CENTRAL BANK OF MALTA

A STUDY OF THE EQUILIBRIUM REAL EXCHANGE RATE OF THE MALTESE LIRA

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Introduction

This study provides the theoretical background and empirical investigation that are essential for the estimation of the equilibrium real exchange rate (ERER) for the Maltese lira.

The real exchange rate is the nominal exchange rate adjusted for domestic and international price levels while the ERER is the rate to which the real exchange rate tends over the medium to long term. Although not known directly, the ERER can be estimated under a number of assumptions. Some of these assumptions refer to the circumstances that need to prevail for the equilibrium to occur, others to the relation between the real exchange rate and economic fundamentals. In this study it is the equilibrium over the medium run that was of interest, since in the long run real adjustment is probably inevitable, even in the absence of corrective policy. The estimation of the ERER signals possible exchange rate misalignment and is therefore an essential input into the identification of the appropriate level of the Maltese lira exchange rate.

The study is divided into six chapters. Chapter 1 surveys the literature and presents well known approaches to ERER determination. Chapters 2 - 5 then report the results obtained by applying the Maltese data to a number of these approaches. These are the Purchasing Power Parity and the Behavioural Equilibrium Exchange Rate approaches. An extension of these approaches was also undertaken, inspired by a study authored by Maeso-Fernandez *et al* (2004). Following the introduction of a new price deflator, the Central Bank of Malta updated its estimates of the ERER by applying the newly available Harmonised Index of Consumer Prices to two of the methods used in the original study. The updated results are presented in Chapter 6. All relevant findings are being published in this merged document. It should be noted that this research project involved independently conducted studies undertaken between 2003 and 2005 by the Bank's Research Office with external technical support and advice. Consequently the Bank wishes to acknowledge the contribution of P Caselli, Director of the Research Department at the Banca d'Italia and L Schembri, Research Director, International Department, Bank of Canada. It also wishes to highlight the input provided by B Gauci, Emeritus Professor of Business and Economics at Hollins University, Virginia, and A Markowski, Head of International and Financial Analysis, National Institute of Economic Research, Stockholm. Finally, the Bank wishes to thank C Osbat and A Dieppe from the Directorate General Economics of the European Central Bank and B Egert of the Austrian National Bank for reviewing the study and providing valuable comments.

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PART ONE: SURVEY OF THE LITERATURE

Chapter 1: Survey of the major theories

1.1 Definitions

The real exchange rate is defined as the relationship between the representative foreign product and the representative domestic product. Countries with compatible price index measurements estimate their national price levels by calculating the value of a comparable bundle of products in each of the national currencies. Let P stand for the domestic price level (the price of the representative domestic product) and P^* for the foreign price level (the price of the representative foreign product). S is the nominal exchange rate, the number of units of the home money that trade for one unit of foreign currency.[1]

The real exchange rate is then defined as:

$$r = \frac{S.P^*}{P}$$

On the right hand side of this identity, the numerator is the foreign price level converted into the home currency at exchange rate S. The denominator is the home price, already measured in the home currency. The real exchange rate, r, compares the purchasing power of the home currency in the foreign and home markets. Analogously to S, an appreciation or strengthening of the real exchange rate for the country under scrutiny is equivalent to a decline in r.[2]

Most investigations of the equilibrium exchange rate focus on the real rather than the nominal exchange rate, because of the presumption of eventual neutrality of monetary changes. Fundamental or real factors determine the rate of exchange between the representative domestic product and the representative foreign product, i.e. the real exchange rate.[3]

The studies surveyed in this chapter focus on the medium term and the long term. The medium term is long enough for the elimination of nominal rigidities and cyclical influences. The focus on medium-term results implies that monetary policy and its consequences can be ignored. The long run is consistent with portfolio equilibrium.

What follows is an overview of the major methods used to calculate the ERER, followed by a detailed look at two specific methods: the purchasing power approach and the behavioural equilibrium exchange rate approach.

1.2 Overview

In this section, the prevailing theories of ERER determination are presented in order of complexity: first purchasing power parity, then a behavioural explanation and finally an explanation that focuses on fundamentals.

As already mentioned, the real exchange rate is the rate of exchange between the representative foreign product and the representative domestic product. The real exchange rate is, therefore, dependent on the relative supply of, and demand for foreign and domestic products. For example, an increase in the worldwide demand for domestic products will raise the purchasing power of the local currency in the foreign market, compared to the local market. It will thus strengthen the real exchange rate.

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1 Nominal exchange rate appreciation, as commonly understood, is equivalent to a reduction in S, or a reduction in the number of units of the home currency per unit of the foreign currency.

2 The overvaluation of a currency occurs when $r < r_e$, where the latter represents the ERER.

3 The assumption of neutrality means that the long-run exchange rate varies homogeneously with monetary variables, and non-homogeneously with real variables.

Inspired by the effectiveness of competitive pressures and profit-seeking arbitrage, proponents of **Purchasing Power Parity (PPP)** predict a real exchange rate of one. They predict that the nominal rate of exchange between the two national currencies is equal to the ratio of the two national price levels. In that manner, the common bundle of products contained in the national price indices will sell for the same price in the two countries, and the law of one price obtains.

More intricate versions of PPP allow a deviation of *r* from one. Various authors recognise that limitations on arbitrage and differences in price measurement methods mitigate the effectiveness of the law of one price and cause a permanent but stable deviation in PPP from unity.

One approach searches the recent past for a period during which the economy showed signs of internal and external equilibrium, and then labels the average real exchange rate during that period as the equilibrium level.

However, the evidence suggests that deviations from PPP are substantial and take a very long time to correct themselves. A commonly held belief is that at best PPP holds only over very long stretches of time. Such reservations have spawned a number of alternative explanations of the determinants of the ERER, introducing such variables as the terms of trade, interest rate differentials and the fiscal deficit. There may also be an influence in the reverse direction, from the real exchange rate back to these variables.

A recently popular theory involves the **Behavioural Equilibrium Exchange Rate (BEER)**, described in more detail in two separate sections below. Starting from theoretical foundations, proponents of BEER search for the variables that have influenced the real exchange rate in the past. The current equilibrium rate is then estimated by plugging current values of the explanatory variables into the estimated relationship.

BEER's theoretical foundation starts off from the PPP, which BEER proponents modify in recognition of the rigidities that reduce the applicability of PPP. This theoretical pedigree dates back to Rogoff [4], who starts from PPP and then introduces three modifications: the Balassa-Samuelson (BS) hypothesis, accumulated current account deficits and government spending. MacDonald and Ricci go a step further by elevating one of these modifications - the BS hypothesis - to the status of an overarching explanation of BEER deviations from PPP. They anchor the BEER theory to its neoclassical foundation via the BS distinction between tradable and non-tradable products:

> The rationale for most variables is based on a simple neo-classical theoretical framework that assumes that prices of tradable products are equalised across countries and investigates how changes in the real exchange rate arise mainly from relative movements in the prices of non-tradable products across countries. Relaxation of the assumption of price equalisation [for tradables] should provide richer insights into the transmission mechanisms … but leads to broadly similar conclusions…. In either case, the chosen variables explain why the real exchange rate can be expected to vary over time and provide a rationale for deviations from PPP.[5]

In this vein, these authors' rationale for the inclusion of each key explanatory variable centres on the distinction between tradable and non-tradable products. Deviations from purchasing power parity that make BEER consistent with neoclassical doctrine involve such variables as the terms of trade, the ratio of non-tradable to tradable product prices and the volume of net foreign assets.

A third approach is known as the **Fundamental Equilibrium Exchange Rate (FEER)**. This equilibrium exchange rate is compatible with the medium-term values of the fundamental

[4] Rogoff (1996), page 658 ff.
[5] MacDonald and Ricci (2003), pages 3 - 4.

variables. The medium run is defined as one that averages over economic cycles, where variables manifest the values that would occur in the absence of cyclical influences.

From a FEER perspective, macroeconomic balance has two dimensions: the internal and the external. Internal equilibrium is compatible with the non-accelerating inflation rate of unemployment (NAIRU) and a low and stable inflation rate. External balance is associated with the "sustainable desired flow of resources between countries when they are in internal balance." [6]

> Because this approach aims at calculating exchange rates for a particular set of economic conditions, it abstracts from short-run cyclical conditions and temporary factors and focuses on "economic fundamentals", which are identified as those conditions or variables that are likely to persist over the medium term. These conditions are not necessarily projected to occur in the future, but rather are desirable outcomes that may in fact never be realised. In this sense, the FEER exchange rate measure is a normative one, and indeed Williamson has characterised the FEER as the equilibrium exchange rate that would be consistent with "ideal economic conditions".[7]

Barisone *et al* (2002) list the various types of FEER applications. One is the complete macroeconomic model, about whose strengths and weaknesses Barisone *et al* note:

> On the one hand, the estimated FEER will reflect a complete set of endogenous feedbacks. On the other, estimating a complete model from scratch is quite costly, while adapting an existing model may lead to problems in interpretation.[8]

Since the majority of the available structural models are not limited to the medium run, the use of such models introduces interpretation difficulties in disentangling various runs.[9]

Another is the use of the reduced form method, where the real exchange rate is regressed directly on the relevant explanatory variables, usually in a single equation format. This method shares the advantages and disadvantages of the reduced form method, as noted by Barisone *et al*.[10]

The third and most commonly used approach is the partial equilibrium method, where only part of the full macroeconomic system is estimated, with the remainder being included exogenously. Barisone *et al* note the "advantage that only part of the macroconomy needs to be estimated – the net trade function …" and the "disadvantage … that inconsistencies may arise between off-model assumptions and the solution for the real exchange rate."[11] This approach does not allow for any feedback from the real exchange rate to the current account and output.

1.3 PPP: an elaboration

The Purchasing Power Parity (PPP) doctrine suggests that national price levels should be identical, once translated into a common currency. If arbitrage brings the law of one price into effect across a wide enough range of microeconomic product markets, the law of one price will be reflected in macroeconomic price measurements.[12]

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6 Clark and MacDonald (1998) page 6.
7 Clark and MacDonald (1998) page 6.
8 Barisone *et al* (2000), page 4.
9 Wren-Lewis (2003), page 16, para 3.6.
10 Barisone *et al* (2000), page 4.
11 Barisone *et al* (2000), pages 4 - 5.
12 Wren-Lewis (2003) points out that given enough time there may be various forms of market adjustments that bring about PPP:
Consider a depreciation in the nominal "home" exchange rate generated by capital account outflows. The depreciation will make the price of the home produced goods cheaper, generating a current account surplus to offset the capital account outflows. However, the depreciation also reduces the relative price of home labour relative to overseas labour. Multinational companies will be tempted to relocate production in the home economy … . PPP may be more appropriate to a long-run rather than a medium-term equilibrium. (Pages 8, 9)

Traditionally, this was investigated through a test of the following logarithmic relationship:

$$S_t = \alpha + \beta P_t + \beta^* P^*_t + u_t$$

where S is the nominal exchange rate, P is the domestic price level and P^* is the foreign price level. Evidence that $\beta = 1$ and $\beta^* = -1$ provides support for the absolute version of PPP.[13]

The relative version of PPP uses rates of change in place of levels, and requires changes in the nominal exchange rate to offset the differences between the rates of domestic and foreign inflation. Evidence of the stationarity of the real exchange rate is supportive of the PPP, as is evidence of co-integration of the nominal exchange rate and the relative price level.

Empirical investigation points to purchasing power parity in the very long run, as deviations from PPP take a very long time to correct themselves. PPP theory requires real exchange rates to revert to a constant mean, but the evidence suggests that such reversion is a very slow process, such that prolonged deviations from PPP result. As Wren-Lewis[14] points out, if the real exchange rate is stationary, it may still take a long time for such stationarity to materialise. This reduces the relevance of PPP for a study with a focus on the medium term.

According to Taylor's 1995 survey:

> Earlier cointegration studies generally reported a failure of significant mean reversion of the exchange rate towards purchasing power parity for the recent floating experience …, but were supportive of reversion toward purchasing power parity for the interwar float …, for the 1950s U.S.-Canadian float …, and for the exchange rates of high-inflation countries …. Very recent applied work on long-run purchasing power parity among the major industrialized countries has, however, been more favourable toward the long-run purchasing power parity hypothesis for the recent float …. A number of authors have argued that the data period for the recent float alone may simply be too short to provide any reasonable degree of test power in the normal statistical tests for stationarity of the real exchange rate. [15]

A recent summary of empirical findings published in the ECB *Monthly Bulletin* reports that:

> According to empirical studies, which take either a very long-term perspective by employing correspondingly long data series or use a panel data approach, the adjustment process is typically found to have a half-life of three to six years. This implies that following a shock, which drives the exchange rate away from its long-run PPP value, about half a decade is required for the exchange rate to revert half way back to this level. While some of these fluctuations could be attributed to transactions costs impeding arbitrage transactions in goods markets, the observed medium-term swings in the exchange rate are generally too large to be accounted for by these factors alone. In addition, some currencies, like the Japanese yen, for instance, exhibit a clear trend in their real effective exchange rate, requiring some additional explanation.[16]

Sarno and Taylor note:

> Interestingly, stronger evidence supporting PPP is found when the WPI [wholesale price index], rather than the CPI [consumer price index], is used and, even more so, than when the GDP deflator is used. This is easy to explain since the WPI contains a relatively smaller non-tradable component and represents, therefore, a better approximation required by the PPP hypothesis than either the CPI or the GDP deflator.[17]

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13 Taylor (1995), page 19.
14 Wren-Lewis (2003), page 9.
15 Taylor (1995), page 20.
16 ECB *Monthly Bulletin* (2002), page 44.
17 Sarno and Taylor (2002), page 62.

In general, difficulty in attaining PPP can be attributed to:

Nominal inertia. P and P^* may be rigid. However, Rogoff disagrees.[18]

Non-tradable products. Arbitrage is less likely in the case of non-tradable products. For example, importation of a service may be impossible without the migration of the factor producing the service. This consideration may contaminate even studies that restrict themselves to tradable items since these too may have non-tradable components. For example, the prices paid by consumers for imports include significant costs of distribution services, which are themselves not tradable.

More broadly, there is the *Balassa-Samuelson* (BS) theory concerning the effect of inter-sectoral differences in productivity growth. According to this theory, there is likely to be faster productivity growth in the tradable-products sector compared with the non-tradable-products sector, because of a presumed lack of foreign competition in the latter.

Next, consider two countries, the first of which has faster productivity growth in its tradable-products sector. Arbitrage equalises the prices of tradable products across countries; wage growth in that sector is accommodated by productivity growth. On the other hand, the prices of non-tradable products will be higher in the first country. The reason is that its tradable-products sector will pay its resources a higher return to match their higher productivity. In turn, in bidding resources away from the tradable products sector, the non-tradable products sector will have to pay higher wage and other costs, which will then be passed on in the form of higher prices, making up for the lack of productivity growth. Therefore the national price level in the faster growing country will be higher than what would be predicted by PPP. [19]

Since national price indices include both types of products, PPP will not be observed in these indices.[20] National price indices that include non-tradable products will rise faster in countries with faster productivity growth. The BS effect associates higher productivity with an appreciation in the real exchange rate.[21]

Imperfect substitutability between similar products across different monetary areas leaves sellers with some measure of monopoly power. Even in the presence of competitive pressures, price differences between the products of price makers are likely to persist.

The *absence of production* of an item in a particular country reduces competitive pressure by the home product on the foreign product. However, at least in principle, this should not be seen as an impediment to the application of the law of one price, but rather as the manifestation of

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[18] Rogoff writes:

> The failure of short-run PPP can be attributed to stickiness in nominal prices; as financial and monetary shocks buffet the nominal exchange rate, the real exchange rate also changes in the short run. This is the essence of Dornbush's … overshooting model of nominal and real exchange rate volatility. If this were the entire story, however, one would expect substantial convergence to PPP over one to two years, as wages and prices adjust to a shock. As we shall see, the evidence suggests this is not the case. Rogoff (1996), page 654.

[19] There may be also technological or other practical difficulties in raising capital intensity in most non-tradable services.

[20] An alternative explanation goes as follows: for non-tradable product prices to rise relative to those of tradable products, one mechanism would be a lower domestic-currency price for tradable products, and for a country that is a price taker in tradable products, this would be achieved through exchange rate appreciation.

[21] Consider the identity presented at the start of this chapter, $r = \frac{S.P^*}{P}$.

Let price parity apply, but only in tradable products, and let the terms P_T and P_T^* refer to the prices of tradable products only. Then arbitrage would ensure that the nominal exchange rate, S, will equal P_T/P_T^*, such that $r = 1$. In the case where the home country is the one with the higher productivity level, and therefore the one with the higher relative price level, $P_T^*/P_T > P^*/P$. (P^* and P are the comprehensive price levels that include also non-tradable products.) For the same S, $r < 1$ for the home country, which will therefore have an appreciating exchange rate.

the application of the law. Consider the alternative. If a product remains in production in a higher-cost location, it would signal the absence of competitive pressures and arbitrage.

Legal *barriers to trade* include both tariff and non-tariff barriers.

Transport costs imply that price differences between countries in the amount of such costs will not be arbitraged away. A rough estimate of the importance of transport costs is obtained from a comparison of world exports, which are measured on an FOB basis that excludes transport costs, and world imports, measured on a CIF basis that includes transport costs (as well as insurance costs). The resulting estimate is around 10 per cent of value, with considerable variation between countries.

Comparing international with intra-national variation in prices, various studies have estimated the influence of an international border across which products are transported. There is evidence that this border effect boosts not just the volatility of price differences but also their persistence.[22]

The *index number problem*. A country's product mix may differ from another country's. This leads to different weightings in the price index (including possibly a zero weight for a particular product in only one country). This would be less of a problem if the indices are geometric in nature. In practice, most indices are arithmetic. Thus the problem becomes more serious the more disparate the rates of price change between products.[23]

For the empirical examination of the PPP, the available international statistics are limited. Rogoff provides this evaluation:

> Unfortunately, available absolute PPP measures such as the ICP [International Comparison Programme] data set still have a number of limitations that make it impossible for them to fully supplant standard government indices in empirical and policy research. The main problem is that ICP data are gathered infrequently … and country coverage is limited. …. For non-benchmark years and countries, data is filled in largely by extrapolation.[24]

Sarno and Taylor point out:

> The most influential work in this context has been carried out by Summers and Heston[25,] who developed the International Comparison Program (ICP) data set, which reports estimates of PPP for a long sample period and a number of countries, using a common basket of goods across countries. The ICP is not, however, of great practical help in empirical work since it is constructed at large time intervals and, for certain time periods, data are available only for a few countries. Moreover, since extensive use of extrapolation has been made in order to solve this problem, the data presented in the ICP become partially artificial, somewhat losing reliability.[26]

In a restricted application of the ICP data, only the data subset that is collected directly is used, but not that generated by extrapolation.

In summary, a list of reasons for not using PPP in the search for a medium-term equilibrium exchange rate includes:

- a priori reservations about the applicability of the law of one price;

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22 Sarno and Taylor (2002), page 55.
23 Sarno and Taylor (2002), pages 53 - 54.
24 Rogoff (1996), pages 651 - 652.
25 Summers and Heston (1991).
26 Sarno and Taylor (2002), page 54.

- the unevenness of empirical support for PPP, and its apparent inapplicability in conditions other than very long periods of time; and
- the substantial data limitations.

Still, several studies have used the PPP in the search for the ERER. Since the law of one price is even less likely to apply to the markets in non-tradable products, one can make the case for excluding them from the national price indices used in the PPP exercise. In the absence of national price indices that directly exclude non-tradable products, a correction for the BS effect using regression techniques permits the use of a PPP approach to search for the equilibrium exchange rate.

