves (\$28 billion) on the eve of the Great Recession, triggered a change in the BOI's policy towards the foreign exchange market. After allowing the exchange rate to float freely for over a decade between 1998 and March 2008, the BOI resumed its policy of direct exchange market intervention. This policy seemed to reverse the appreciation trend of the NEER and the REER and resulted in a depreciation of about 10%.<sup>9</sup>

The appreciation trend resumed in the second quarter of 2009, and in the third quarter of 2010 the REER and the NEER were back to their levels of the first quarter of 2008, prior to the period when direct intervention had started.

The reasons for the appreciation in 2008 were both local, as the economy reached its potential capacity, and external, as the financial crisis that began in the summer of 2007 caused capital inflows to the Israeli economy, which was considered to have a relatively safe and stable banking system, as was later confirmed when the crisis reached its peak in late 2008.

The appreciation trend resumed in 2009 and continued in 2010, due to both fundamental and financial factors. There are several other fundamental reasons for the appreciation trend in recent years. Israel has become officially a developed economy, a change that was manifested in its status in international organisations – eg joining the OECD – and in the markets – eg the classification change by Morgan Stanley. This may have affected negatively the long-run risk premium of the country and therefore added to the appreciation trend. In addition, in 2009 and 2010 large natural gas fields were discovered, and this will work to reduce the imports of fossil fuels in the future.<sup>10</sup>

The increase in the interest rate spread between Israel and the main developed economies in 2010 resulted in the formation of massive short-term capital inflows and in appreciation of the RER.

The REER and the NEER depreciated considerably between 2001 and 2006. Between 2001 and 2003 Israel suffered from a major economic downturn caused by the *intifada* – a period during which the country suffered from a multitude of Palestinian terror attacks on civilian targets and the high-tech crisis in the world financial markets. Consequently, during this period GDP per capita in Israel dropped, the government deficit increased dramatically and the debt/GDP ratio reached a level of about 100%. The country risk premium increased

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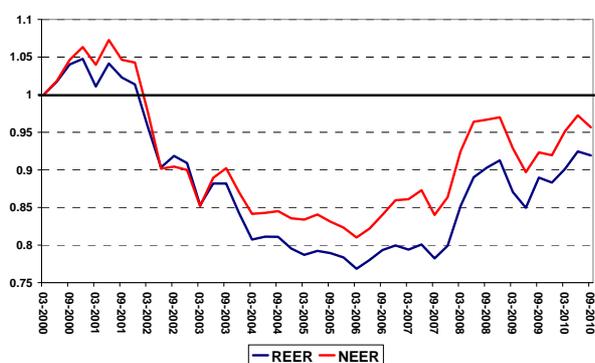
<sup>9</sup> Sorezcky (2010).

<sup>10</sup> For a review on this subject and the possibility that the Israeli economy will suffer from Dutch disease, see the BOI Annual Report 2010, Box 7.1.

significantly. These factors, and a drastic 2 percentage point interest rate cut by the BOI in early 2002, led to the depreciation of both the NEER and REER.

Even when these circumstances changed, however, as the *intifada* petered out and the economy started to recover rapidly from mid-2003, and the current account moved into surplus starting in 2003 after deficits since the state was established in 1948,<sup>11</sup> the depreciation trend continued in 2004 and 2005. Depreciation during the first stages of the expansionary phase of the cycle, when the output gap is still large, may occur in the case of capital market imperfections.<sup>12</sup> In addition, the liberalisation process that took place at that time created exogenous pressure for capital outflows, as the ceiling on foreign assets as a share of total portfolios of institutional investors was raised, and the tax discrimination against investing abroad was cancelled. These changes resulted in rapid portfolio adjustments that were probably the principal catalyst behind the depreciation in those years.

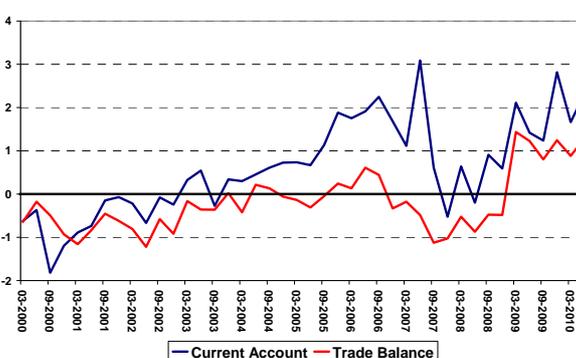
Figure 1  
REER and NEER index  
Q1 2000 = 1



An increase indicates an appreciation.