Coudert and Couharde use cross-sectional data on 168 countries in 2000 to measure the BS effect on the relative price level.[27] National price levels (relative to the euro-area price level) are regressed on per capita GDP (relative to per capita GDP in the euro area). They report the following result:

$$\log (\boldsymbol{P}_j / P_{\text{euro area}}) = 0.2448 \log (Y_j / Y_{\text{euro area}}) + 2.9919 \qquad (1.1)$$

where $\boldsymbol{P}_j / P_{\text{euro area}}$ is the price level of country j compared with the euro area's and $Y_j / Y_{\text{euro area}}$ is the relative per-capita GDP.[28]

The method is borrowed from Rogoff, who reports similar findings in a study that used the U.S. rather than the euro area as the benchmark. [29]

$$\log (\boldsymbol{P}_j / P_{\text{US}}) = 0.366 \log (Y_j / Y_{\text{US}}) + 0.035. \qquad (1.2)$$

where $\boldsymbol{P}_j / P_{\text{US}}$ is the price level of country j compared with the US's and Y_j / Y_{US} is the relative per-capita GDP.

With GDP on the horizontal axis and the price level on the vertical, points on the fitted regression line indicate the PPP-compatible price level for the corresponding level of GDP, allowing for the BS effect. Since the dependent variable is $1/r$, where r is the real exchange rate as defined on page 1, the equations postulate that differences between bilateral ERERs are due to differences in development levels and productivity. As expected, the estimate of the slope is positive, since a higher stage of economic development and higher productivity lead to a higher price level. Section 3.4 below discusses explanations for the measured value of the intercept.

Once the parameters are estimated, the extent of exchange rate deviation from the ERER for country j is given by the corresponding residual from the regression. A relative price level which is higher than the estimate generated by the right hand side of Equations 1.1 or 1.2 indicates a real overvaluation of the currency of country j with respect to the currency of the benchmarked country or currency area, while the opposite indicates an under-valuation.

1.4 BEER: Theoretical elaboration

Despite the theoretical roots described in Section 1.2 above, the Behavioural Equilibrium Exchange Rate (BEER) approach is sometimes viewed as a theoretic, devoid of a clear paradigmatic anchor and having only a limited framework of shared theoretical content. Still, various explanatory variables are common to many BEER studies.

The theoretical innovation in BEER is its search for an equilibrium exchange rate that varies with changing values of the explanatory variables, without necessarily setting them at their equilibrium levels, unlike the FEER approach. To search for evidence of the equilibrium relationships, most BEER studies use cointegration techniques.

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[27] Coudert and Couharde (2002), page 17. See also Coudert and Couharde (2003).

[28] $\boldsymbol{P}_j$ is the price level of country j, converted into the currency of the benchmark area or country.

[29] Rogoff (1996), page 660.

BEER studies have gained widespread acceptance and have gained wider currency than FEER, even if some misgivings about BEER are expressed in the literature. For example, the ECB *Monthly Bulletin* suggests:

> Apart from the lack of consensus on the appropriate concept of the 'equilibrium exchange rate', even models belonging to the same category often send conflicting signals, not only with respect to the magnitude, but also with regard to the direction of the perceived divergence from equilibrium.[30]

Stein, too, expresses misgivings. Selecting six studies, he reports their findings on the equilibrium euro-deutschemark rate and finds their results "contradictory and often puzzling".[31]

Flagship BEER studies include Clark and MacDonald's.[32] In a specification that is mirrored in several other BEER studies, the determination of the long-run ERER is represented as follows:

$$r_e = \text{f}(TOT, TNT, NFA)$$

The real long-run equilibrium exchange rate, r_e, is dependent on the relative terms of trade, *TOT*, the relative ratio of the prices of tradable products to those of non-tradable products, *TNT*, and net foreign assets expressed as a percentage of the GDP, *NFA.*

In the uncovered interest parity relationship, E is the expectations operator, *S* is the nominal exchange rate, *i* is the nominal interest rate and the asterisk stands for the corresponding foreign variable. $\boldsymbol{\pi}$ represents the risk premium.

$$\text{E}(\Delta S_{t+k}) = (i - i^*) + \pi$$

Subtracting, from both sides, the difference between the home and foreign inflation rates, one gets:

$$\text{E}(r_{t+k}) - r_t = (i_R - i_R^*) + \pi,$$

where *r* is the real exchange rate, and i_R is the real interest rate. Since

$\text{E}(r_{t+k}) = r_e$ or the long run equilibrium rate,

$r_t = r_e - (i_R - i_R^*) - \pi.$

The time-varying part of $\boldsymbol{\pi}$ is a function of the ratio of domestic and foreign public debt, relative to nominal GDPs, $gdebt / gdebt^*$.

The preceding relationships generate this general equation:

$$\text{BEER} = \text{f}(i_R - i_R^*, gdebt/gdebt^*, TOT, TNT, NFA).$$

Clark and MacDonald define the *current* misalignment as "the difference between the actual real exchange rate and the real exchange rate estimated from the current values of the fundamentals." On the other hand, the *total* misalignment is the difference between the actual

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30 ECB *Monthly Bulletin* (2002), page 52.

31 On net foreign assets, Stein (2002), notes:

> [It] is included as a variable in five of the six studies … In three studies, it is not significant, in one study it depreciates the real exchange rate and in only one study does it appreciate the real exchange rate. Moreover, Maeso-Fernandez, Osbat and Schnatz found that the net foreign assets variable was weakly exogenous. These results are not consistent with basic economic theory. (Pages 355, 356)

32 Clark and MacDonald (1998, 2000).

real exchange rate and the real exchange rate that would prevail if the economic fundamentals were at their long run or sustainable levels.[33]

As a result, Clark and MacDonald note that the BEER is broader in scope than the FEER:

> … in the BEER approach the total exchange rate misalignment at any point can be decomposed into the effect of transitory factors, random disturbances, and the extent to which the economic fundamentals are away from their sustainable values. Whereas the FEER is a medium to long-run concept, the BEER is more general in that it can in principle be used to explain cyclical movements in the real exchange rate.[34]

On the proper comparison between the two methods, Clark and MacDonald write:

> One key difference is that the FEER is the real exchange rate associated with an independently specified equilibrium capital account together with both domestic and foreign output set at potential, whereas the BEER is estimated using actual values of the fundamental determinants of the real exchange rate. A proper comparison [of BEER and FEER] would therefore involve calculating the BEER with these determinants set at their full-employment values. One interpretation of such a comparison could involve matching the potential output variable of the FEER with the calibrated values of the relative price variables ([*TOT* and *TNT*]) and the interest rate differential. Variation in the equilibrium capital account could be seen as captured by movements in the calibrated values of net foreign assets, relative government debt, and the interest differential.[35]

1.5 BEER: Elaboration of explanatory variables

This section introduces a range of explanatory variables referred to in the BEER literature.

1.5.1 Productivity indicators

In the BEER literature, the justification for using productivity measures to explain the real exchange rate is the BS doctrine, already discussed above.

Proxies for BS range from total and sectoral productivity measures to ratios of price indices. The ideal explanatory variable for capturing the BS effect measures the difference in productivity growth between the two sectors at home relative to abroad. However, an assumption that only the tradable-product sector enjoys productivity growth justifies the use of economy-wide productivity measures that do not distinguish between the two sectors.

The BS effect can be represented by the ratio of the CPI to the WPI (or producer price index), where the CPI includes tradable as well as non-tradable products, while the other includes mostly tradable products.[36] The ratio is related positively to the BS effect.

Maeso-Fernandez *et al* [37] compare two proxies - the relative price differential between tradable and non-tradable products at home and abroad and the total labour productivity differential - and

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[33] Clark and MacDonald (1998), page 10. In their application, Pattichis *et al* (2003) first plug in actual values of the explanatory variables in the BEER equation. They then estimate the equilibrium exchange rate using smoothed versions of the explanatory variables, obtained by means of the Hodrick-Prescott filter. (Page 20)

[34] Clark and MacDonald (1998), page 11.

[35] Clark and MacDonald (1998), page 17.

[36] Coughlin and Koedijk (1990) write, "Wholesale price indices generally pertain to baskets of goods that contain larger shares of tradable goods than consumer price indices do. Consumer price indices tend to contain relatively larger shares of non-tradable consumer services." (Page 40)
ECB *Monthly Bulletin* (2002) notes that the use of the relationship between consumer and producer prices suffers from the drawback "that changes in taxes – and in particular value added taxes – as well as the effects of domestic demand shocks on prices in non-tradable goods sectors may conceal the actual productivity information conveyed by this variable." (Page 45)
It should also be noted that the CPI is more likely to contain products with regulated prices than the PPI.

find them not to be equivalent. They note that with an increase in tradable-products productivity, both proxies change in the same direction, but if non-tradable-products productivity rises, the two proxies diverge. However, similarity is expected in the evolution of the two proxies as the catching-up process proceeds.

1.5.2 Net debt position or net foreign assets

Different international debt positions are associated with different ERERs. Greater net external indebtedness requires an improved trade balance to finance the additional debt-servicing costs, necessitating depreciation in the real exchange rate. Additionally, a rise in the risk premium results from a deterioration in the international investment position. For a given domestic interest rate, a higher risk premium is compatible with a weaker real exchange rate.

The distinction between tradable and non-tradable products introduces another causal channel.[38] Larger holdings of net foreign assets prompt an increase in domestic spending. While this has no effect on the prices of internationally arbitraged tradable products, it pushes up the prices of non-tradable products and strengthens the real exchange rate. [39]

Data on international investment positions are available only for a few countries and for only a short span of years. The difficulty in their compilation arises from valuation changes, i.e. the effects of fluctuations in exchange rates and interest rates. The accumulated current account position may serve as a proxy for net foreign assets or net debt position. The measurement of this proxy may not correctly account for valuation changes, reinvested earnings and so on. In the case of equity holdings in direct or portfolio investments, there is the additional difficulty in the valuation of unlisted holdings.

1.5.3 Terms of trade and commodity prices

Higher relative import prices are compatible with an exchange rate depreciation that preserves competitiveness.[40]

Assuming competition and arbitrage, the ratio of export to import prices is also the ratio of domestic tradable-product prices to foreign tradable-product prices. These two terms are important components of P and P^* in the definition of the real exchange rate. Therefore, if there is any rigidity in the nominal exchange rate, the link between the real exchange rate and the ratio of export to import prices is definitional.

Some writers use the relative price of oil as an explanatory variable.[41] The relationship with the real exchange rate depends on whether a country is an oil exporter or an oil importer, and in the case of the latter, the relationship varies with the dependence of the economy on oil imports. An increase in the price of imported oil or a country's greater dependence on imported oil is associated with a weaker real exchange rate.

Various authors explore other links between commodity prices and the exchange rate. Higher prices of exported commodities generate increases in wages and non-tradable product prices.[42] A similar mechanism works through the wealth effect of higher commodity prices and the resulting rise in the prices of non-tradable products.[43]

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37 Maeso-Fernandez *et* al (2001), pages 12 - 13.

38 MacDonald and Ricci (2003), page 6.

39 Pattichis *et al* (2003) found the net foreign asset variable to be statistically insignificant (page 19). Lane and Milesi-Ferretti (2000) found the influence of NFA to be stronger on the CPI based real exchange rate than on the WPI based counterpart (page 21).

40 Nillson (2002) uses export and import unit values for a number of countries in his BEER studies, and export and import prices for the rest (page 12).

41 Pattichis et al. (2003) deflate the price of oil by the wholesale price index (page 14). They found that a higher real oil price led to a depreciation of the real exchange rate for Cyprus, which is an oil importing country (page 19).

42 See Cashin *et al* (2002), quoted in MacDonald and Ricci (2003).

43 See Dias-Alejando (1982), quoted in MacDonald and Ricci (2003).

Measurement of the terms of trade is likely to be less accurate than that of commodity prices, whose measurement is more straightforward. This may result in relatively weaker empirical results relating to the terms of trade. Moreover, foreign exchange markets are more currently informed about commodity prices than on national terms of trade, so that these markets are more efficient in processing information on commodity prices than on the terms of trade. This increases the likelihood that commodity prices will be found to be more statistically relevant in empirical work.

1.5.4 Interest rate differential

Interest parity associates a higher interest rate with expected depreciation of the currency and, for a given expected exchange rate, a higher interest rate is compatible with a stronger current exchange rate.

Noting little evidence in the literature of a relationship between real exchange rates and real interest rate differentials, MacDonald and Nagayasu attempt a formulation that allows expected real exchange rates to vary across countries. Their panel cointegration results provide evidence of a significant relationship, especially when using long-term interest rates.[44]

In their study of the ERER for South Africa, MacDonald and Ricci explore other relationships involving the real interest rate differential.

> First, an increase in absorption relative to savings would put upward pressure on the real interest rate in an economy with less than perfect capital mobility. At the same time, the demand for both tradable and non-tradable goods would increase, inducing an increase in the price of non-tradables, which, in turn, would result in an appreciation of the real exchange rate. Second, real interest rate differentials may also reflect productivity differentials: to the extent that the measure employed to proxy for the Balassa-Samuelson effect is not perfect, the real interest rate differential may help capture this empirically; also if the productivity of capital [rises] with respect to trading partners, capital will flow to the home country, thereby inducing an appreciation of the real exchange rate.[45]

In an analysis of the relationship between the real exchange rate and medium-term economic fundamentals, the ECB *Monthly Bulletin* remarks:

> The cyclical pattern of the [real interest rate differential] over the medium term may display … the relative business cycle position of the countries or areas under consideration as well as their relative growth prospects … To the degree that the expected growth differential has reflected temporary differences in the business cycle [between the two economies], the exchange rate would need to revert to its long-term path over the medium term. By contrast, a structural or permanent shift in economic growth could have required a long-term adjustment in the exchange rate level.[46]

Computation of the expected inflation rate, needed to obtain the real interest rate, presents measurement problems. Only in certain countries can information from inflation-proof securities be exploited, and such information has been available only for a relatively short period of time. It is commonplace to use current inflation rates instead, or to employ a filtering technique to extract information on inflation expectations from actual inflation rates.[47]

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44 MacDonald and Nagayasu (2000).

45 MacDonald and Ricci (2003) pages 4 - 5. These authors discuss also the influence of monetary and fiscal policy.

46 ECB *Monthly Bulletin* (2002), page 48.

47 ECB *Monthly Bulletin* (2002), page 46. Pattichis *et al* (2002) use the nominal interest rate minus an eight-quarter centred moving average of the CPI inflation rate (page 14). Nilsson (2002) deflates by using the percentage change in the consumer price index over four quarters. As Nilsson points out, this technique assumes that inflationary expectations are adaptive in nature (page 13).

1.5.5 Fiscal position

If unmatched by an equal cut in private spending, a larger budget deficit reduces the current account surplus (or increases the deficit), worsening the country's net foreign assets position, and weakening the real exchange rate. A link that draws on the divide between tradable and non-tradable products goes as follows: If government spending is directed more heavily than private spending towards non-tradable goods, a higher fiscal deficit pushes up the price of non-tradable products, and in so doing strengthens the real exchange rate. The reallocation towards non-tradable products and the effect on the exchange rate will be weaker if the rise in the public deficit comes from a tax cut rather than from increased public sector spending.[48]

In the absence of a difference between the public and private sector propensities to spend on non-tradable products, the impact on the real exchange rate of a higher deficit depends on whether there is Ricardian equivalence and how temporary the deficit shocks are. In the longer run, the distorting effects of the higher taxes needed to finance added government spending can have growth-reducing effects that will depress the exchange rate.[49]

1.5.6 Openness

This explanatory variable is found in, for example, MacDonald and Ricci.[50] Trade restrictions raise the domestic price of tradable goods, and in the process lift overall domestic prices and strengthen the real exchange rate. As a proxy for openness, MacDonald and Ricci, as well as Goldfajn *et al*,[51] use the ratio of the sum of exports and imports to GDP. MacDonald and Ricci recognise that this ratio is influenced by factors other than openness and their econometric method is designed to correct for the ratio's endogeneity. To measure openness, Cady's[52] study of the Malagasy franc uses the effective tax rate on international trade, equal to the ratio of import tax revenue to imports plus the ratio of export tax revenue to exports. [53]

1.6 BEER: Elaboration of the panel approach

A highly relevant BEER study that draws also on the Balassa-Samuelson-adjusted PPP theory is contained in Maeso-Fernandez *et al* (2004).[54] Although these authors follow BEER practice by exploring the relationship of key explanatory variables to a time-varying equilibrium exchange rate, their method is related also to the PPP approach, in that their specification is in terms of deviations from PPP. Whereas many of the BEER studies referred to earlier use time-series analysis, and the PPP approaches mentioned before are cross-sectional in nature, the panel studies in Maeso-Fernandez *et al* are an amalgam of the two methods.

Defining the exchange rate gap as the difference between the current values of the exchange rate and the PPP exchange rate, Maeso-Fernandez *et al* estimate the gap for acceding countries in Central and Eastern Europe (CEE).

Because of the lack of time series data for the CEE countries, Maeso-Fernandez *et al* use a two-stage approach to estimate the exchange rate gap. In a first stage, they employ panel data on 25 industrialised countries between 1975 to 2002 to estimate the key parameters of their regression

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48 See MacDonald and Ricci (2003), who describe the link between the fiscal balance and the real exchange rate as ambiguous. (Page 5 - 6.) See also Goldfajn and Valdes (1999), pages 234 - 235.

49 It is noted in the literature that a larger public debt may also influence the real exchange rate through changes in risk premia.

50 MacDonald and Ricci (2003), pages 6 and 21.

51 Goldfajn and Valdés (1999), page 235.

52 Cady (2003), page 5.

53 Additional explanatory variables used in BEER studies include:
Dependency ratio (the ratio of the non-working population to the working age population); R&D expenditures; the output gap; private and public sector consumption as percent of the GDP. See ECB *Monthly Bulletin* (2002), page 51, and Stein (2002), page 352.

54 Maeso-Fernandez *et al* (2004).

model. Then they sketch out a methodology to estimate the exchange rate gap for the CEE acceding countries.[55]

1.7 Conclusion

This chapter discussed the determinants of the ERER. The following chapters will test variants of the PPP and BEER methods for the purpose of estimating the equilibrium exchange rate of the Maltese lira. Because of the demanding data and complex computational requirements of the FEER approach, and also because the application in this study of other methods provided the comprehensiveness needed for an estimate of the ERER, it was found unnecessary to supplement these other methods with the FEER approach.

[55] Although they suggest using the slope coefficients estimated from their first-stage regression model to generate estimates of the exchange rate gap for the acceding CEE countries, they recommend caution in the choice of the constant terms for these countries, because their experience is likely to be different from the industrialised countries included in the sample. This issue is discussed further in Chapter 5.

PART TWO: ESTIMATION OF THE EQUILIBRIUM REAL EXCHANGE RATE

Chapter 2: Basic Purchasing Power Parity

2.1 Introduction

In this chapter the ERER for the Maltese lira is estimated using a basic Purchasing Power Parity (PPP) approach. This entails the identification of a recent period when the Maltese economy appeared to be close to equilibrium. The real exchange rate prevailing in that period could thus be assumed to be close to its equilibrium level.

2.2 Indicators of equilibrium

It is not obvious how the equilibrium of the economy should be defined. In principle, PPP is consistent with a long-run equilibrium position, which can hardly be found in empirical data. In practice, one can look for a period when a number of economic indicators show relatively small deviations from what are assumed to be their long-run values. Such a period would be one of at least three years, with the relevant economic indicators averaged out over the period.