Sources: IMF; Bank of Israel.

Figure 2  
Current account and trade balance  
2000–10  
(Quarterly, SA, US\$ billions)



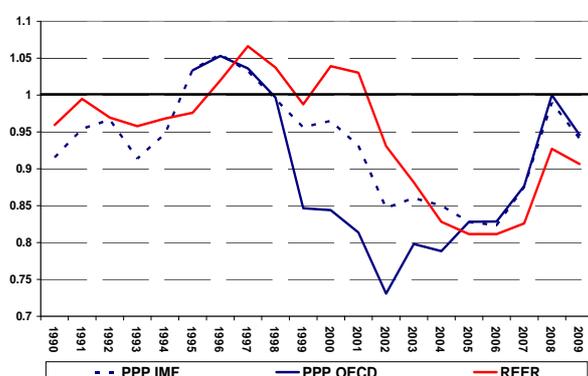
Source: CBS.

An alternative measure for the RER is the PPP index. While the REER is based on nominal exchange rates corrected for inflation differences, the (deviation from) PPP is more related to the relative price of non-tradable goods. One of the advantages of the PPP measure is comparability: it allows cross-country analyses of the levels, rather than just analysing changes in the RER, as is the case when using the REER. Figure 3 below compares the REER to the PPP indices from two different sources. Generally, the trends of the different measures of the RER coincided in the last two decades. The deviations from PPP indicate that on average prices in Israel are lower than in the US. However, in 1995–97 prices were higher than in the US, and in 2008 prices reached the US level.

<sup>11</sup> In 1985 the dramatic fiscal consolidation programme (the Economic Stabilization Plan) and foreign aid from the US resulted in a temporary current account surplus.

<sup>12</sup> Friedman and Liviatan (2009).

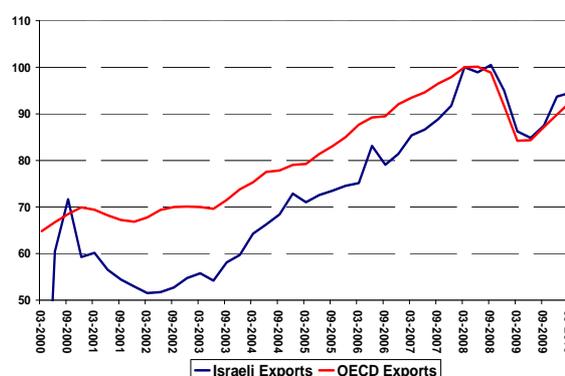
Figure 3  
REER and PPP indices  
1990–2009



An increase indicates an appreciation.

Sources: IMF; OECD.

Figure 4  
Israeli exports vs OECD exports  
Volume, Q1 2008 = 100



Sources: IMF; OECD; CBS.

After the outbreak of the Great Recession, world trade collapsed by 15%, and Israeli exports dipped accordingly (Figure 4). Although exports plunged, the effects of the recession on the Israeli economy were mild relative to the effects on other developed economies. The decrease in the volume of exports was matched by a decrease in imports of the same order of magnitude, and the terms of trade improved, so that the current account surplus returned to its pre-crisis level in less than a year (Figure 2).

### 3. The equilibrium real exchange rate

Our direct empirical approach for estimating the equilibrium RER is to relate it to a number of economic fundamentals that affect its behaviour. The rationale for this approach is derived from the uncovered interest parity (UIP) in real terms:

$$E_t(q_{t+1}) - q_t + \rho_t = r_t - r_t^*,$$

where  $q$  denotes the natural logarithm of the RER,  $r$  denotes the real interest rate in the home country,  $r^*$  denotes the real interest rate level abroad, and  $\rho$  denotes the country risk premium. Thus, the level of the RER at time  $t$  is a function of the interest rate differential, risk premium and the expected level of the RER at time  $t+1$ . The methodology is based on the assumption that this expected level,  $E_t(q_{t+1})$ , can be related to a set of economic fundamentals at time  $t$ ,<sup>13</sup> while the interest rate differentials are assumed to be transitory and therefore the empirical assessments of the EREER do not take them into account.

In the next sections the actual RER is related to a set of economic fundamentals. The fitted values are interpreted as equilibrium values: this interpretation is based on the assumption that on average, over long sample periods, the RER is aligned. The fact that the average current account balance in Israel between 1995 and 2010 is close to zero provides support for this assumption.

<sup>13</sup> This approach follows Frankel and Rose (1995), Driver and Westaway (2004) and Lee et al (2008).

### 3.1 Assessments based on panel data

We start by relating the PPP index to per capita GDP.<sup>14</sup> The relation between price levels or the RER and per capita income is well known in the literature. Theoretically this correlation holds both in cross sections and over time, which may be the result of a Balassa-Samuelson effect, although there are other possible reasons for this relation. Moreover, this correlation seems to be higher in countries with a floating exchange rate regime.<sup>15</sup>

In Figure 5 and Figure 6 below, the PPP index is plotted against the level of per capita GDP. The fact that the level of the PPP is below the logarithmic regression line in 2006 implies that the RER was undervalued, by 7.5%. In 2009, after appreciating considerably, mainly versus the US dollar, the RER is still slightly undervalued, by 2%. The reason is that the RER appreciation versus the US dollar is common to other countries, so the regression line shifted upwards.

Figure 5

PPP and per capita GDP, 2006

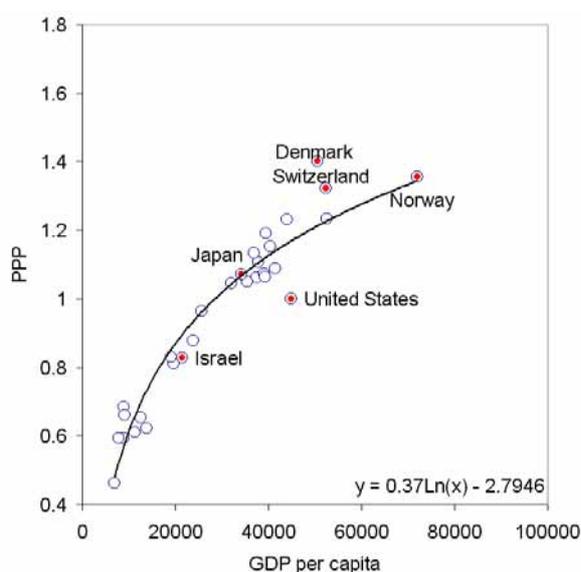
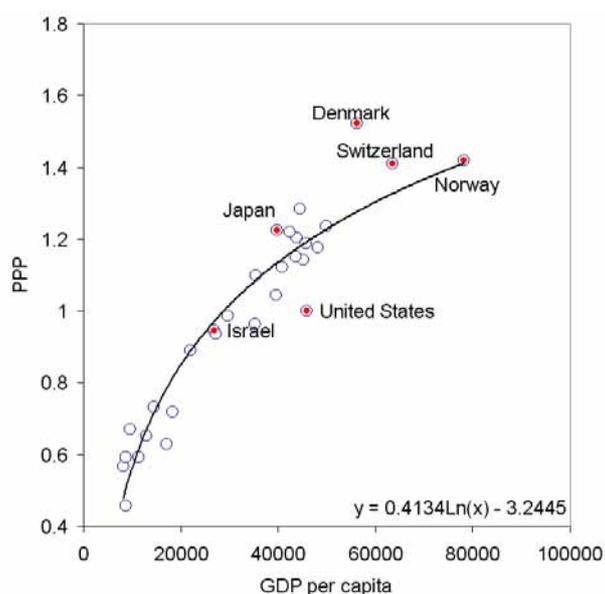


Figure 6

PPP and per capita GDP, 2009



OECD countries excluding Iceland and Luxembourg, and including Estonia and the Russian Federation.

Sources: OECD; authors' calculations.

In order to take other factors into account, we estimate the relation between RER and per capita GDP using panel data, and control for other variables that may affect the RER.

We use the variables below:

<sup>14</sup> Eichengreen (2008), Berka and Devereux (2010). We use the OECD PPPs as in the second study.

<sup>15</sup> Berka and Devereux (2010).