Table 2.1 below shows a number of relevant economic indicators for Malta covering the period 1980 - 2002. These include:

a. the real effective exchange rate
b. real GDP growth
c. the unemployment rate
d. the inflation rate
e. the current account balance, after subtracting the retained earnings of foreign-owned corporations, as a percentage of GDP
f. the current account balance, after subtracting the retained earnings of foreign-owned corporations and adding errors & omissions, as a percentage of GDP
g. the output gap computed using the production function
h. the output gap computed using the Hodrick-Prescott filter

2.3 Data

Although the data series begins in the early eighties, the Maltese economy was significantly regulated at that time, so that the indicators did not then fully reflect the operation of market forces. Only in the late eighties were most regulations abolished or relaxed. Thus, the period of interest for the present exercise starts towards the end of that decade.

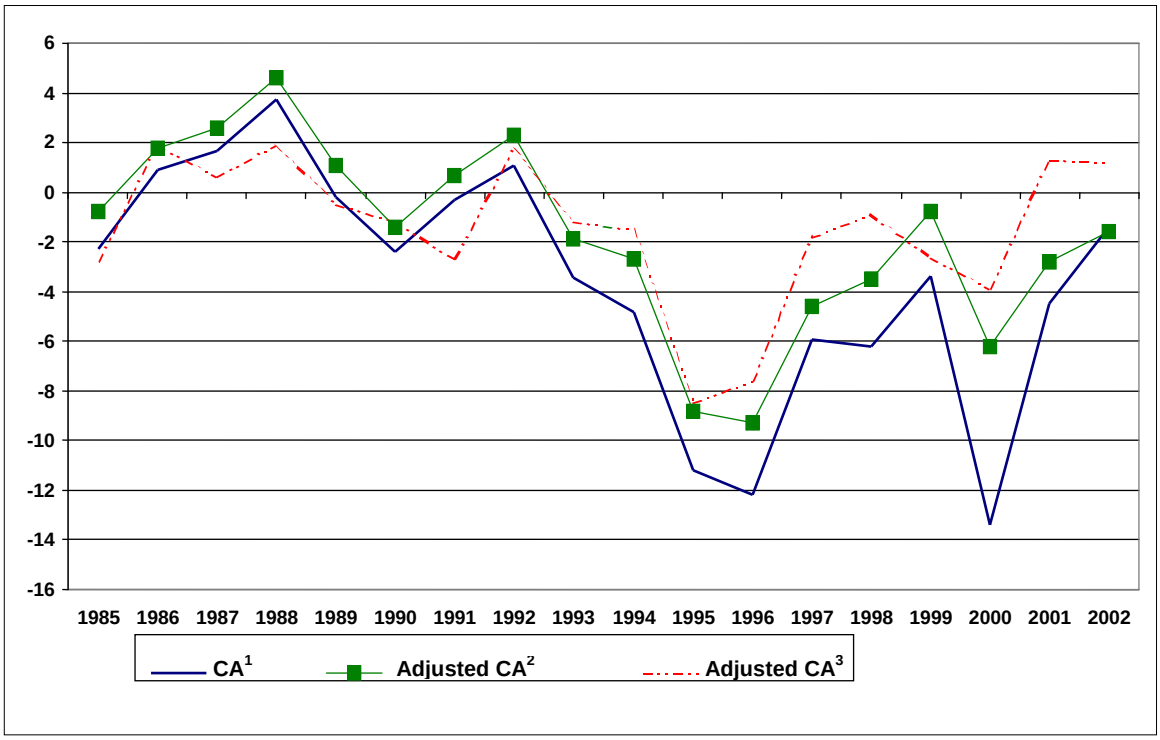
For this exercise, the current account balance was adjusted in two ways, as indicated above. Retained profits were subtracted because these are reported as a debit entry in the current account and then as a credit entry in the capital and financial account. The second adjustment, involving the addition of errors and omissions, was made because these are likely to stem largely from under or over reporting of the goods and services balance. The three measures of the current account balance are shown in Chart 2.1 below.

TABLE 2.1: REAL EXCHANGE RATE AND INDICATORS OF EQUILIBRIUM

	Real effective exchange rate[1] (a)	Real GDP growth (b) %	Unemployment rate (c) %	Inflation rate (d) %	Adjusted current account[2] / GDP (e) %	Adjusted current account[3] / GDP (f) %	Output gap[4] (g) %	Output gap[5] (h) %
1980	112.92	7.0	3.3	15.8	10.0	8.7	8.5	8.8
1981	122.85	3.3	4.7	11.5	10.5	10.7	7.0	6.8
1982	129.29	2.3	8.6	5.8	3.1	4.6	4.4	4.4
1983	126.64	-0.6	9.3	-0.9	0.4	2.4	-2.3	-0.5
1984	126.81	0.9	9.4	-0.4	2.2	1.7	-5.1	-3.7
1985	123.39	2.6	9.1	-0.2	-0.8	-2.8	-6.5	-5.3
1986	119.96	3.9	7.5	2.0	1.8	1.9	-6.7	-6.0
1987	113.79	4.1	4.9	0.4	2.6	0.6	-6.2	-6.6
1988	112.52	8.4	4.4	1.0	4.6	1.9	-2.7	-3.5
1989	106.35	8.2	4.1	0.9	1.1	-0.5	0.6	-0.7
1990	99.86	6.3	4.3	3.0	-1.4	-1.2	1.0	0.2
1991	99.33	6.3	4.1	2.5	0.7	-2.7	1.6	1.0
1992	94.50	4.7	4.5	1.6	2.3	1.7	0.8	0.4
1993	95.01	4.2	5.2	4.1	-1.9	-1.2	-0.2	-0.5
1994	95.71	3.0	4.8	4.1	-2.7	-1.5	-2.0	-2.5
1995	100.00	9.3	4.2	4.0	-8.8	-8.5	1.3	1.7
1996	97.77	4.0	5.0	2.5	-9.3	-7.6	0.0	1.1
1997	97.18	4.8	5.5	3.3	-4.6	-1.8	0.5	1.5
1998	98.59	3.4	5.6	2.2	-3.5	-0.9	0.6	0.9
1999	101.02	4.1	5.8	2.1	-0.8	-2.6	0.9	1.0
2000	99.37	6.4	5.0	2.4	-6.2	-3.9	3.4	3.6
2001	100.73	-1.2	5.1	2.9	-2.8	1.3	-0.7	-1.0
2002	101.53	1.2	5.2	2.2	-1.6	1.2	-2.6	-3.0
1980-2002	**107.6**	**4.2**	**5.6**	**3.2**	**-0.2**	**0.1**	**-0.2**	**-0.1**
1989-1993	**99.0**	**5.9**	**4.4**	**2.4**	**0.2**	**-0.8**	**0.8**	**0.1**
1989-1994	**98.5**	**5.4**	**4.5**	**2.7**	**-0.3**	**-0.9**	**0.3**	**-0.3**
1992-1994	**95.1**	**4.0**	**4.9**	**3.3**	**-0.8**	**-0.4**	**-0.5**	**-0.8**

[1] Equivalent to an index of 1/*r*, where *r* is the real exchange rate as defined in Chapter 1, page 1.
[2] Current account minus retained earnings.
[3] Current account minus retained earnings plus errors & omissions.
[4] Measured using production function method.
[5] Measured using Hodrick-Prescott filter method.

CHART 2.1: UNADJUSTED AND ADJUSTED CURRENT ACCOUNT, AS PER CENT OF GDP



1 Unadjusted current account, as per cent of GDP
2 Current account minus retained earnings, as per cent of GDP
3 Current account minus retained earnings plus errors & omissions, as per cent of GDP

2.4 Estimation

On the basis of these current account balances, it appears that **1989 - 1993** was a period of relative equilibrium, as Chart 2.1 shows. The average values of the indicators for this period are also shown in Table 2.1. As can be seen in the table, average GDP growth for the period 1989 - 1993 was somewhat higher than that for the entire time span shown. The unemployment rate was, consequently, somewhat lower. At the same time, the inflation rate was lower than the average for the whole period, while the output gap was either positive or close to zero, depending on the computation method chosen.

One peculiarity of the period was that it includes the year 1992, during which the Maltese lira was officially devalued by 10%. However, since other major currencies included in the Maltese lira's real effective exchange rate index depreciated concurrently, the real exchange rate was not affected significantly by this devaluation.[56]

When the selected period was stretched by one year to 1994, the corresponding statistics for this extended period, **1989 - 1994**, were quite similar to the full period averages. It is in the three-year period from **1992 - 1994** that the average rates of real growth, unemployment and inflation are closest to their full period averages. However, both the output gap and the current account balance are negative for this period, giving a stronger indication of disequilibrium than in the previous two sub-periods.

The average values of the real effective exchange rate for each of the two sub-periods that manifested the strongest signs of equilibrium, namely the **1989 - 1993** and **1989 - 1994** sub-

[56] The inflation rate accelerated during the subsequent three years, taking the real effective exchange rate in 1995 back to its 1991 level.

periods, were estimated, with 1995 set as the base year. The conclusion was that, with the real exchange rate at 101.5 in 2002, the degree of deviation from the ERER was as follows:

TABLE 2.2: ESTIMATED DEVIATION FROM ERER: BASIC PPP APPROACH

	Implied deviation in 2002
Estimated equilibrium period: 1989 - 1993	+2.6%
Estimated equilibrium period: 1989 - 1994	+3.1%

2.5 Summary

These results suggest that in 2002 the deviation of the real exchange rate from the ERER ranged from +2.6% to +3.1%. As already mentioned, a limitation of this approach is the assumption that the equilibrium rate is constant. Departing from this assumption may yield different levels of divergence from the ERER.

Chapter 3: Modified Purchasing Power Parity

3.1 Introduction

An advantage of the Purchasing Power Parity (PPP) approach is its conceptual and computational simplicity. However, while the basic version presented in the previous chapter may be appropriate when the countries involved are at a similar level of economic development, it has to be modified for countries that are still catching up with the income levels of their more developed counterparts.

3.2 Modifications to the basic PPP approach

The basic purchasing power parity theory states that the home country's price level will equal the foreign price level when both are expressed in the same currency. Any deviation would imply that the real exchange rate is not equal to unity and is consequently misaligned.

But empirical research shows that the price level in developing countries is lower than that in developed countries, when both are expressed in a common currency. This suggests an under-valuation of the currencies of developing countries. Therefore, the basic PPP approach is valid only when comparing countries that are at a similar stage of economic development. Differences in price levels may reflect differences in productivity, especially in the non-tradable sector. This is probably the case for Malta, which has a lower productivity level than the EU average. Thus, in adopting the PPP approach to measure the appropriate level of the real exchange rate, a correction for the Balassa-Samuelson effect is needed.

Rogoff (1996) pioneered a method for estimating the equilibrium exchange rate using a PPP interpretation that takes into account international differences in relative productivity.[57] The problem of applying PPP logic to countries at different stages of economic development can be addressed by estimating the following relationship:

$$\log (\boldsymbol{P}_j / P^*) = \alpha + \beta \log(Y_j / Y^*) + \varepsilon_j \qquad [3.1][58]$$

where:

$\boldsymbol{P}_j = P_j(1/S_j)$ = Price level for country j, converted at the exchange rate into the currency of the benchmark country.
P^* = Price level of the benchmark country.[59]
Y_j = GDP per capita in PPS in country j.
Y^* = GDP per capita in PPS in the benchmark country.
j = Countries 1,…, n.

Equation 3.1 postulates that differences in bilateral ERERs are due to differences in development levels. The coefficient β is likely to be positive, since a more advanced stage of economic development is expected to lead to a higher price level. Once the coefficients α and β are estimated, the extent of exchange rate misalignment for country j is measured by the corresponding residual from the regression. A relative price level which is higher than the result estimated from the right hand side of Equation 3.1 indicates a real overvaluation of the currency of country j with respect to the currency of the benchmark country, while the opposite indicates an under-valuation.

3.3 Data sources and compilation

As can be seen from Equation 3.1, the application of the PPP approach corrected for the Balassa-Samuelson effect requires data for price levels and per-capita GDP at the Purchasing Power Standard (PPS). The PPS is an internationally uniform basket of representative products. Since Malta's main trading partner is the EU, the respective indicators for the EU were used as benchmarks against which the price level and per capita GDP in PPS for each selected country were compared.

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[57] See Section 1.3 above.
[58] Equivalent to Equations 1.1 and 1.2 in Chapter 1, page 7.
[59] $\boldsymbol{P}_i / P^* = 1/r$, where r is the real exchange rate as defined in Chapter 1, page 1.

An important issue concerned the type of price level measure to be employed in the estimation of the equation. The choice was between the consumer price index and the GDP deflator. The latter was preferred because it includes a wider range of goods and services.

Given the data requirements, and the need of a large sample comprising a wide variety of countries, the Penn World Tables (PWT) were used as these were the best source of data on both relative prices and relative per capita GDP. The latest data from the PWT were for the year 1999 and, thus, these were employed in the study. In the case of relative prices, the PWT provides data on relative GDP deflators and relative consumer price indices. As both types of price measures, as well as the GDP data for each country listed in the PWT are expressed in relation to the US (the benchmark country), the data were recomputed in order to relate them to the EU countries.[60]

The issue of country selection was important because the results proved sensitive to the choice. The criterion used was that the sample of countries should include a wide variety of countries, provided that good quality data were available for each of the selected countries. Therefore, although the PWT provide statistics on 168 countries, the data for 67 countries classified as of "low" quality were excluded from the sample, with the exception of Malta and Cyprus. Thus, the sample included 103 countries, comprising a mix of both industrialised and developing countries. The selection is displayed in Table 3.1 below.

TABLE 3.1: COUNTRIES INCLUDED IN THE ESTIMATION

Argentina	Croatia	India	Malta	Spain
Armenia	Cyprus	Indonesia	Mauritius	Sri Lanka
Australia	Czech Republic	Iran	Mexico	St. Lucia
Austria	Denmark	Ireland	Moldova	Swaziland
Azerbaijan	Lithuania	Israel	Morocco	Sweden
Bangladesh	Luxembourg	Italy	Nepal	Switzerland
Barbados	Macedonia	Jamaica	Netherlands	Syria
Belarus	Ecuador	Japan	New Zealand	Tajikistan
Belgium	Egypt	Jordan	Nigeria	Tanzania
Bolivia	Estonia	Kazakhstan	Norway	Thailand
Botswana	Fiji	Kenya	Pakistan	Trinidad
Brazil	Finland	Korea	Panama	Tunisia
Bulgaria	France	Kyrgyzstan	Peru	Turkey
Cameroon	Gabon	Latvia	Philippines	United Kingdom
Canada	Georgia	Lebanon	Poland	Ukraine
Chile	Germany	Sierra Leone	Portugal	Uruguay
China	Greece	Singapore	Romania	Venezuela
Colombia	Grenada	Slovak Republic	Russia	Zambia
Congo	Hong Kong	Madagascar	Senegal	Zimbabwe
Costa Rica	Hungary	Malawi	Slovenia	
Cote d'Ivoire	Iceland	Mali	South Africa	

While data pertaining to Malta and Cyprus were graded as being of "low" quality, their inclusion or exclusion from the sample did not materially alter the estimated coefficients of Equation 3.1. This notwithstanding, the data pertaining to Malta had a significant bearing on the results obtained where the estimation of Malta's ERER was concerned.

3.4 Estimation results

Equation 3.1 was thus estimated on the basis of this sample of countries. As already indicated, the GDP deflator was used as the price variable. The estimated coefficients were statistically significant, even at the 1% level. These estimates suggested a faster increase in relative prices during the catching-up process compared to the surveyed studies. As shown in Table 3.2, the coefficient for relative per capita GDP, β, is almost double that obtained by Coudert and Couharde (2002), and somewhat higher than that found by Rogoff (1996).

[60] For this purpose, conversion factors of 1.0202 for relative prices and 1.4175 for relative per capita GDP were used.

This study also undertook an alternative estimation of Equation 3.1 based on the OECD's *Main Economic Indicators* for the thirty OECD member countries. Data for 2002 were available and employed in this estimation. As can be seen from Table 3.2, the coefficient of relative GDP was higher in this case.

TABLE 3.2: ESTIMATION OF EQUATION 3.1

	α	β
Coudert & Couharde (2002)[61]	2.9919	0.2448
Rogoff (1996)[62]	0.0350 [63]	0.3660
CBM (Sample of 103 PWT countries)[64]	2.3115	0.4490
CBM (Sample of 30 OECD countries)	1.8827	0.5824

The Bank's estimate based on the sample of 103 PWT countries predicts that, once the catching-up process has been completed, and Malta's relative GDP per capita has reached the EU average, prices in Malta would be around 79% of the EU average. That Malta's price level would not reach the EU average at the end of the catching-up process suggests that GDP per capita in PPS is an imperfect proxy for the level of productivity.[65] A possibly better indicator would be GDP per employed person in PPS, because this measures productivity more adequately. However, such data were not available for most countries.[66]

As a further check on the robustness of the coefficients, various other estimations were undertaken. One used consumer prices as the relative price measure (Column A in Table 3.3). Another excluded Malta and Cyprus from the sample (Column E). Other adjustments included additional variables, including the degree of openness, expressed as imports plus exports as a proportion of GDP (Column C), as well as a dummy variable for island states (Column D).

In all these cases, α and β remained very stable, as can be seen in Table 3.3. The degree of openness and the dummy for island states were not statistically significant, while the exclusion of Malta and Cyprus from the sample did not substantially affect the results.

TABLE 3.3: ESTIMATION OF EQUATION 3.1 BASED ON PWT DATA*

	A CPI	**B GDP deflator**	**C GDP deflator**	**D GDP deflator**	**E GDP deflator****
Constant	**2.2743** (13.92)	**2.3115** (14.39)	**2.3919** (6.32)	**2.3254** (14.50)	**2.3126** (14.21)
Relative per capita GDP in PPS	**0.4532** (9.65)	**0.4490** (9.73)	**0.4523** (9.34)	**0.435**8 (9.26)	**0.4486** (9.55)
Openness	-	-	**-0.0212** (-0.23)	-	-
Dummy for island states	-	-	-	**0.1631** (1.31)	-
Number of observations	103	103	103	103	101
R^2	0.480	0.484	0.484	0.493	0.479

* Parentheses contain the t statistic.
** Estimation excluded Malta and Cyprus.

61 Equation 1.1 in Chapter 1, page 7.
62 Equation 1.2 in Chapter 1, page 7.
63 In Rogoff's data, $\boldsymbol{P}_j / P^*$ and Y_j / Y^* are each equal to 1 in the benchmark country. In the other three studies, each is equal to 100. These differences in scale affect the resulting estimate of the constant.
64 These countries are listed in Table 3.1, above.
65 GDP per capita data may be influenced by differences in labour market participation rates.
66 In this regard it should also be mentioned that differences in the productivity of capital could also affect the results, although capital is generally observed to be highly mobile and modern technological methods are more easily transferable across countries.

3.5 Estimated ERER

The results of Equation 3.1 were subsequently used to estimate the ERER of the Maltese lira in 2002. This required relative price and GDP data for Malta and the EU for that year. Since these indicators were available only up to 1999 from the PWT source, GDP and inflation in Malta and the EU were extrapolated to 2002, using NSO and Eurostat data. From these computations it resulted that both Malta's GDP per capita in PPS and its GDP deflator were 65.1% of the corresponding EU averages in 2002.