- **Terms of trade:** An improvement in the external terms of trade has a positive income effect on the economy and therefore is expected to result in an RER appreciation.
- **Government consumption:** Government consumption is usually biased towards non-tradable goods and therefore may result in an RER appreciation.<sup>16</sup>
- **Dependency ratio:** An increase in the child and old-age dependency ratio may increase the relative demand for non-tradable goods.<sup>17</sup> In addition, the increase in child dependency tends to increase investment, reduce savings and accordingly increase the RER.<sup>18</sup>

The results of the panel regressions are reported in Table 1 below. The dependent variable is either an index of the REER (log), as in Lee et al (2008), or PPPs (log) from the OECD database, as in Berka and Devereux (2010). As the dependent variables and the explanatory variables are integrated of order one, these models represent long-run cointegrating vectors for the equilibrium RERs, so that the residuals are a measure of RER misalignment with respect to the equilibrium RER.<sup>19</sup>

The elasticity of the REER with respect to relative per capita GDP is about unitary and the elasticity of PPPs with respect to relative per capita GDP is above one – in both cases, much higher than in comparable studies. The disparity is generated because the estimation is based on advanced economies only, and on a relatively short sample from 1995 onwards, while the results when using a longer sample period (starting from 1980) are on a par with those reported in Berka and Devereux (2010). In addition, we note that the elasticity in cross sections is much lower, about 0.4, suggesting that the time dimension of the panel increased the estimate. The elasticity of the REER to the terms of trade or government consumption is somewhat lower than those reported in Aguirre and Calderón (2005) and Lee et al (2008). Other variables that were tested but eventually excluded are: (i) the net inflow of FDI: this “exogenous” inflow might be expected to put positive pressure on the RER; our results, however, imply that causality runs from the RER to FDI, ie undervalued countries attract FDI, as in Kosteletou and Liargovas (2000); (ii) net foreign assets (NFA): a higher level of NFA generates higher income flows and therefore allows for a higher RER level as these flows can finance a trade balance deficit (Lee et al (2008)); we found that the effect of this variable was insignificant or alternatively negligible (Aguirre and Calderón (2005)); (iii) government debt, which is a proxy for the country risk, was found to be significant; however, it is available only for a limited number of countries and was therefore excluded; and finally (iv) the oil position was found to be insignificant.

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<sup>16</sup> Lee et al. (2008).

<sup>17</sup> Braude (2000).

<sup>18</sup> Braude et al (2009).

<sup>19</sup> Although in some cases the integration level of the residuals is inconclusive as the sample period is relatively short, dynamic difference equations point to an error-correction process of about five years – in line with slow convergence usually found in the literature.

Table 1

**Real exchange rate and PPP regressions**

Dependent variables: REER and PPP in levels

|                               | Model 1         |                 | Model 2         |                 | Model 3         |                 | Model 4         |                 |
|-------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                               | PPP             | REER            | PPP             | REER            | PPP             | REER            | PPP             | REER            |
| Relative per capita GDP       | 1.32<br>(12.2)  | 0.98<br>(15.2)  | 1.12<br>(7.7)   | 0.76<br>(9.6)   | 1.56<br>(8.8)   | 1.09<br>(9.7)   | 1.58<br>(6.9)   | 0.95<br>(7.8)   |
| Terms of trade                |                 |                 | 0.30<br>(4.0)   | 0.27<br>(6.7)   | 0.34<br>(5.0)   | 0.30<br>(6.8)   | 0.63<br>(4.9)   | 0.47<br>(6.8)   |
| Government consumption        |                 |                 |                 |                 | 1.87<br>(2.1)   | 1.42<br>(2.6)   |                 |                 |
| Dependency ratio              |                 |                 |                 |                 |                 |                 | 2.91<br>(3.3)   | 1.14<br>(2.5)   |
| R <sup>2</sup> <sub>adj</sub> | 0.86            | 0.51            | 0.77            | 0.53            | 0.87            | 0.62            | 0.76            | 0.59            |
| D-W                           | 0.46            | 0.46            | 0.48            | 0.51            | 0.66            | 0.70            | 0.47            | 0.47            |
| Sections                      | 28              | 28              | 21              | 21              | 21              | 21              | 13              | 13              |
| Observations                  | 420             | 420             | 314             | 314             | 220             | 220             | 194             | 194             |
| URT *                         | -3.36<br>(0.00) | -0.95<br>(0.16) | -3.33<br>(0.00) | -1.15<br>(0.12) | -0.51<br>(0.3)  | -1.44<br>(0.07) | -2.07<br>(0.02) | -0.14<br>(0.44) |
| EC **                         | -0.26<br>(-8.1) | -0.27<br>(-8.2) | -0.27<br>(-7.2) | -0.29<br>(7.6)  | -0.31<br>(-6.1) | -0.33<br>(-5.9) | -0.27<br>(-6.0) | -0.27<br>(-5.7) |

\* Test for unit root in residuals. Im, Pesaran and Shin W-statistic. P-values in parentheses.

\*\* Error correction in a dynamic equation. Dependent variable: rate of change in RER/PPP.

Sample: 28 OECD countries excluding Iceland, Korea, Mexico, Slovenia and Turkey. Sample period: 1995–2009. PPPs are calculated by OECD. REER are indices chained to 1995. All regressions include fixed country effects. Relative per capita GDP is chained to 1995 PPPs. Dependency ratio is the sum of children up to age 15 plus persons age 65 and over, divided by the population between 15 and 65 years of age.

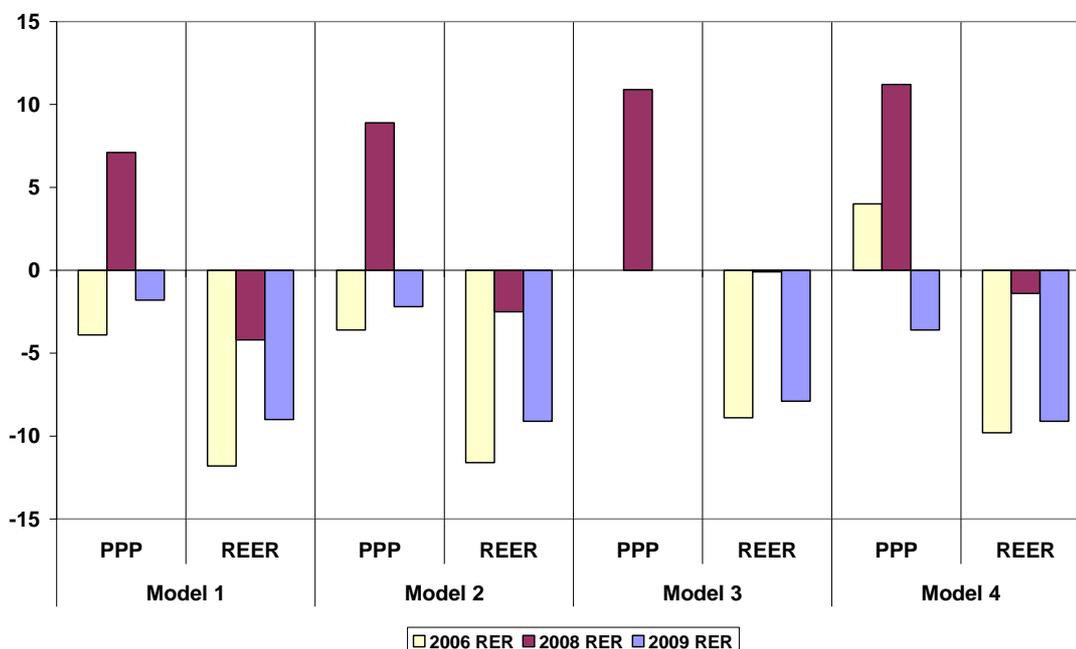
The RER assessments based on the panel regressions above are presented in Figure 7. When the REER was used as a measure for the RER, the conclusion is that the rapid appreciation in 2008 was eventually a movement towards equilibrium, after undervaluation of about 10% in 2006, when the current account surplus reached its peak. Thus, depreciation in 2009 represents undervaluation of the RER by about 5%.

Estimation based on PPPs, however, tells a different story: the appreciation in 2008 is interpreted as an overvaluation of 10% on average. Yet the RER in 2009 is undervalued by 2% on average. Thus, although the models yielded different conclusions with respect to the past, the assessments of 2009 were quite similar.