The relative price and GDP per capita data for Malta were applied to the preferred coefficients, estimated on the basis of the CBM sample of 103 PWT countries (Column B in Table 3.3). The results indicate that the estimated -6.8% deviation from ERER in 1999 was corrected during the subsequent three years. As shown in Table 3.4 below, there was virtually no exchange rate misalignment by 2002, when the difference between the actual relative price and the equilibrium value amounted to -0.05%.

In applying Eurostat's revised GDP per capita and price level for Malta to the estimated coefficients, the results remain broadly similar, with an estimated deviation from the ERER of -7.22% in 1999 and one of +0.22% in 2002.

3.6 Summary

The modified version of the PPP in this chapter improves on the model in Chapter 2 by taking into account international differences in the stage of economic development relative to the EU. The estimation was based on data obtained from the PWT for a sample of 103 countries that included a mix of both developed and developing countries. The regression included a coefficient that measured a catching-up factor that influences developments in the real effective exchange rate. Coefficient estimates were then applied to Malta's per capita GDP and relative price level to estimate the ERER. The results showed virtually no deviation from the estimated equilibrium level in 2002.

TABLE 3.4: ESTIMATED DEVIATION FROM ERER: MODIFIED PPP APPROACH*

	2002
Data source for 2002: CBM estimates	-0.05%
Data source for 2002: Eurostat	+0.22%

* Based on coefficients estimated from 1999 PWT data.

Chapter 4: Behavioural Equilibrium Exchange Rate

4.1 Introduction

The Behavioural Equilibrium Exchange Rate (BEER) approach relates the real exchange rate to a set of economic fundamentals that vary over time, making the BEER a time-varying concept. The deviation of the exchange rate from its equilibrium value is estimated from a comparison of the actual real effective exchange rate and the corresponding equilibrium rate for the selected time period.

As mentioned in Chapter 1, the BEER approach involves the estimation of a cointegrating relationship containing the real exchange rate and a set of economic fundamentals. These include the relative terms of trade, the relative ratio of non-tradable to tradable product prices, the relative ratio of net foreign assets to GDP and the relative interest rate differential.

4.2 Definitions and Data Sources

4.2.1 Real effective exchange rate

The real effective exchange rate, *R*, is an inflation-adjusted index of a home currency's value relative to a basket of other currencies where these currencies are weighted according to the home country's trade with the countries using the currencies. The index is adjusted for differences in the national rates of inflation. *R* is equivalent to the ratio of Malta's price level relative to foreign prices, where all prices are measured in a common currency.[67]

Malta's major trading partners were identified as France, Germany, Italy, the United Kingdom and the United States, together accounting for 70% of Malta's total trade. The weights used to measure *R* were time varying and were based on both merchandise trade flows and tourist arrivals. Time variation reflects the effects of changing trade patterns, while the inclusion of both manufacturing and tourism recognizes the importance of these sectors for the Maltese economy.[68]

The selection of an adequate price measure was an important methodological issue in the calculation of *R*. The more widely used price measures found in the supporting literature are consumer prices (CPI), producer prices (PPI) and unit labour costs (ULC)[69].

Chart 4.1 plots three effective real exchange rates for the Maltese lira, based on CPIs, PPIs and ULCs, respectively. These exhibit a common downward trend with a roughly similar pattern. However, between 1994 and 1998 the path of the CPI-based *R* diverged from that observed in both the PPI- and the ULC-based counterparts. While the latter two indices continued to drop,

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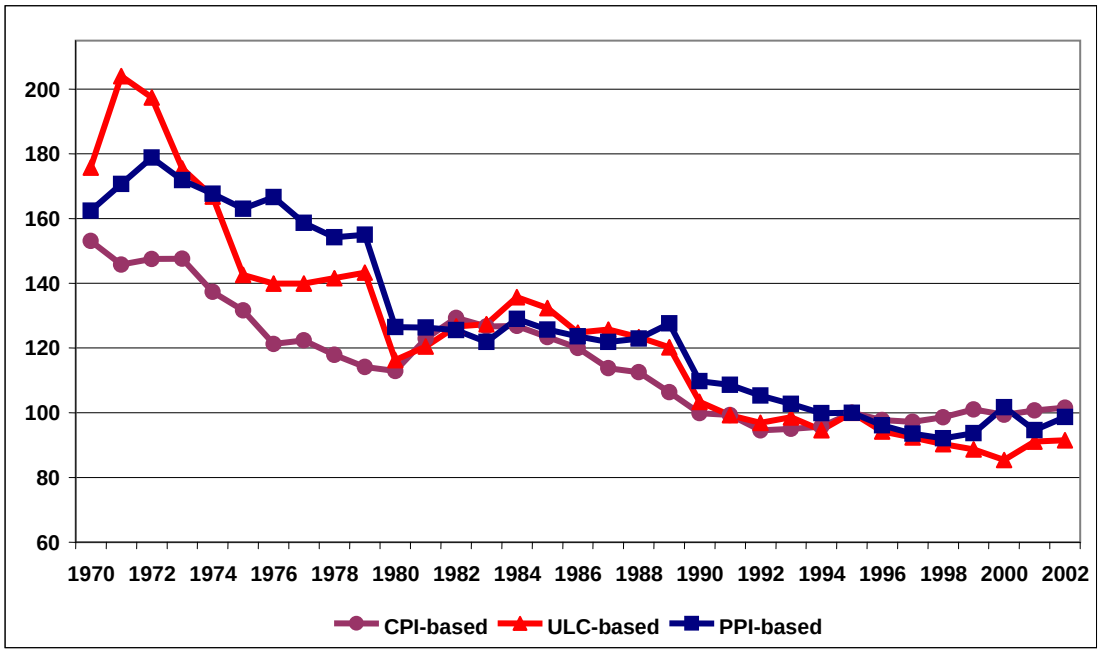
[67] $R = 1/r$, where r is the real exchange rate as defined in Chapter 1, page 1. Real exchange rate appreciation, as commonly understood, is represented by an increase in *R*.

[68] The weights for the index were constructed on the basis of employment, rather than external trade, which is a turnover or gross measure. Due to the relatively large turnover of the electronics industry, turnover data distort the relative importance of manufacturing as well as the relative importance of the major trading partners. However, in the case of tourism data on employment were unavailable prior to 1983, and thus the index was based on turnover from 1970 to 1983. An inspection of the data for the 1983 - 1989 period shows that the relative importance of tourism was very similar whether measured in terms of employment or turnover.

[69] The sources of the PPI and ULC statistics are as follows:
The PPIs for the foreign countries, comprising all manufacturing industries including oil production, were obtained from a database available at the Banca d'Italia. The corresponding PPI for Malta was constructed using as its basis the index of industrial production (Source: NSO *Abstract of Statistics*), which was however only available up to 1996. Upon inspection of an overlapping sample, real exports and the index of industrial production were found to move in line with each other. In addition, three-quarters of manufacturing turnover is exported. Therefore, export volumes were used to obtain a longer time series for the index of industrial production.
Since data on nominal manufacturing output were available only through 1999, the series was extrapolated using growth in nominal exports. The PPI was then extracted as the ratio of nominal manufacturing output to the constructed real manufacturing output.
For the ULC-based alternative, the foreign indices were obtained from the Banca d'Italia database, while the Maltese equivalent was constructed by computing the ratio of wages and salaries in manufacturing (Source: NSO *National Accounts*) to real manufacturing output.

suggesting that Malta's manufacturing sector was relatively more competitive in relation to its trading partners, the CPI-based *R* increased. Furthermore, both the PPI and ULC-based *R* exhibited a negative relationship after 1998.

CHART 4.1: ALTERNATIVE INDICES OF THE REAL EFFECTIVE EXCHANGE RATE OF THE MALTESE LIRA (1995 = 100)



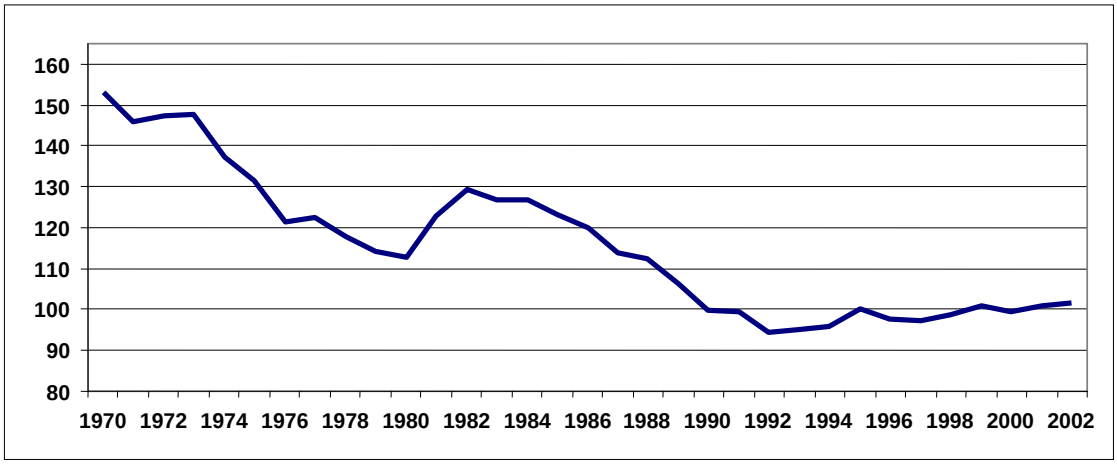
For estimation purposes, the CPI-based variant of the *R* was preferred mainly on account of the CPI's comparability across countries. The local PPI and ULC are not directly comparable to the foreign indices as the Maltese indices are estimated as implicit deflators, while their foreign counterparts are measured directly. More importantly, however, the preference for this measure is justified by the far-reaching differences between the production structures of Malta's manufacturing industry and those of its major trading partners. Indeed Malta's production base is more concentrated than that of its trading partners, as its manufacturing output is dominated by the electronics industry. On the other hand, one would expect consumption patterns in Malta and in its trading partners to be similar in nature, especially when compared to production patterns. For all these reasons, the CPI-based *R* was deemed a better measure.

The path followed by this *R* is shown again in Chart 4.2, which displays an almost continuous depreciation up to 1992.[70] The overall decline reflected the low inflation rate in Malta compared with its main trading partners, and took place notwithstanding the fact that in nominal terms the exchange rate was appreciating.[71] Subsequently, *R* embarked on an upward trend. This was the result of the inflationary effect of the official devaluation of the lira in 1992, as well as rapid economic growth.

[70] This trend was temporarily interrupted in 1981, following the second surge in the price of oil.

[71] See Caruana Galizia (1989) for details of Malta's exchange rate policy and the effective exchange rate between 1970 and 1988.

CHART 4.2: *R*: CPI-BASED REAL EFFECTIVE EXCHANGE RATE (1995 = 100)

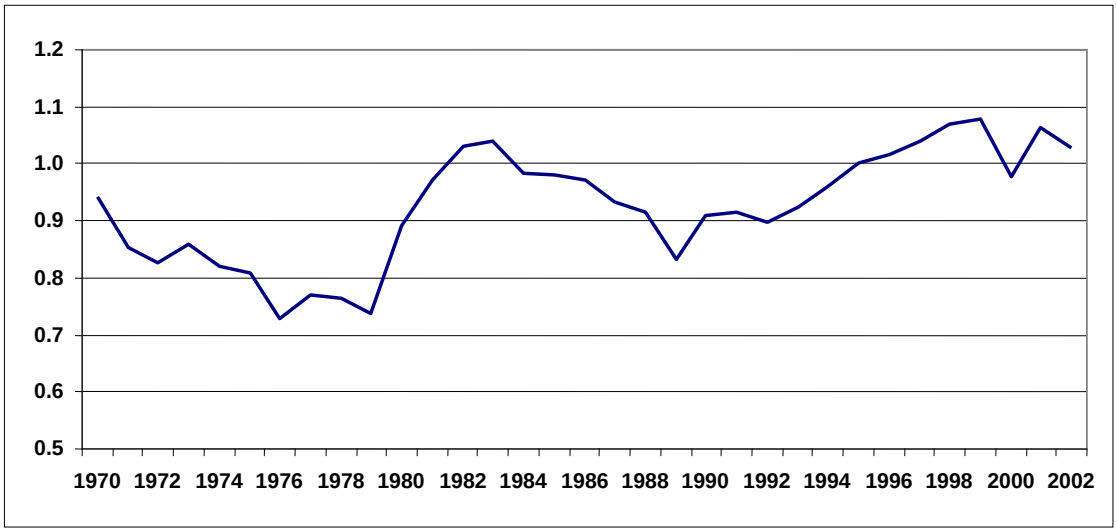


4.2.2 Relative ratio of non-tradable to tradable product prices[72]

This ratio (NTT) is defined as the ratio of domestic consumer prices to producer prices in the Maltese manufacturing sector, relative to its equivalent in Malta's trading partners.[73]

The resulting NTT series is shown in Chart 4.3. This shows a declining trend in NTT throughout the 1970s, followed by a sharp rise in the early 1980s. During this period, the second oil-price shock boosted price and wage inflation, which led to a rise in NTT. For the remainder of the eighties the NTT declined, with the wage freeze of 1982 - 1989 and productivity losses experienced in the mid to late eighties contributing to the fall. Subsequently, NTT increased, but the rising trend was halted in the year 2000.

CHART 4.3: RELATIVE RATIO OF NON-TRADABLE TO TRADABLE PRODUCT PRICES



4.2.3 Relative ratio of net foreign assets to GDP

As discussed in Chapter 1, the net indebtedness of an economy is best represented by the country's international investment position (IIP). However, since IIP data were only available from 1994, the net foreign assets of the monetary sector, *NFA*, were used as a proxy, measured as a percentage of GDP.[74] An adjusted version of this proxy, *ANFA*, includes the net foreign assets of the monetary sector netted of the stock of outstanding foreign loans of government.

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[72] As an alternative to NTT, the GDP per employed person was considered. Although less prone to measurement error, it yielded unsatisfactory results in estimation.

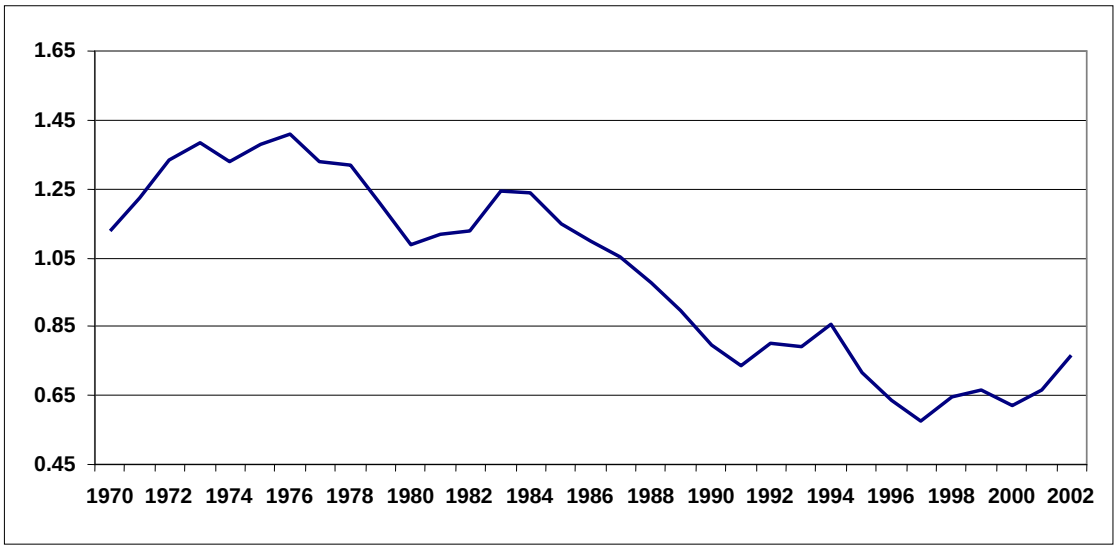
[73] CPIs for Malta and its trading partners were obtained from the IMF's *International Financial Statistics*, while the method of constructing the PPIs is described in Footnote 69.

[74] Attempts were made to estimate back data by adjusting the available statistics backwards, using the current account balances, whilst taking into account nominal exchange rate changes. However, the resulting series yielded unsatisfactory results. This was mainly the consequence of a lack of information on asset price changes, as well as the problem of exchange rate adjustments, since these may not have reflected the currency composition of the stock of foreign assets and liabilities in each time period.

The exclusion from the *NFA* and *ANFA* proxies of the non-monetary sector's net external asset is justified by the rigid capital controls that were used to support Malta's hard exchange rate peg for most of the sample period.

A graphical representation of *NFA* as a ratio of GDP is shown in Chart 4.4. It shows a decline in the net foreign asset position of the monetary sector from 140% of GDP in 1976 to about 60% by 1997. The drop in the ratio after the mid-eighties reflected economic liberalisation and faster rates of GDP growth. After 1997 the declining trend in the ratio was reversed, mainly on account of privatisation proceeds from the sale of various public assets to foreign investors.

CHART 4.4: RELATIVE RATIO OF NET FOREIGN ASSETS TO GDP



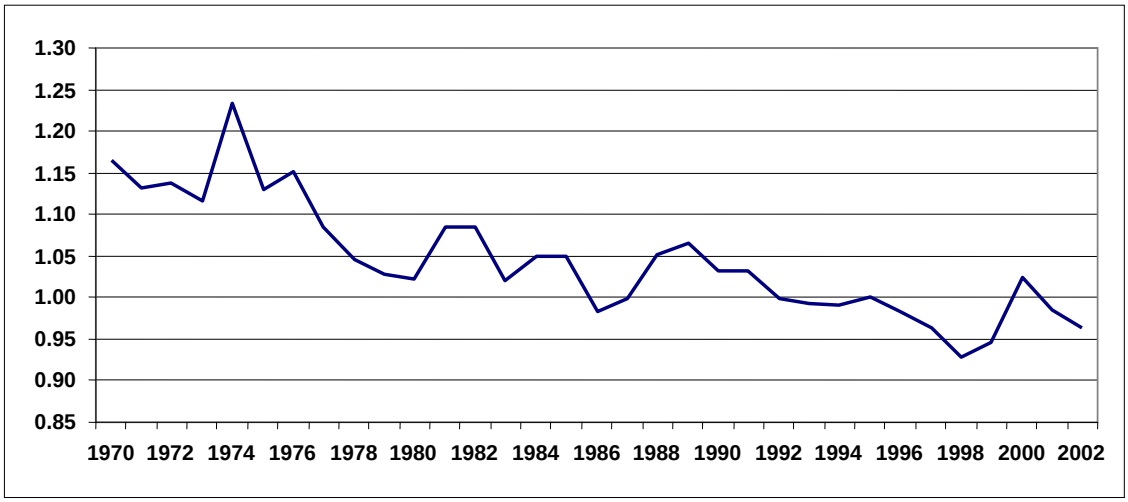
4.2.4 Relative terms of trade

The relative terms of trade (*TOT*) are defined as the ratio of Maltese export prices to import prices divided by the similar ratio for trading partners. Due to a lack of data on import and export prices, unit value indices were used for Malta and the selected countries, with the exception of the UK and the US, for which the available import and export price data were used.[75]

Chart 4.5 shows a generally declining trend in the relative terms of trade since 1974. The spike in 2000 mainly reflected higher export prices of electronic products following the international boom in this industry during that year.

[75] These data were obtained from the IMF's *International Financial Statistics*.

CHART 4.5: RELATIVE TERMS OF TRADE

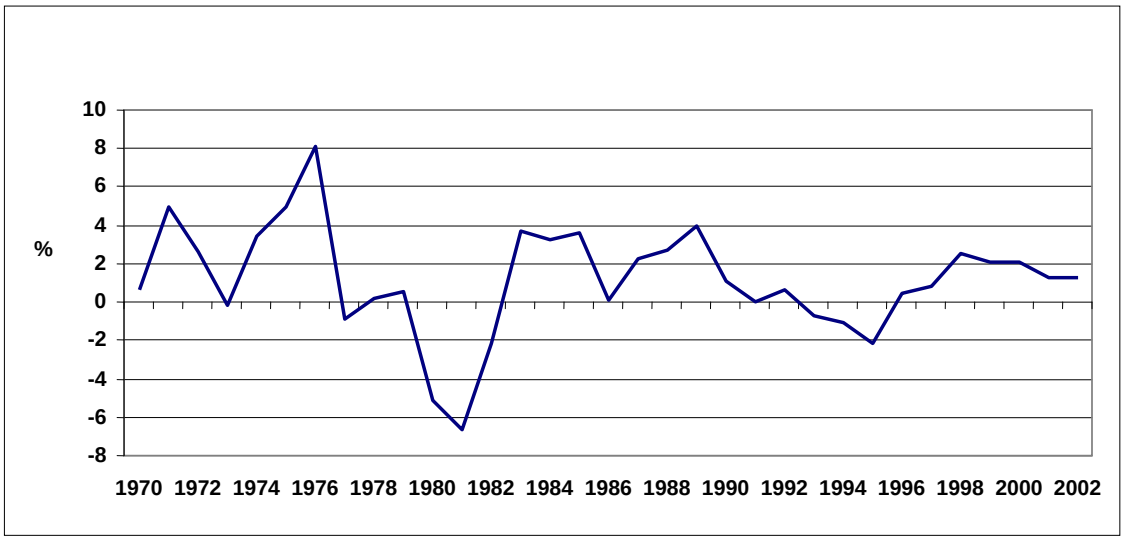


4.2.5 Real interest rate differential

The real interest rate differential (*RI*), which is depicted in Chart 4.6, is measured as the difference between the Maltese real lending rate and the effective real yield on foreign long-term government bonds. In the construction of this variable, the average bank lending rate was used in the absence of public debt instruments for a large part of the sample period. This proxy was also justified by the fact that from 1993 onwards lending rates and long-term government bond yields moved roughly in the same direction. The real interest rate was derived by adjusting the nominal interest rate by the country's consumer price inflation.

Until 1994 interest rate levels in Malta were set administratively. Therefore, the path of *RI* prior to 1994 reflected changes in relative inflation and in foreign interest rates, as portrayed in Chart 4.6.

CHART 4.6: REAL INTEREST RATE DIFFERENTIAL



4.3 Estimation

The Engle-Granger approach to cointegration was preferred over the Johansen Maximum Likelihood alternative mainly due to the small size of the sample employed, which consisted of annual data for 1970 - 2002. However, the Johansen technique was also tested in order to relax the restriction of one cointegrating relationship, as implied by the Engle-Granger alternative.

The first step in estimating a cointegrating relationship is to test for the order of integration of the variables. For this reason Augmented Dickey-Fuller (ADF) tests were performed on the variables included in the model, namely log (*R*), log (*TOT*), log (*TNT*), *NFA* and *RI*.

As shown in Table 4.1, only *RI* is I (0). This variable can therefore be perceived as explaining the cyclical variation in *R*, rather than its long run values.

TABLE 4.1: UNIT ROOT TESTS

Variable	ADF Test Statistic	Critical Value (95%)
log (*R*)	-1.691	-2.971
Δlog (*R*)	-2.667	-2.975
log (*TOT*)	-2.933	-2.971
Δlog (*TOT*)	-4.788	-2.975
log (*TNT*)	-1.499	-2.971
Δlog (*TNT*)	-3.267	-2.975
NFA	-1.218	-2.971
Δ*NFA*	-3.263	-2.975
RI	-3.192	-2.971

The rest of the variables were judged as being I(1). Although the test for Δlog(*R*) rejected the unit-root hypothesis, log (*R*) was still retained as an I(1) variable given the low power of the ADF tests and given that the test statistic is very close to the critical value.

The cointegrating relationship therefore included log (*R*), log (*TOT*), log (*TNT*) and *NFA*, as RI was judged an I(0) exogenous variable. Table 4.2 shows static regressions estimated over different sub-sample periods. Models 1 to 3 in Panel A use *NFA*, while Models 4 and 5 use *ANFA* (see Section 4.2.3 above).

TABLE 4.2: ENGLE-GRANGER ESTIMATES[*]

Dependent Variable: log (*R*)

	Panel A			Panel B	
	Model 1[**]	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Variable	**1970 - 2002**	**1980 – 2002**	**1982 - 2002**	**1980 - 2002**	**1982 - 2002**
log (*TOT*)	**1**	**0.73524**	**0.78724**	**0.73063**	**0.7887**
	(NA)	(3.2798)	(3.0352)	(3.4236)	(3.2139)
log (*TNT*)	**0.55949**	**0.58367**	**0.60829**	**0.58617**	**0.61505**
	(5.1728)	(5.3411)	(4.8945)	(5.6276)	(5.2198)
NFA	**0.43258**	**0.40206**	**0.39705**		
	(9.7275)	(1.0583)	(9.5859)		
ANFA				**0.44321**	**0.43676**
				(11.184)	(10.188)
Intercept	**4.3077**	**4.3271**	**4.3315**	**4.3152**	**4.3204**
	(106.73)	(130.37)	(120.29)	(132.90)	(123.55)

[*] Parentheses contain the t statistic.

[**] The coefficient of log (*TOT*) in Model 1 was estimated at 1.1825. It was reset at 1 after a Wald test was run on such a restriction ($\chi^2 = 0.27935$ [p=0.71]).

Estimates for 1980 - 2002 in Models 2 and 4 were aimed at excluding the effect of a regime of price controls that prevailed during most of the seventies. Furthermore, the 1982 - 2002 span of Models 3 and 5 excluded the spike in *R* resulting from the 1981 oil shock.

The coefficients of the three models in Panel A were reasonably stable, with the exception of those for log (*TOT*), which was much higher for the extended estimation period. A possible explanation for this instability could be the fluctuations in prices of electronics goods, which significantly influence Malta's terms of trade. The coefficients were virtually unchanged when *ANFA* was

substituted for *NFA* (in Panel B). This is understandable given that the level of the government's foreign debt is very low in relation to GDP.

All the coefficients in the models carry the expected signs and are significant at conventional levels. Their magnitude is well in line with the estimates of similar studies, which exhibit considerable disparity among each other.[76]

Model 2, which represents the preferred long run model of the ERER, suggests that, in the long run, an improvement of 1% in the relative terms of trade would lead to a real appreciation of 0.74%. This model also indicates that to maintain equilibrium, an increase of 1% in the relative price of non-tradable to tradable products would result in an increase of 0.58% in Maltese consumer prices relative to the movement in the CPIs of trading partners. This represents the impact of the Balassa-Samuelson effect in Malta. At the same time, an increase of one percentage point in the ratio of banks' net foreign assets to GDP would lead to a real appreciation of 0.40%.

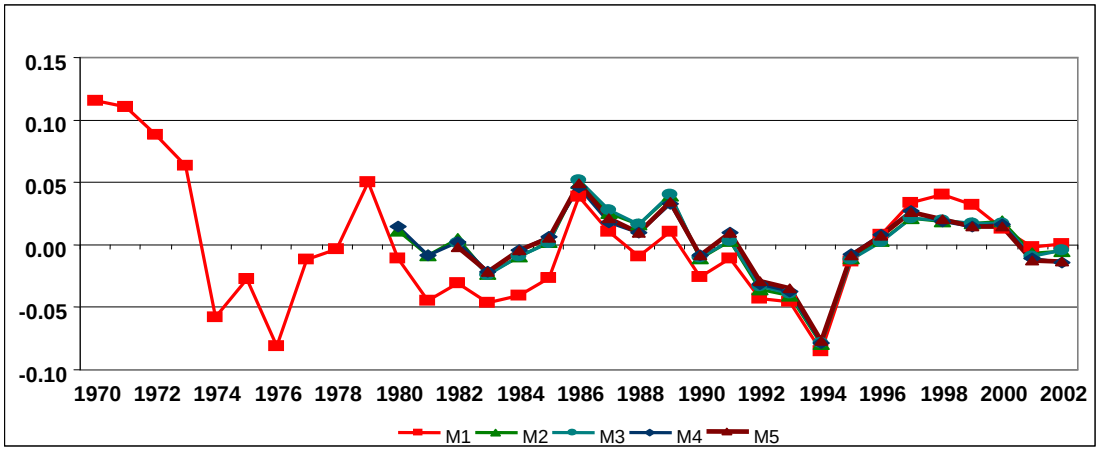
From the plots of the residuals and the cointegration tests in Chart 4.7 and Table 4.3, the residuals from Model 1 can be judged as stationary. The tests show also that the residuals of the remaining models are non-stationary. However, these results are to be interpreted with caution since the ADF test has a very low power in small samples. Thus, given the small residuals in Models 2 to 5, as well as the fact that upon graphical inspection their pattern is practically identical to the residuals in Model 1, one can also consider the residuals in Models 2 to 5 as being stationary.

TABLE 4.3: ADF TESTS FOR COINTEGRATION (ENGLE-GRANGER APPROACH)

UNIT ROOT TESTS FOR RESIDUALS

Residuals of	Test Statistic	ADF Critical Value (95%)
Model 1	-4.6648	-4.0362
Model 2	-2.8303	-4.6912
Model 3	-2.6383	-4.7635
Model 4	-3.0169	-4.6912
Model 5	-2.7726	-4.7635

CHART 4.7: RESIDUAL PLOT



The use of the Johansen procedure was hampered by the small size of the sample. The VAR, in Table 4.4, included log (*R*), log (*TNT*), log (*TOT*) and *NFA*, with *RI* as an I(0) exogenous variable. The intercept was restricted to the cointegration space, so that the error-correction representation of the VAR would not contain any drifts. In choosing the lag structure of the VAR, both the BIC and AIC statistics suggested an order of 2. However, no cointegration was found, and thus VAR (1) and VAR (3) alternatives were tested. The VAR (1) specification yielded no cointegration, while for the VAR (3) two cointegrating vectors were found.

[76] See Clark and MacDonald (1998), Nilsson (2002) and Peng *et al* (2003).

TABLE 4.4: RESULTS OF COINTEGRATION TESTS

Rank Ho	Max Eigenvalue Test	Critical Value 95%	Trace Test	Critical Value 95%
Tests on the VAR (1) Model: log (*R*) log (*TOT)* log (*TNT) NFA* & RI [I(0)]				
		Restricted intercept and no trends		
R=0	17.2113	28.27	46.1825	53.48
R<=1	15.1927	22.04	28.9712	34.87
R<=2	8.4544	15.87	13.7785	20.18
R<=3	5.3241	9.16	5.3241	9.16
		Unrestricted intercept and no trends		
R=0	15.1942	27.42	37.3817	48.88
R<=1	13.5094	21.12	22.1875	31.54
R<=2	8.1892	14.88	8.6781	17.86
R<=3	0.48882	8.07	0.48882	8.07
Tests on the VAR (2) Model: log (*R*) log (*TOT)* log (*TNT*) *NFA* & RI [I(0)]				
		Restricted intercept and no trends		
R=0	22.8923	28.27	58.2674	53.48
R<=1	14.6773	22.04	35.3751	34.87
R<=2	10.7564	15.87	20.6978	20.18
R<=3	9.9414	9.16	9.9414	9.16
		Unrestricted intercept and no trends		
R=0	19.8694	27.42	44.4233	48.88
R<=1	14.0535	21.12	24.5538	31.54
R<=2	10.4999	14.88	10.5003	17.86
R<=3	0.0003606	8.07	0.0003606	8.07
Tests on the VAR (3) Model: log (*R*) log (*TOT*) log (*TNT*) *NFA* & *RI* [I(0)]				
		Restricted intercept and no trends		
R=0	38.0702	28.27	94.3211	53.48
R<=1	37.1789	22.04	56.2509	34.87
R<=2	13.7558	15.87	19.072	20.18
R<=3	5.3162	9.16	5.3162	9.16
		Unrestricted intercept and no trends		
R=0	39.4937	31.79	73.7635	63
R<=1	24.557	25.42	34.2699	42.34
R<=2	8.1136	19.22	9.7129	25.77
R<=3	1.5993	12.39	1.5993	12.39
Tests on the VAR (3) Model: log (*R*) log (*TOT*) log (*TNT*) *NFA*				
		Restricted intercept and no trends		
R=0	38.7839	28.27	93.3797	53.48
R<=1	32.4275	22.04	54.5957	34.87
R<=2	17.3105	15.87	22.1682	20.18
R<=3	4.8577	9.16	4.8577	9.16
		Unrestricted intercept and no trends		
R=0	39.7049	31.79	88.8782	63
R<=1	24.3548	25.42	49.1732	42.34
R<=2	19.3937	19.22	24.8184	25.77
R<=3	5.4247	12.39	5.4247	12.39

Attempts to identify the two vectors were not successful, and since the error-correction equations revealed that only the first vector was significant in the real exchange rate equation, the VAR was restricted to contain only the first cointegrating vector. (The VEQM representation of the variables is presented in Table 4.5.) This cointegrating vector, estimated for the period 1970 - 2002, has the form:

$$\log(R) = \underset{(5.6143)}{0.60747}\log(TNT) + \underset{(7.4754)}{0.37377}NFA + \underset{(4.0215)}{1.5314}\log(TOT) + \underset{(98.7166)}{4.3534} \qquad (4.1)^{77}$$

All coefficients in this cointegrating vector show the *a priori* correct signs and are statistically significant. In addition, the resulting vector is roughly similar to the Engle-Granger estimates presented in Table 4.2, except for the coefficient of log (*TOT*), which exceeded unity. Indeed the estimate of 1.5 for the coefficient of log (*TOT*) appears on a priori grounds to be too high when compared with the Engle-Granger estimates for the comparable sample period.

Although the parameter estimates from the Engle-Granger technique were generally similar to those from the Johansen procedure, the former method was preferred on account of the effect of the data limitations on the robustness of the results from the Johansen procedure.

TABLE 4.5: VEQM REPRESENTATION OF VARIABLES

Panel (a): ECM for variable log (*R*) estimated by OLS based on cointegrating VAR (3)

Dependent variable is Δlog (*R*) - 30 observations used for estimation from 1973 to 2002

Regressor	*Coefficient*	*Standard Error*	*T-Ratio [Prob]*
Δlog (*R*)(-1)	.35074	.22969	1.5270 [.142]
Δlog (*TNT*)(-1)	.095190	.10560	.90139 [.378]
NFA (-1)	.19958	.067135	2.9729 [.008]
Δlog (*TOT*)(-1)	.20734	.14133	1.4670 [.158]
Δlog (*R*)(-2)	.37287	.15151	2.4611 [.023]
Δlog (*TNT*) (-2)	-.31588	.14544	-2.1720 [.042]
Δ*NFA* (-2)	-.27538	.10215	-2.6958 [.014]
Δlog (*TOT*)(-2)	-.39585	.17452	-2.2683 [.035]
ecm1 (-1)	-.19626	.12083	-1.6243 [.120]
RI	-.0064938	.0016146	-4.0219 [.001]

ecm1 = 1.0000 log(*R*) -.63862 log(*TNT*) -.36772 *NFA* -1.6221 log(*TOT*) -4.3592

R-Squared	.78253	R-Bar-Squared	.68467
S.E. of Regression	.020803	F-stat. F(9, 20)	7.9964[.000]
Mean of Dependent Variable	-.012454	S.D. of Dependent Variable	.037046
Residual Sum of Squares	.0086553	Equation log-likelihood	79.6936
Akaike Info. Criterion	69.6936	Schwarz Bayesian Criterion	62.6876
DW-statistic	1.8359	System log-likelihood	258.5728

Diagnostic Tests

Test statistic	*LM Version*	*F Version*
A: Serial Correlation	CHSQ(1) = .33759[.561]	F(1,19) = .21624[.647]
B: Functional Form	CHSQ(1) = 2.3246[.127]	F(1,19) = 1.5959[.222]
C: Normality	CHSQ(2) =.10933[.947]	Not applicable
D: Heteroscedasticity	CHSQ(1) = .0076493[.930]	F(1,28) = .0071412[.933]

[77] Parentheses contain the t statistic.

TABLE 4.5 (contd.)

Panel (b): ECM for variable log (*R*) estimated by OLS based on cointegrating VAR(3)

Dependent variable is Δlog(*R*) - 30 observations used for estimation from 1973 to 2002

Regressor	*Coefficient*	*Standard Error*	*T-Ratio [Prob]*
Δlog(*R*)(-1)	.68310	.27665	2.4692[.022]
Δlog(*TNT*)(-1)	.099585	.13523	.73640[.470]
Δ*NFA*(-1)	.16697	.086051	1.9404[.066]
Δlog(*TOT*)(-1)	.23428	.17872	1.3109[.204]
Δlog(*R*)(-2)	.56291	.18667	3.0155[.007]
Δlog(*TNT*)(-2)	-.55380	.17155	-3.2282[.004]
Δ*NFA*(-2)	-.42772	.12201	-3.5056[.002]
Δlog(*TOT*)(-2)	-.73931	.19209	-3.8487[.001]
ecm1(-1)	-.28963	.15702	-1.8445[.079]

ecm1 = 1.0000 log(*R*) -.60747 log(*TNT*) -.37377 *NFA* -1.5314 log(*TOT*) -4.3534

R-Squared	.61586	R-Bar-Squared	.46952
S.E. of Regression	.026982	F-stat. F(8, 21)	4.2084[.004]
Mean of Dependent Variable	-.012454	S.D. of Dependent Variable	.037046
Residual Sum of Squares	.015289	Equation log-likelihood	71.1592
Akaike Info. Criterion	62.1592	Schwarz Bayesian Criterion	55.8538
DW-statistic	1.8402	System log-likelihood	245.2814

Diagnostic Tests

Test statistic	*LM Version*	*F Version*
A: Serial Correlation	CHSQ(1)= .52161[.470]	F(1,20) =.35389[.559]
B: Functional Form	CHSQ(1)= 2.3794[.123]	F(1,20) = 1.7229[.204]
C: Normality	CHSQ(2)= .18554[.911]	Not applicable
D: Heteroscedasticity	CHSQ(1)= .028326[.866]	F(1,28) = .026463[.872]

Panel (c): ECM for variable log (*TNT*) estimated by OLS based on cointegrating VAR (3)

Dependent variable is Δlog(*TNT*) - 30 observations used for estimation from 1973 to 2002

Regressor	*Coefficient*	*Standard Error*	*T-Ratio [Prob]*
Δlog(*R*)(-1)	.28055	.68484	.40966[.686]
Δlog(*TNT*)(-1)	-.12942	.33476	-.38659[.703]
Δ*NFA*(-1)	-.23415	.21302	-1.0992[.284]
Δlog(*TOT*)(-1)	.16131	.44242	.36461[.719]
Δlog(*R*)(-2)	.17092	.46210	.36988[.715]
Δlog(*TNT*)(-2)	-.17562	.42466	-.41354[.683]
Δ*NFA*(-2)	-.18962	.30204	-.62781[.537]
Δlog(*TOT*)(-2)	-.44131	.47553	-.92805[.364]
ecm1(-1)	-.066069	.38871	-.16997[.867]

List of additional temporary variables created:
ecm1 = 1.0000 log(*R*) -.60747 log(*TNT*) -.37377 *NFA* -1.5314 log(*TOT*) -4.3534

R-Squared	.16044	R-Bar-Squared	-.15940
S.E. of Regression	.066794	F-stat. F(8, 21)	.50162[.841]
Mean of Dependent Variable	.0073609	S.D. of Dependent Variable	.062033
Residual Sum of Squares	.093690	Equation log-likelihood	43.9663
Akaike Info. Criterion	34.9663	Schwarz Bayesian Criterion	28.6609
DW-statistic	1.9923	System log-likelihood	245.2814

Diagnostic Tests

Test statistic	*LM Version*	*F Version*
A: Serial Correlation	CHSQ(1) = .22672[.634]	F(1,20) = .15230[.700]
B: Functional Form	CHSQ(1) = .25547[.613]	F(1,20) =. 17178[.683]
C: Normality	CHSQ(2) = 1.7368[.420]	Not applicable
D: Heteroscedasticity	CHSQ(1) = .13680[.711]	F(1,28) = .12826[.723]

A: Lagrange multiplier test of residual serial correlation
B: Ramsey's RESET test using the square of the fitted values
C: Based on a test of skewness and kurtosis of residuals
D: Based on the regression of squared residuals on squared fitted values

TABLE 4.5 (contd.)