Figure 7

**Model-based RER misalignment, direct method**

(Positive figures indicate overvaluation)



**3.2 Assessment based on time-series data**

In order to provide high-frequency real-time estimates of the EREER, we use a cointegrating relation between the REER (log), relative per capita GDP (RGDP) and the terms of trade (ToT, log, HP-filtered). The equation is estimated using a long sample period, starting from 1980, in order to establish a cointegrating relation between the variables. Additional variables that were checked but excluded from the model were: net financial assets, public debt (both normalised by GDP), the Tel Aviv stock market premium relative to an international benchmark, and various capital flows, including both portfolio investment and FDI.

We find only RGDP and ToT to be robust; however, both elasticities increase over time. The elasticities in the shorter subsample starting from 1995 are doubled relative to the full sample, starting from 1980.<sup>20</sup> The elasticity with respect to RGDP in the long sample (0.7) is somewhat lower but still on a par with the results based on panel estimation, while the elasticity of the REER with respect to the ToT (1.0) is considerably higher than that in a panel of countries, and higher than estimated in the literature.<sup>21</sup> This may reflect the relatively high openness of the Israeli economy, which implies that the income effect of a change in ToT is larger than that in other countries.

The actual vs equilibrium RER and the RER misalignments based on this equation ( $\varepsilon_t$ ) are presented in Figure 8 below.

<sup>20</sup> This result also emerges in the panel regression in the previous section.

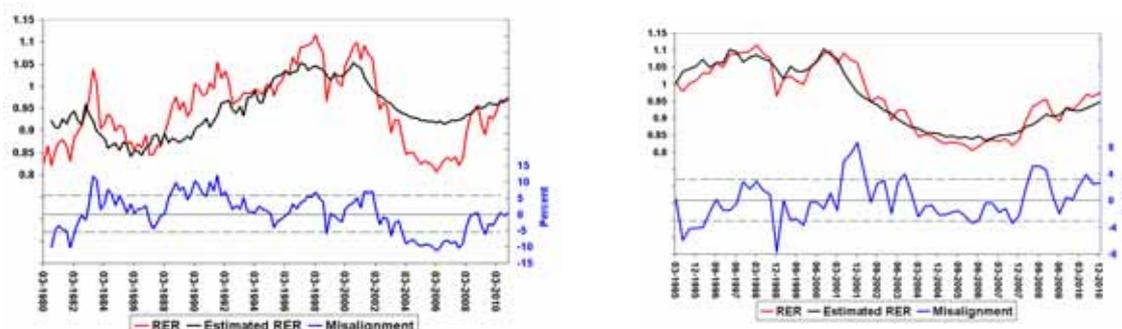
<sup>21</sup> In a related study, Sellin (2007) reports that the empirical elasticities of the “real” Swedish krona with respect to RGDP and ToT are 0.7 and 0.5 respectively.

Figure 8

**Actual vs equilibrium RER and RER misalignments, direct method**

Long sample: 1980–2010

Short sample: 1995–2010



$$\text{Log}(REER)_t = 0.71^* (\text{RGDP})_t + 1.04^* \text{log}(ToT)_t + \varepsilon_t$$

(4.7)                      (9.4)

$$R^2_{adj} = 0.48, \quad D.W. = 0.28, \quad ADF(\varepsilon) = -3.27$$

$$\text{Log}(REER)_t = 1.48^* (\text{RGDP})_t + 2.00^* \text{log}(ToT)_t + \varepsilon_t$$

(14.4)                      (19.7)

$$R^2_{adj} = 0.89, \quad D.W. = 0.81, \quad ADF(\varepsilon) = -3.88$$

The conclusions from the long-sample equation are similar to those from panel data assessments based on REERs: The RER was undervalued between 2004 and 2007 by more than 10%, and the rapid appreciation in 2008 can be interpreted as a return to the equilibrium level. According to the subsample, however, undervaluation in 2006 was considerably lower, so in early 2008 an overshooting of the real exchange rate resulted in overvaluation of about 5%. When estimating the model up to the first quarter of 2008 and conducting an out-of-sample forecast for two quarters ahead, the overvaluation is estimated at 8%. The depreciation in early 2009, which was apparently the result of the BOI’s foreign exchange purchase policy, worked against this overvaluation, and resulted in the reversion of the REER to its equilibrium level. Thus, this case demonstrates the importance of EREER assessment for policy purposes.

The EREER assessment for 2010, based on the subsample, points to a low, insignificant overvaluation of about 4% in late 2010.