Panel (d): ECM for variable *NFA* estimated by OLS based on cointegrating VAR (3)

Dependent variable is Δ*NFA* - 30 observations used for estimation from 1973 to 2002

Regressor	*Coefficient*	*Standard Error*	*T-Ratio [Prob]*
Δlog(*R*)(-1)	.070573	.71850	.098223[.923]
Δlog(*TNT*)(-1)	.34552	.35122	.98376[.336]
Δ*NFA*(-1)	.37576	.22349	1.6813[.108]
Δlog(*TOT*)(-1)	.58118	.46417	1.2521[.224]
Δlog(*R*)(-2)	-.21712	.48481	-.44784[.659]
Δlog(*TNT*)(-2)	.046911	.44554	.10529[.917]
Δ*NFA*(-2)	.013338	.31689	.042092[.967]
Δlog(*TOT*)(-2)	.68107	.49890	1.3652[.187]
ecm1(-1)	.13472	.40782	.33033[.744]

List of additional temporary variables created:
ecm1 = 1.0000 log(*R*) -.60747 log(*TNT*) -.37377 *NFA* -1.5314 log(*TOT*) -4.3534

R-Squared	.27530	R-Bar-Squared	-.7693E-3
S.E. of Regression	.070077	F-stat. F(8, 21)	.99721[.467]
Mean of Dependent Variable	-.018837	S.D. of Dependent Variable	.070050
Residual Sum of Squares	.10313	Equation log-likelihood	42.5267
Akaike Info. Criterion	33.5267	Schwarz Bayesian Criterion	27.2213
DW-statistic	2.1868	System log-likelihood	245.2814

Diagnostic Tests

Test statistic	*LM Version*	*F Version*
A: Serial Correlation	CHSQ(1) = 1.3739[.241]	F(1,20) = .95992[.339]
B: Functional Form	CHSQ(1) = 1.1118[.292]	F(1,20) = .76971[.391]
C: Normality	CHSQ(2) = .40677[.816]	Not applicable
D: Heteroscedasticity	CHSQ(1) = 1.0640[.302]	F(1,28) = 1.0296[.319]

Panel (e): ECM for variable log (*TOT*) estimated by OLS based on cointegrating VAR (3)

Dependent variable is Δlog(*TOT*) - 30 observations used for estimation from 1973 to 2002

Regressor	*Coefficient*	*Standard Error*	*T-Ratio [Prob]*
Δlog(*R*)(-1)	-.68251	.34633	-1.9707[.062]
Δlog(*TNT*)(-1)	.51114	.16929	3.0192[.007]
Δ*NFA*(-1)	.24308	.10773	2.2565[.035]
Δlog(*TOT*)(-1)	.23024	.22374	1.0291[.315]
Δlog(*R*)(-2)	-.27108	.23369	-1.1600[.259]
Δlog(*TNT*)(-2)	.32947	.21476	1.5342[.140]
Δ*NFA*(-2)	.24459	.15274	1.6013[.124]
Δlog(*TOT*)(-2)	.19744	.24048	.82102[.421]
ecm1(-1)	.68368	.19658	3.4780[.002]

List of additional temporary variables created:
ecm1 = 1.0000 log(*R*) -.60747log(*TNT*) -.37377 *NFA* -1.5314 log(*TOT*) -4.3534

R-Squared	.52676	R-Bar-Squared	.34648
S.E. of Regression	.033779	F-stat. F(8, 21)	2.9219[.023]
Mean of Dependent Variable	-.0055234	S.D. of Dependent Variable	.041784
Residual Sum of Squares	.023961	Equation log-likelihood	64.4199
Akaike Info. Criterion	55.4199	Schwarz Bayesian Criterion	49.1145
DW-statistic	1.9741	System log-likelihood	245.2814

Diagnostic Tests

Test statistic	*LM Version*	*F Version*
A: Serial Correlation	CHSQ(1) = 2.9163[.088]	F(1,20) = 2.1536[.158]
B: Functional Form	CHSQ(1) = .011561[.914]	F(1,20) = .0077103[.931]
C: Normality	CHSQ(2) = .75131[.687]	Not applicable
D: Heteroscedasticity	CHSQ(1) = .079562[.778]	F(1,28) = .074455[.787]

A: Lagrange multiplier test of residual serial correlation
B: Ramsey's RESET test using the square of the fitted values
C: Based on a test of skewness and kurtosis of residuals
D: Based on the regression of squared residuals on squared fitted values

4.4 Estimates of BEER and BEER (SF)

Plugging the contemporaneous values of the explanatory variables generates the estimated BEER. Chart 4.8 plots the latter according to Models 1 and 2, along with the actual *R*. The results that emerge from these two models are very similar, as can be seen from the chart. For example, the estimated deviation from the ERER in 2002 ranges from an under-valuation of 0.5% in Model 2 to an overvaluation of 0.1% in Model 1. Given the recent state of the fundamental variables, the deviation in Malta's ERER from the corresponding equilibrium rate was negligible.

However, the fundamental variables themselves may have strayed away from their equilibrium levels. Thus, it would be more appropriate to consider the extent of the deviation that would have prevailed had the fundamentals been in equilibrium or at their long-run levels. This approach measures the divergence of *R* from the BEER, where the latter is estimated from the *smoothened* values of the *fundamental* variables. This variant of the BEER is labelled BEER (SF). Among the various statistical smoothing techniques used to obtain estimates of BEER (SF) this study used the Hodrick-Prescott filter (λ=100).[78] [79]

CHART 4.8: *R* AND BEER

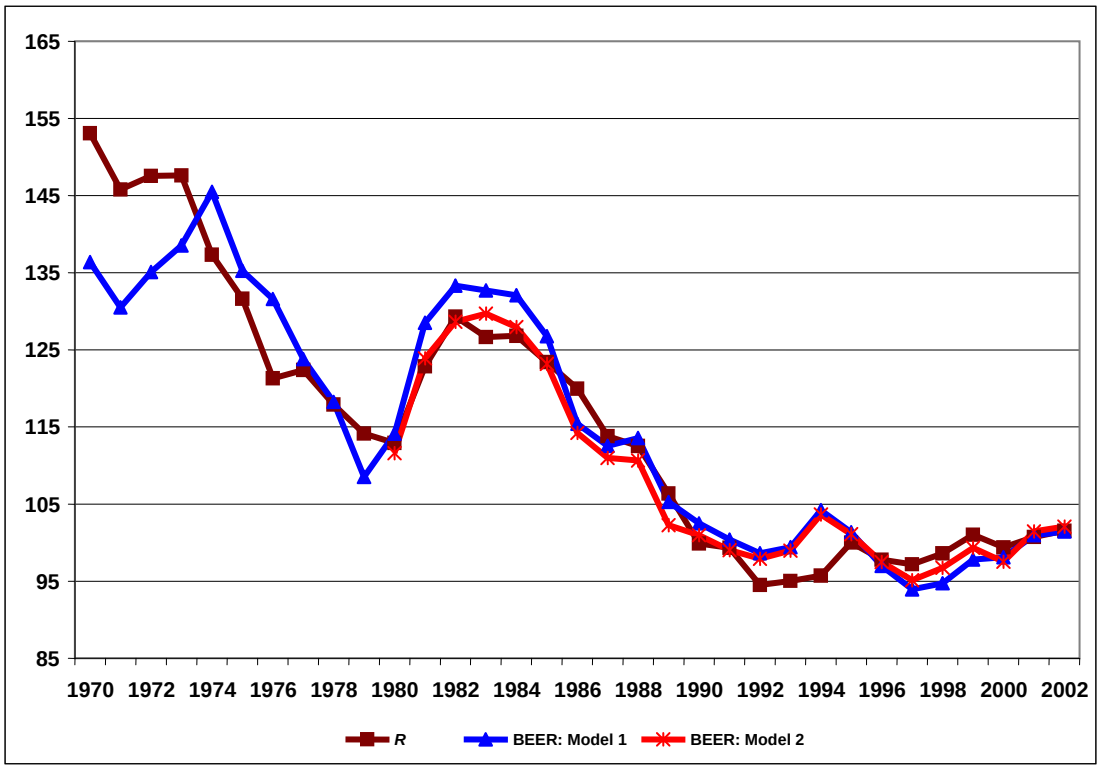


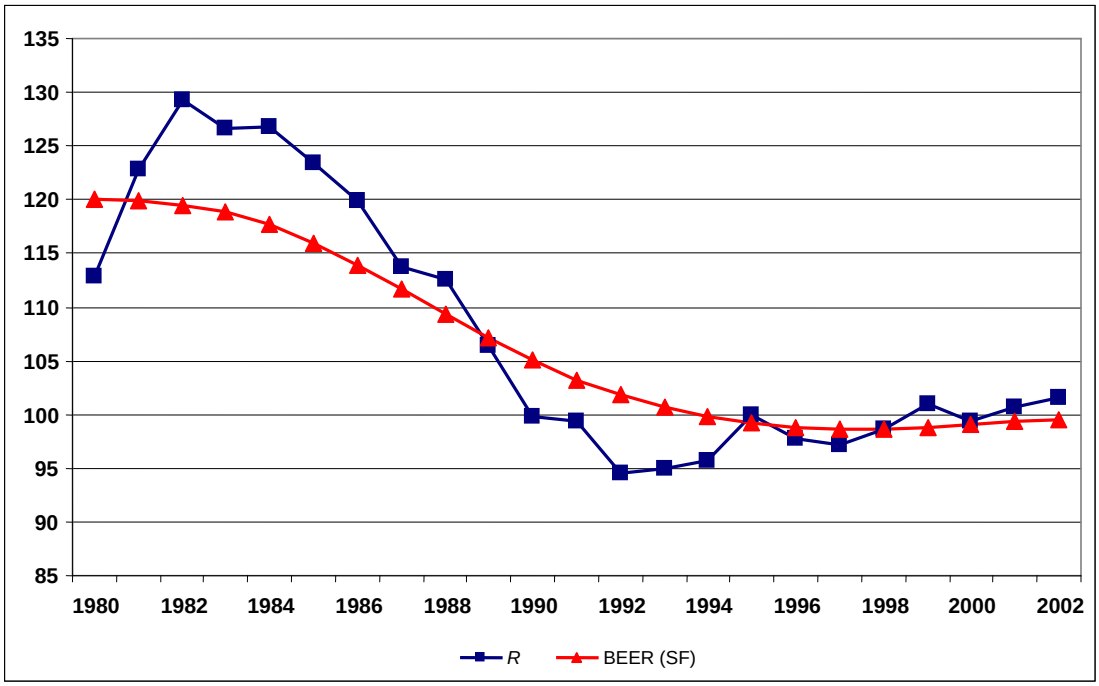
Chart 4.9 plots the observed *R* along with the BEER (SF), which in turn, was obtained by plugging filtered fundamental variables[80] into the results of Model 2 (Table 4.2, above), which is the preferred long-run model of the BEER.

[78] Although this method simply entails a mechanical procedure that does not correspond to the notion of internal and external equilibrium of an economy, the technique retains the permanent component of a series by filtering away its transitory counterpart. Thus, the resulting smoothed series can be perceived as an 'equilibrium' strand of data.

[79] As in Clark and MacDonald (1998) and Cady (2003).

[80] Before filtering, the fundamental variables were forecasted up to 2010 using the estimated VAR. This was done so as to circumvent the tendency of the HP filter to yield the same values as the actual series towards the end of the sample.

CHART 4.9: *R* AND BEER (SF)



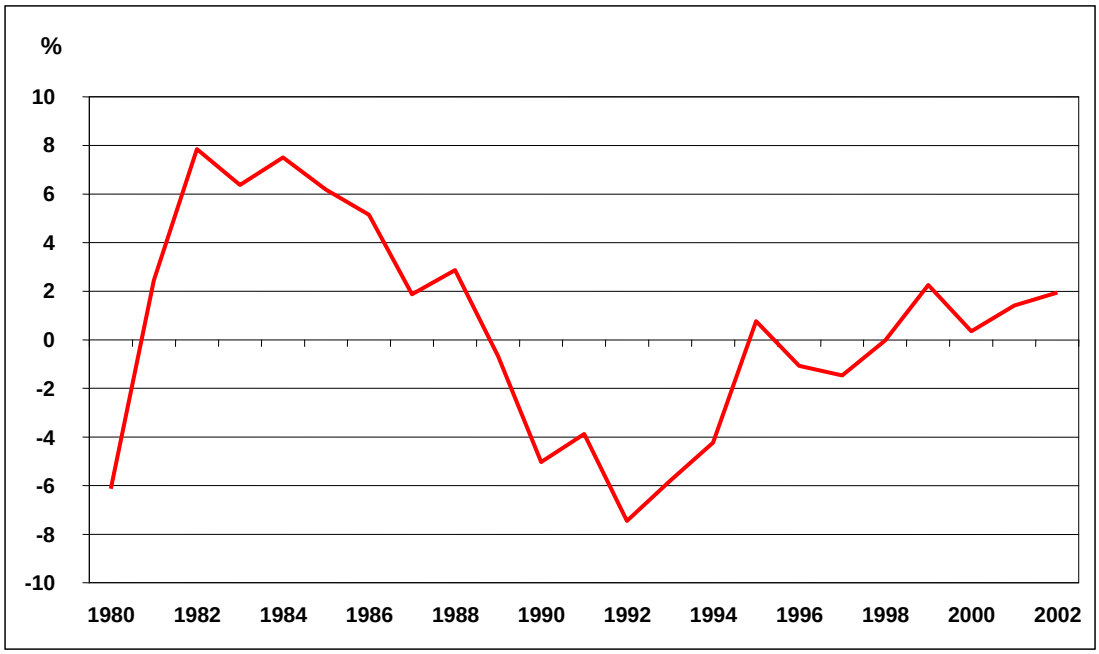
The chart shows a depreciating ERER through to the mid-nineties, which mainly reflects a deterioration in the relative terms of trade and a decline in the ratio of the net foreign assets to GDP. The first is mostly the result of the dominance of the electronics industry in Malta's exports and imports. Prices declined steadily, mainly spurred by technological progress in the industry worldwide. On the other hand, the deterioration in the net foreign asset position of the monetary sector resulted from persistent current account deficits, which grew relative to GDP in the nineties, driven mainly by trade liberalisation and economic growth.

The deviation of Malta's *R* from the BEER (SF) is illustrated in Chart 4.10. This shows a significant positive deviation in the 1980s, especially during the first half of the decade. This in turn mainly reflected the hard exchange rate policy adopted until the mid-eighties. Following the adoption of more market-oriented policies in the late eighties and revisions to the exchange rate basket of the Maltese lira to better reflect trade flows, the economy experienced higher growth rates up to 1994. This led to considerable productivity gains, accompanied by lower inflation relative to Malta's trading partners. Consequently, up to 1994, Malta's real effective exchange rate showed a negative deviation from the BEER (SF). After 1992, this began to narrow, reflecting to some extent the higher imported inflation that was triggered by the 1992 devaluation of the Maltese lira.[81]

The deviation from the ERER averaged a marginal -0.5% between 1995 and 1998. Subsequently this turned slightly positive for the remainder of the sample period. Thus, the estimates of the BEER (SF) generated by the preferred model (Model 2) indicate a deviation of about +2% in 2002.

[81] The devaluation alone contributed to an undervaluation of the currency, but there was the contemporaneous devaluation of the other significant currencies.

CHART 4.10: DEVIATION OF *R* FROM BEER (SF)



4.5 Summary

This chapter used the analytical framework of the BEER to estimate Malta's ERER. Of the two approaches used, the Engle-Granger approach was more suitable, mainly on account of the statistical limitations identified in the application of the Johansen procedure. These notwithstanding, both techniques were applied to the data and these yielded similar results, with the exception of the estimated coefficient for the terms of trade.

The BEER estimates constructed from the smoothened levels of the fundamentals showed a historically depreciating ERER, which was influenced by a steady decline in the relative terms of trade, as well as a deterioration in the net foreign asset position of the monetary sector.

The results indicated an overvalued real exchange rate in the eighties, which was reversed during the first half of the nineties. This was followed by a brief period of virtual equilibrium, and then by a small degree of overvaluation in the 1999 - 2002 period.

TABLE 4.6: ESTIMATED DEVIATION FROM ERER: BEER APPROACH

	Deviation in 2002
BEER: Coefficient-estimation period: 1980 - 2002	-0.5% to +0.1%
BEER (SF): Coefficient-estimation period: 1980 - 2002	+2.0%

Chapter 5: Maeso-Fernandez *et al*

5.1 Introduction

This methodology for estimating the ERER is based on that used by Maeso-Fernandez *et al* (2004), henceforth labelled as Maeso-Fernandez.[82] As already indicated in the literature review in Chapter 1, these authors estimated the exchange rate gap, which is the difference between the actual values of the exchange rate and the PPP rate. They applied this methodology to the EU acceding countries of central and eastern Europe (CEE).

Since time series data for these countries are limited, Maeso-Fernandez adopted a two-stage approach. In the first stage, they used panel data on twenty-five industrialised countries to estimate the key parameters. In the second stage, they drew up a methodology to estimate the exchange rate gap for the acceding countries, using the parameter estimates from the first stage. Although Maeso-Fernandez suggested using the slope coefficients estimated in the first stage to measure the exchange rate gap for the acceding CEE countries, they recommended caution in the choice of the constant term for the CEE countries since the experience of the latter was likely to differ from that of the countries included in their sample.

This chapter estimates an equation for the Maltese exchange rate gap using the same specification as Maeso-Fernandez, and using annual data for 1970 - 2002. The following are the explanatory variables:

- **GDP per capita.** This captures the Balassa-Samuelson effect, or the impact of increased productivity and greater disposable income on the national price level.
- **the degree of openness** ([average of exports and imports]/GDP). This captures the relative price movement (i.e., the real effective exchange rate change) necessary to shift the required resources into the tradable goods sector.
- **government spending as a ratio of GDP**. This represents the impact of government spending, which falls primarily on non-tradable goods.

All of these explanatory variables are expressed in relative terms: Malta compared to the EU15. The logic behind the Maeso-Fernandez method is that as a country's real GDP approaches the EU average, the country's exchange rate gap will decline as its national price level approaches that of the EU. The results provide a useful comparison to the parameters as estimated by Maeso-Fernandez.

5.2 A Dynamic OLS model of the Maltese ERER

In the first stage of their procedure, Maeso-Fernandez use various econometric specifications and techniques to estimate a dynamic model of the exchange rate gap. Because Malta has a longer time series of data than the CEE countries, this chapter applies Maltese data to one of those specifications for the period 1970 - 2002. The Dynamic OLS specification is as follows:

$$\log(EGAP_t) = \alpha_i + \beta_1 \log(y_t) + \beta_2 \log(OPEN_t) + \beta_3 \log(GOV_t) + \sum_{-1}^{+1} \delta_j \Delta x_{t-j} + \varepsilon_t. \quad (5.1)$$

EGAP is the **exchange rate gap**, defined as the ratio of the PPP exchange rate to the actual exchange rate.[83, 84] This gap represents an estimate of the difference between the actual exchange rate and the long-run PPP value. The explanatory variables are: *y*, which is **output per capita in Malta relative to the EU15**,[85] *OPEN*, which is the **openness** of the Maltese economy, defined as the average of imports and exports as a ratio of GDP relative to the EU15; and *GOV*, which is the **ratio of government spending to GDP** in Malta relative to the EU15. The regression model also

[82] See also Schembri (2004).

[83] Prices are measured in terms of the purchasing power standard.

[84] Since relative price and per capita GDP data at PPS were unavailable before 1999, data for 1970-1998 were estimated by adjusting backwards the observation for 1999 using the growth rates for the GDP deflator and real GDP for both Malta and the EU-15 countries. Exchange rates are measured as Maltese lira per euro.

[85] Measured in terms of the purchasing power standard.

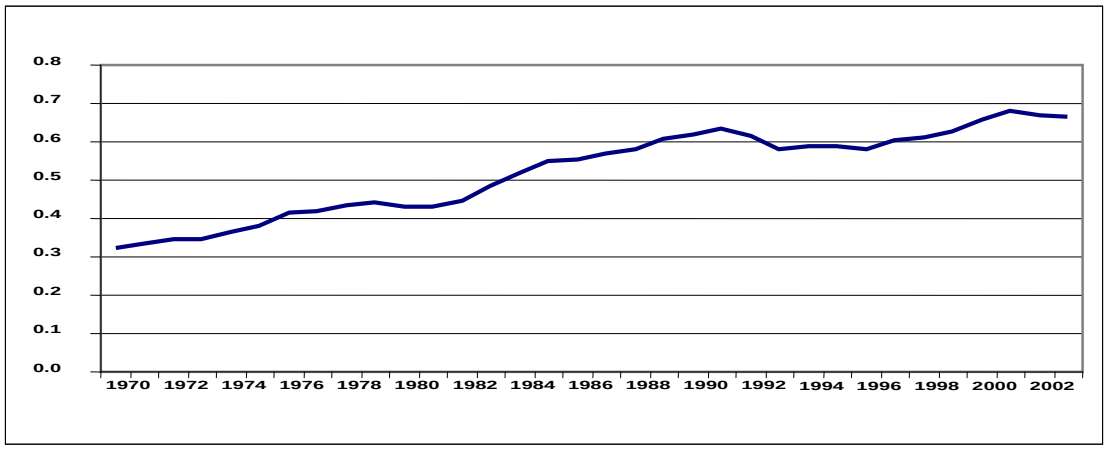
includes constant and trend terms as well as the contemporaneous, lead and lagged values of the differences of the three explanatory variables (the Δx's). These last variables capture the short-run dynamics and ensure super-consistency in the context of a long-run co-integrating relation between the dependent variable and the three explanatory variables.[86]

The data consist of Maltese and EU15 data over the period 1970-2002. Most are taken from the AMECO database[87], as indicated earlier, and also from Maltese sources. Some interpolation was necessary to fill in the gaps, primarily in the PPP series for Malta.

There are also two important differences between the Maeso-Fernandez data and those used in the estimation. First, as a measure of government spending Maeso-Fernandez employ data on final consumption expenditure, which excludes government capital expenditure, transfer payments or interest payments on government debt. However, as there appears to be no justification for restricting the variable to government consumption expenditure, in the Malta case total government expenditure was used in the estimation of Equation 5.1. In addition, this estimation used trade in both goods and services to measure openness, in recognition of the importance of tourist services as a source of export revenue for Malta.

Movements in the dependent variable and the three explanatory variables are shown in Charts 5.1 - 5.4. They indicate that the Maltese economy has been generally converging to EU averages over the period 1970 - 2002. This is particularly true of GDP per capita. However, increasing openness in the EU15 has reduced Malta's relative openness. On the other hand, the level of government spending in Malta is not far from the EU15 average. This general convergence has contributed to a narrowing of the exchange rate gap as the Maltese national price level approaches that of the EU15.

CHART 5.1: EXCHANGE RATE GAP (PPP/ACTUAL)



[86] This co-integrating relationship was found by Maeso-Fernandez in their sample.

[87] AMECO is the database of the Directorate-General, Economic and Financial Affairs, of the European Commission.

CHART 5.2: RELATIVE PER CAPITA GDP

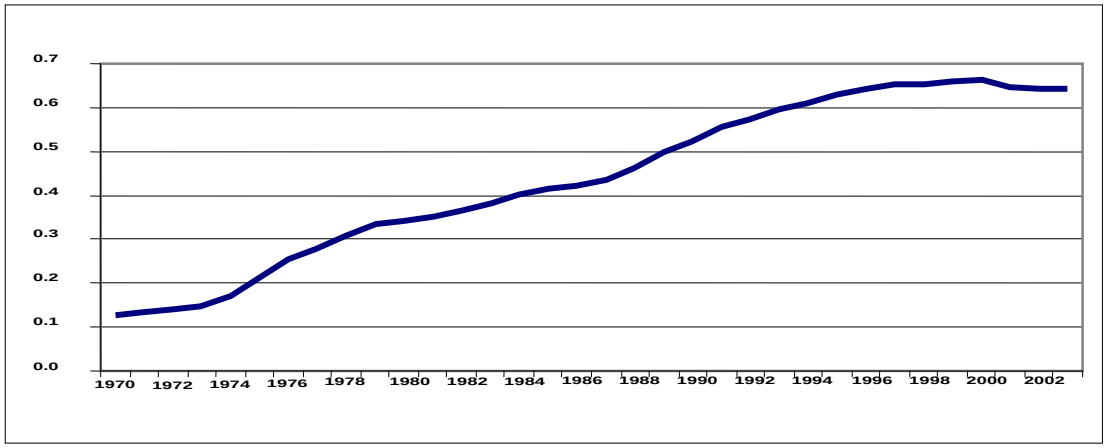


CHART 5.3: RELATIVE OPENNESS

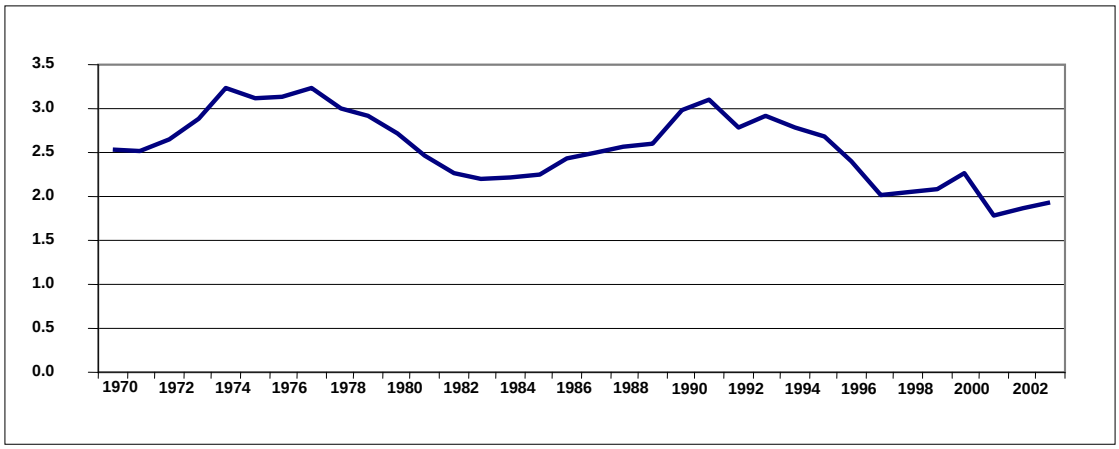
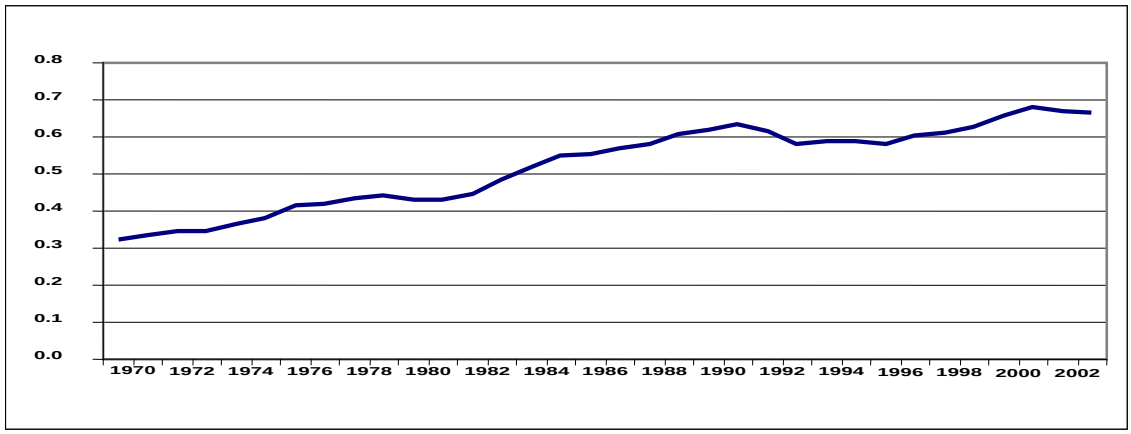


CHART 5.4: RELATIVE GOVERNMENT SPENDING



The test results for Equation 5.1 using Maltese data for 1970-2002 are presented in Table 5.1. Also shown are the Dynamic OLS results obtained by Maeso-Fernandez from the industrial countries sample in the first stage of the procedure. The two sets of results are qualitatively similar. The key coefficients carry the same signs, and they are statistically significant and of comparable magnitude. In general, the coefficients for the Maltese equation are larger in absolute value than those for the industrialised countries, which is not surprising given that Malta is quite different from the countries included in the Maeso-Fernandez sample. One may have expected, however, that the coefficient for the government-spending variable would be smaller for Malta, since the Maltese economy is more open than those other countries, making it more likely that its government spending would be less biased towards non-tradable goods and services.

TABLE 5.1: ESTIMATED EXCHANGE RATE GAP: MALTA & INDUSTRIALIZED COUNTRIES*

Explanatory variable	Malta 1970-2002	Maeso-Fernandez industrialized countries sample 1975-2002[88]
$\log(y)$	**0.451** (7.95)	**0.360** (10.6)
$\log(OPEN)$	**-0.191** (-3.33)	**-0.119** (-2.8)
$\log(GOV)$	**0.328** (2.07)	**0.219** (6.2)
constant	**-0.0818** (-0.71)	

* Parentheses contain the t statistic.

Chart 5.5 shows the actual and fitted values of the exchange rate gap over the period 1970 to 2003. Overall, Equation 5.1 captures the key movements in the exchange rate gap and indicates that the fitted and actual values were essentially the same in recent years. In 2003, the actual gap was slightly smaller than the fitted gap by approximately 1%.[89, 90]

5.3 Summary

The main strength of the Maeso-Fernandez approach is that it incorporates explanatory variables that are both theoretically important and empirically significant in determining real exchange rate movements. In particular, it includes variables that represent the Balassa-Samuelson effect, the effect of increased openness to trade and the impact of government spending.

One of the Maeso-Fernandez specifications was estimated with Maltese data for the period 1970 – 2002. On the basis of this test it was estimated that in 2003 the exchange rate deviated by +1% from the ERER (Table 5.2).

[88] Maeso-Fernandez, Table 6 on page 26.

[89] This difference between the actual exchange rate and the rate predicted by the short-term fundamentals of the equation is appropriate as a measure of over or under-valuation. A measure of the total gap would be useful for predicting future movements in exchange rates or inflation rates as a country converges, its national price level rises and its real exchange rate appreciates.

[90] A separate investigation was conducted in line with Maeso-Fernandez's two-step procedure. It should be recalled that in the first stage Maeso-Fernandez applied three estimation techniques to panel data on 25 industrialised countries for the period 1975-2002. The techniques were:

- pooled group mean estimation (PGME);
- fully modified OLS (FMOLS); and
- dynamic OLS (DOLS).

In turn, Maeso-Fernandez applied each of the last two techniques in two versions – one weighted and the other unweighted - to correct for the small sample bias due to the assumption of fixed effects and the possible correlation of the country-specific constant term and the error term.

Consequently this investigation for Malta applied a constant term of -0.0818, obtained from the findings presented in Section 5.2 above, in conjunction with the slope estimates from the first stage of Maeso-Fernandez (Table 6 on page 26 of Maeso-Fernandez), to comparable Maltese data in order to generate second-stage estimates of the exchange rate gap for the period 1995-2003. This sample period was the longest span for which similar data for Malta and the EU15 data are available from the AMECO database (used by Maeso-Fernandez in their study).

The shortcoming of this method is that the use of the constant term from the Maltese data sample is not consistent with the estimates of the slope coefficients taken from the first stage of the Maeso-Fernandez procedure. This method does not satisfy the property of least squares estimation that requires the sum of residuals to equal zero. This casts a serious doubt on the validity of both the method and the results, particularly since the results of this investigation depend critically on the choice of the constant term. As a consequence of this reservation, this line of inquiry was not pursued further.

CHART 5.5: ACTUAL AND FITTED EXCHANGE RATE GAPS, IN NATURAL LOGS

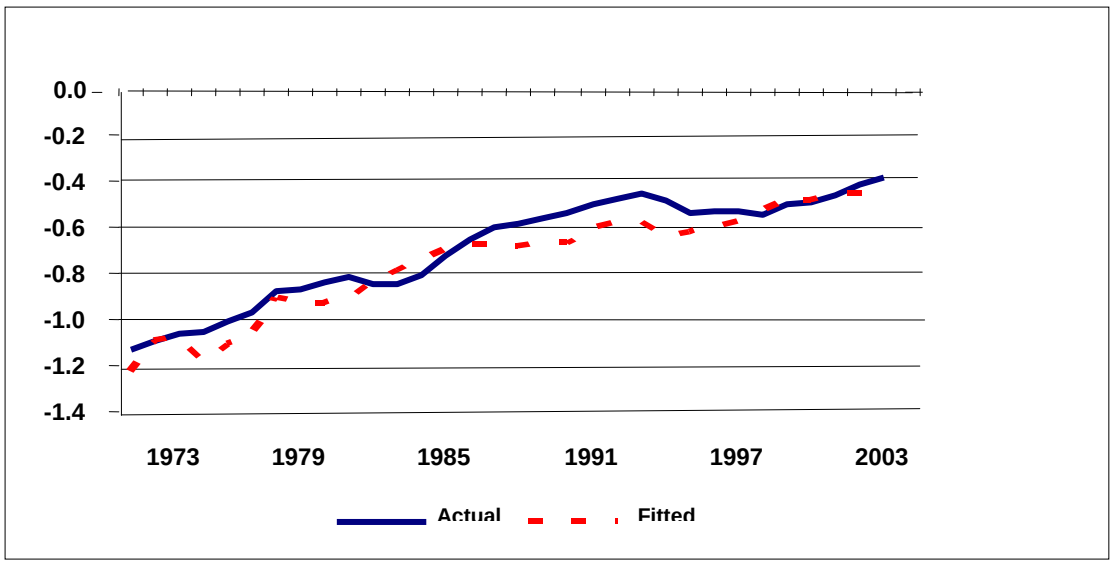


TABLE 5.2: ESTIMATED DEVIATION FROM ERER: MAESO-FERNANDEZ APPROACH

	Deviation in 2003
Coefficient-estimation period: 1970 - 2002	+1.0%

Chapter 6: Update

6.1 Introduction

The estimations of the ERER of the Maltese lira conducted in 2003 and early 2004, as presented in Chapters 2 – 5, are updated and retested in this chapter in the light of the publication of new and revised data.

Earlier in this study estimates were generated from the simple PPP method in Chapter 2, from a modified-PPP approach along the lines of Rogoff (1996) and Coudert and Couharde (2002, 2003) in Chapter 3, from the BEER approach of Clark and MacDonald (1998, 2000) in Chapter 4, and from the Maeso-Fernandez *et al* (2004) variant of BEER in Chapter 5. This chapter re-tests the second (modified PPP) and last (Maeso-Fernandez *et al*) approaches using new and revised data for Malta.

6.2 Update of the modified-PPP approach

On the lines of Rogoff (1996), Chapter 3 presented the estimation of a cross-sectional relationship from a sample of 103 countries between the relative price level and the relative level of economic development. This approach recognized that international differences in relative price levels may occur not only because of possible exchange rate misalignments, but also because of differences in the level of economic development.

The original estimation of Equation 3.1 in Chapter 3 produced an α of 2.30124, and a β of 0.44904. However, it was shown in Chapter 3 that when Malta was removed from the sample of 103 countries, the coefficients remained unaffected. Consequently, since this update and revision concerns only Maltese data, it was not found necessary to re-estimate the coefficients of Equation 3.1.

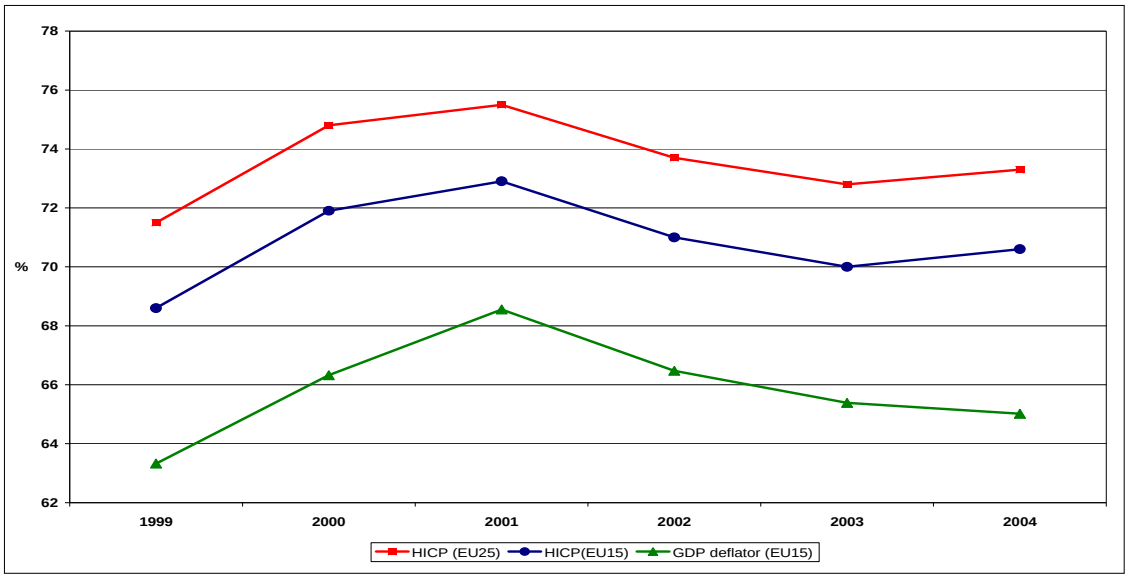
The latest available data for Malta's price level and per capita GDP at PPS, both measured relatively to the EU, were then used to re-estimate the ERER. An issue arose concerning the choice of the appropriate price variable, since the Harmonised Index of Consumer Prices (HICP) became available from 2003, thus providing an alternative to the GDP deflator.