#### 4. The fundamental equilibrium exchange rate (FEER)

An alternative, indirect assessment of the equilibrium RER is based on the analysis of the current account which estimates the FEER. According to this approach, the FEER is the RER which is consistent with external and internal balance of the economy, ie it is the RER that balances the current account while production factors are employed at normal capacity.<sup>22</sup> The FEER concept can be formalised as follows:

$$CA = X(RER, Y_{gap}^+) - M(RER, Y_{gap}^+)$$

The current account, abstracting from rent on production factors and unilateral transfers, is given by exports less imports, which are both affected by the RER in the usual way. In addition, imports increase in the domestic output gap,  $Y_{gap}$ , while exports increase in the

<sup>22</sup> A formal definition of the FEER concept was first introduced by Wren-Lewis (1992).

output gap in the rest of the world,  $Y_{gap}^*$ . Theoretically, the FEER is defined as the RER that results in a balanced current account given that both gaps equal zero.

In order to apply the FEER concept, however, one has to take into account that in the medium run an economy can run a persistent deficit or surplus with no tendency to converge towards zero.<sup>23</sup> Practically, this requires estimation of a fundamental current account for the medium run.<sup>24</sup> In addition, application of the FEER concept requires estimation of the elasticities of export and imports with respect to both the RER and the relevant output gaps – unobserved variables that are roughly assessed. Thus, although having a well defined, “clean”, theoretical background and definition, RER assessment based on the FEER concept requires vast knowledge of the structural characteristics of the economy. As the uncertainty around the assumptions on which the FEER is calculated is high, the results of the assessment are only indicative.

The fundamental current account in Israel was estimated using the Macroeconomic Balance approach.<sup>25</sup> The results indicate that several structural factors were behind the current account reversal in Israel in 2003. The fundamental current account in Israel in 2009 was estimated at between 1 and 2.5% of GDP,<sup>26</sup> while the actual current account surplus reached 4.0%; the fact that the actual current account was higher than the fundamental current account indicates that the RER was undervalued.

In order to quantify the RER undervaluation, we assumed that the elasticity of exports with respect to the RER is between  $-0.2$  and  $-0.3$ , and that the elasticity of imports with respect to the RER is between  $0.4$  and  $1.2$ .<sup>27</sup> These elasticities suggest that the RER was undervalued by 5 to 15% in 2009. When taking into account the fact that the output gap in Israel was lower than in its trading partners, the undervaluation in 2009 is even higher.

## 5. Concluding remarks

In this paper we briefly present some of the analytical tools that were used by the BOI in order to assess the equilibrium RER. These assessments enhance our ability to distinguish whether the RER trends could be attributed to fundamental, long-run factors, or to fluctuations that may be the result of short-run forces such as capital flows, price rigidities and others.

The RER fluctuated considerably during the last decade; between 2000 and 2006 it depreciated by about 30%, and since then has appreciated by about 20% to date. The conclusions from our assessments lend credence to the hypothesis that the RER was undervalued in the mid-2000s, a result which is in line with the unprecedented current account surplus in those years. Thus, the rapid appreciation in 2008 is explained, at least partially, as a reversion towards equilibrium. In early 2008, however, there is (and was in real

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<sup>23</sup> Obstfeld and Rogoff (1996).

<sup>24</sup> Lee et al (2008).

<sup>25</sup> Lee et al (2008).

<sup>26</sup> Bank of Israel Annual Report (2009).

<sup>27</sup> The low elasticities of both exports and imports are based on Friedman and Lavi (2007) long-run elasticities. Note that the sum of the coefficients in absolute value is lower than 1, thus violating the Marshall-Lerner condition. An RER depreciation, however, results in a current account increase because Israeli exports are usually priced in foreign currency, thus leaving only limited room for a negative value effect. The high elasticities of both exports and imports are based on Tokarick (2010) long-run elasticities.

time) evidence of overvaluation; at that time the BOI started to purchase foreign currency, a policy that probably contributed to the realignment and even to the undervaluation of the RER in 2009, and supported the export sector at a critical point in time as world trade collapsed in the fourth quarter of 2008. The slow appreciation trend in 2010 is in line with fundamental factors, so the RER is close to its equilibrium level, and was even slightly overvalued at the end of 2010.

Indirect ERER assessment, however, still indicates that the real exchange rate is undervalued, as a relatively large current account surplus was recorded in 2010.

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