It is recognised that in the estimates of the ERER, the most appropriate price variable is the one that covers the widest variety of goods and services and in addition reflects the prices of a homogeneous basket of goods and services across all countries under consideration. A reason for retaining the GDP deflator, which fully and directly covers exports, is its comprehensiveness. Since intermediate products make up a large proportion of Malta’s exports, price developments in the latter are captured in the GDP deflator, though not in a consumer price index. The deflator’s drawback, on the other hand, is its lack of international comparability. Since Malta's economic structure includes the relatively large electronics and tourism sectors, factors determining movements in Malta’s GDP deflator may differ from those affecting that of the EU. In contrast, the HICP covers a comparable basket of goods and services for both Malta and the EU. However, the advantage of the HICP in this regard is very limited. Since HICP statistics for Malta were only collected from 2003, the HICP index prior to 2003 is based on a backwards extrapolation using rates of change in the RPI. This consideration diminishes the international comparability of Malta’s HICP time series and weakens the case for preferring the HICP over the GDP deflator. This notwithstanding, separate estimations were conducted using both price indices.

Data for the EU as a whole were used, since the required statistical information for the euro area countries as a group was unavailable. Statistics for both relative price variables and relative GDP per capita at PPS for Malta and the EU were obtained from the Eurostat database. This source has the required data for both the EU15 and the EU25. Consequently estimates of the ERER were made on the basis of both EU15 and EU25 data to check whether the results were sensitive to the choice between the two groupings. Since no such sensitivity was observed, all subsequent

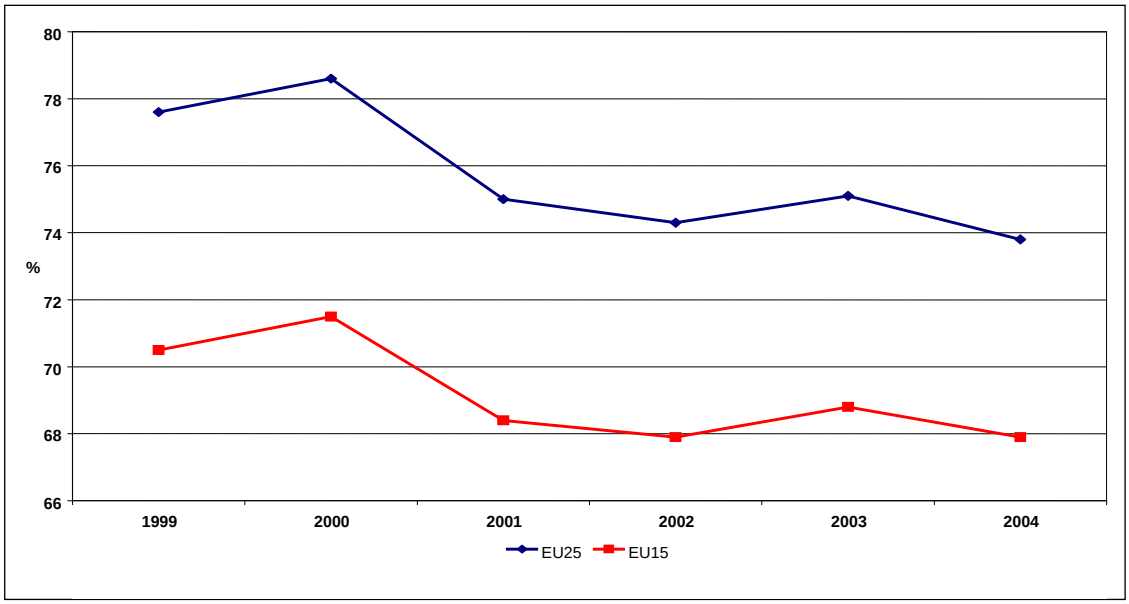
estimations were based on data for the EU15. The data set used in this update is shown in Charts 6.1 and 6.2. The ERER was estimated for the years 1999 – 2004.[91]

CHART 6.1: MALTA'S HICP AND GDP DEFLATOR, RELATIVE TO EU15/25*



* Data on the GDP deflator for EU25 were not available.

CHART 6.2: MALTA'S PER CAPITA GDP IN PPS RELATIVE TO EU15 AND EU25



[91] Data pertaining to Malta's price level and GDP relative to those of the EU15 were available as from 1999. Relative price variables for 2004 were estimated on the basis of data for the first three quarters of the year in the case of the GDP deflator and for the first eleven months of the year as regards the HICP. At the same time, data for Malta's GDP relative to that of the EU15 up to 2004 were available from the Eurostat database.

CHART 6.3: UPDATE OF THE MODIFIED-PPP METHOD: DEVIATION FROM ERER, USING HICP AND DEFLATOR

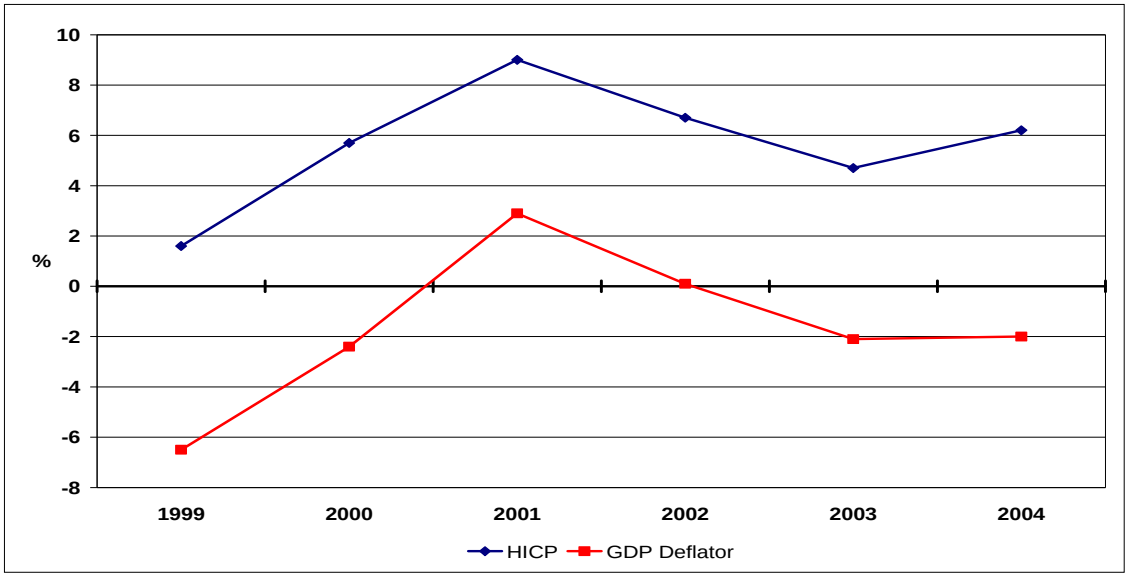


Chart 6.3 displays two estimates of the exchange rate deviation from equilibrium, one on the basis of the HICP and the other on the basis of the GDP deflator. It shows that the two measures follow a similar path. The margin of over-valuation as measured on the basis of the HICP (under-valuation, in the case of the deflator) increased (decreased) between 1999 and 2001. This trend was reversed between 2001 and 2003, but in 2004 the degree of over-valuation on the basis of the HICP (under-valuation on the basis of the deflator) rose (remained stable). The results show that in 2004 the estimated deviation on the basis of the two price variables ranged from around -2% to +6%.

6.3 Update of the Maeso-Fernandez approach

In view of the revisions relating to data on Malta's GDP per capita at PPS and its price level relative to that of the EU, as well as the availability of HICP data, a re-estimation was also undertaken on the basis of the Maeso-Fernandez specification discussed in Chapter 5.

The re-estimation was specified in the Dynamic OLS form, and included the same variables with one addition. A dummy variable, set at 1 from 2003 onwards, recognized a structural break in the time series. As stated above, since HICP data became available only from 2003, data prior to 2003 were extrapolated by applying RPI inflation rates to the HICP level in 2003. The HICP is also used in the computation of the consumption component of the real GDP.

As with the update of the modified-PPP method presented in Section 6.2 above, separate estimations were made using relative prices based on the HICP and the GDP deflator. The data sets for the period 1970 through 2004 (annual frequency) are plotted in Charts 6.4, 6.5 and 6.6.[92]

[92] Since relative price and per capita GDP data at PPS were unavailable before 1999, data for 1970-1998 were estimated by adjusting backwards the observation for 1999 using the growth rates for the GDP deflator, the RPI and real GDP for both Malta and the EU-15 countries.

CHART 6.4: MALTA'S PRICE LEVEL RELATIVE TO EU15

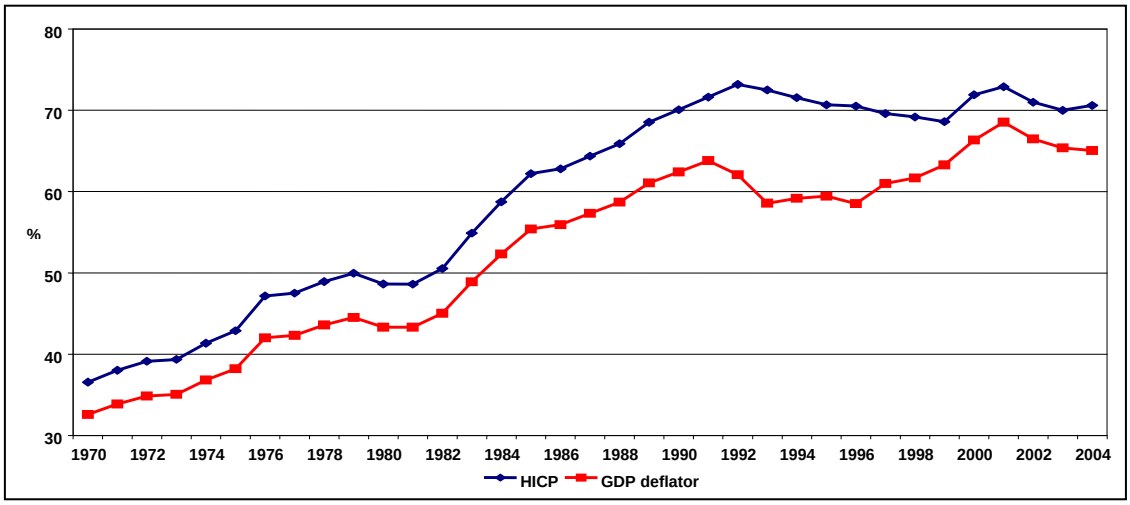


CHART 6.5: MALTA'S OPENNESS RELATIVE TO EU15

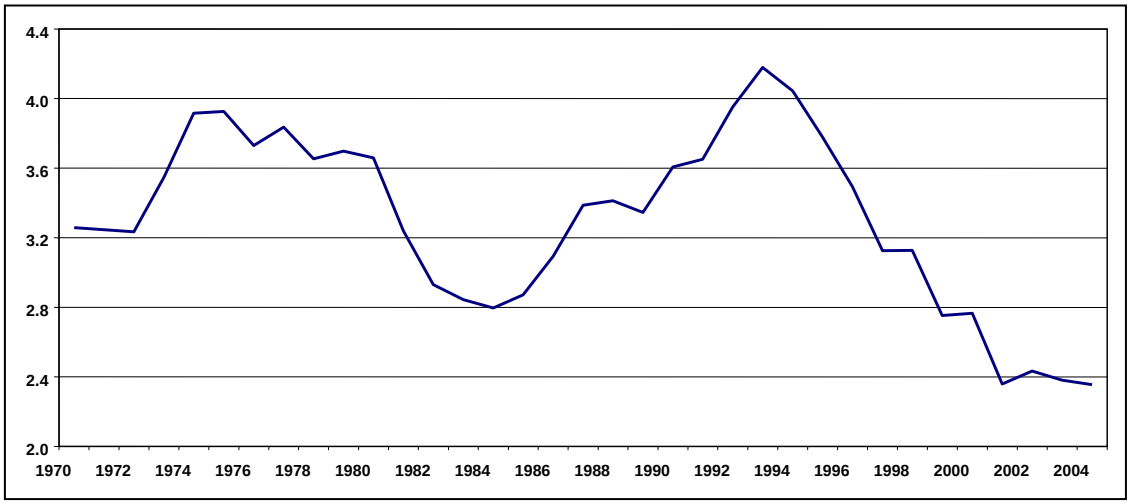
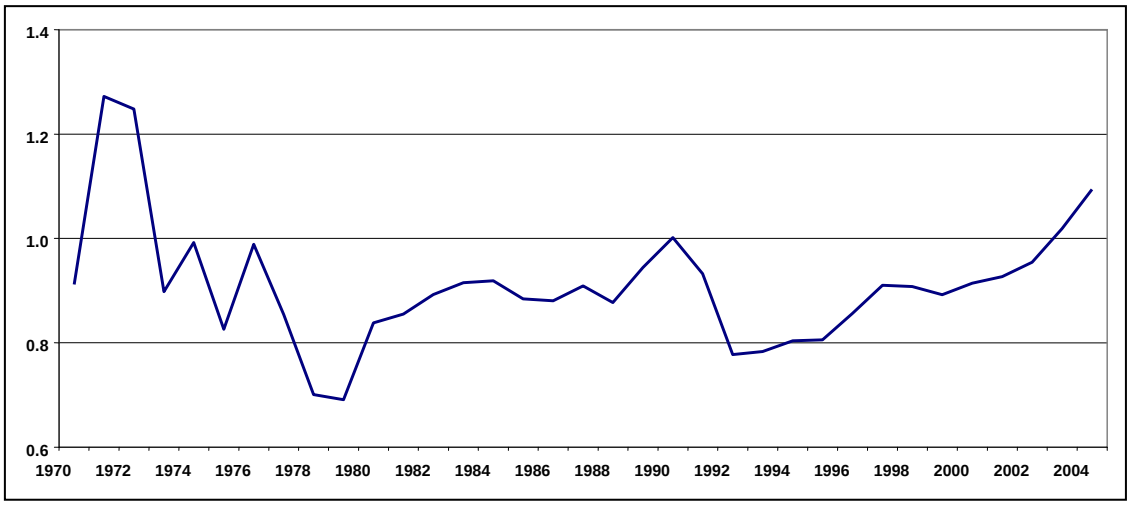


CHART 6.6: MALTA'S RATIO OF GOVERNMENT SPENDING TO GDP RELATIVE TO EU15



In Table 6.1, column 1 shows the results of the test that used the HICP as the relative price variable, while those for the GDP deflator are displayed in column 2. Column 3 reproduces the results of the previous estimation for the 1970 - 2002 period using the Maeso-Fernandez specification with Maltese data (Section 5.2 above). The original Maeso-Fernandez slope estimates are shown in column 4.

TABLE 6.1: UPDATED AND PREVIOUS PARAMETER ESTIMATES: MAESO-FERNANDEZ APPROACH*

Explanatory Variable	Malta: update (1970 – 2004)		Malta: estimates reported in Chapter 5 (1970 – 2002) using GDP deflator	Industrialised countries: Maeso-Fernandez estimates (1975 – 2002)
	Using HICP	Using GDP deflator		
	(1)	(2)	(3)	(4)
log (*y*)	**0.507** (28.63)	**0.499** (30.25)	**0.451** (7.95)	**0.360** (10.60)
log (*OPEN*)	**0.086** (1.48)	**-0.186** (-3.45)	**-0.191** (-3.33)	**-0.119** (-2.80)
log (*GOV*)	**0.432** (4.05)	**0.435** (4.38)	**0.328** (2.07)	**0.219** (6.2)
Break-in-series dummy	**-0.085** (-3.14)	**-0.110** (-4.36)	N.A.	N.A.
Constant term	**-0.151** (-2.35)	**0.032** (0.53)	**-0.082** (-0.71)	N.A.

* Parentheses contain the t statistic.

The two updated estimations in columns 1 and 2 show similar coefficients with respect to relative per capita GDP at PPS (*y*) and relative government expenditure (*GOV*). By contrast, the relative openness indicator (*OPEN*) produced diverging results, although in the case of the estimation based on HICP data the coefficient was not statistically different from zero, even for shorter sample periods. Meanwhile, the absolute value of the coefficient for the structural break in the data series was slightly higher in the estimation based on the GDP deflator. The latter estimation also produced a constant term that was not statistically different from zero, while that based on the HICP was statistically significant at almost the 1% level.

Only the revised estimates based on the GDP deflator in column 2 are strictly comparable to the earlier one for the 1970 - 2002 sample period in column 3. The results show that the coefficients for relative per capita GDP at PPS (*y*) and relative openness (*OPEN*) have remained broadly unchanged, while that for relative government expenditure (*GOV*) increased slightly in the new estimation. In neither test was the constant significantly different from zero, even at the 10% confidence level. When compared to the results obtained by Maeso-Fernandez, the relatively larger coefficient for government expenditure indicates that a bigger proportion of government expenditure in Malta (compared with the EU15) may be directed towards the purchase of non-tradable goods and services.

Separate estimates of the ERER were computed using first the HICP and then the GDP deflator. Two estimates of the ERER were made for each of these two price measures. These were based on

i. the updated coefficients from the 1970 - 2004 sample,
ii. the earlier results obtained from the 1970 - 2002 sample (Chapter 5).

The two estimates of the HICP-based deviation from ERER are shown in Chart 6.7, while the two using the GDP deflator are shown in Chart 6.8.

CHART 6.7: DEVIATION FROM ERER USING THE HICP

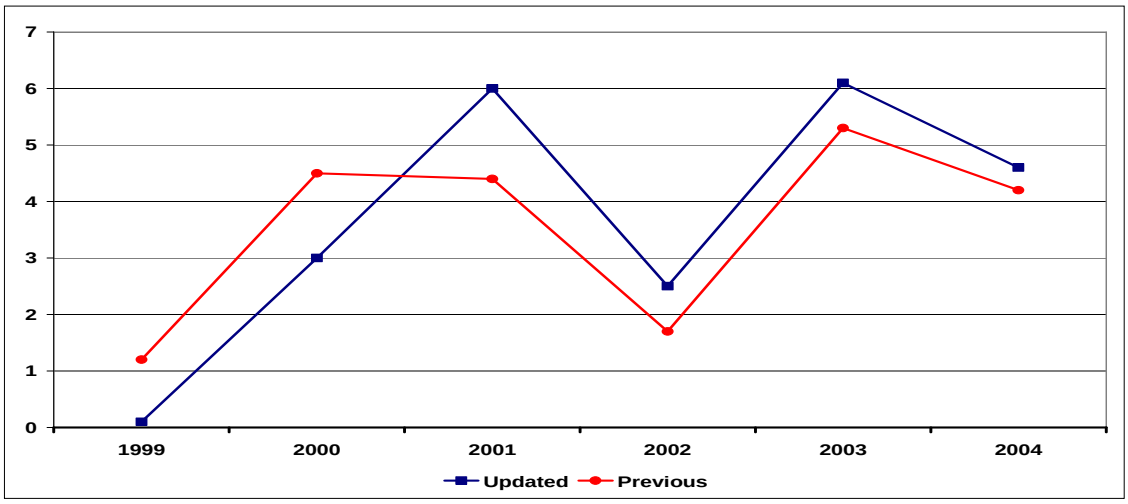
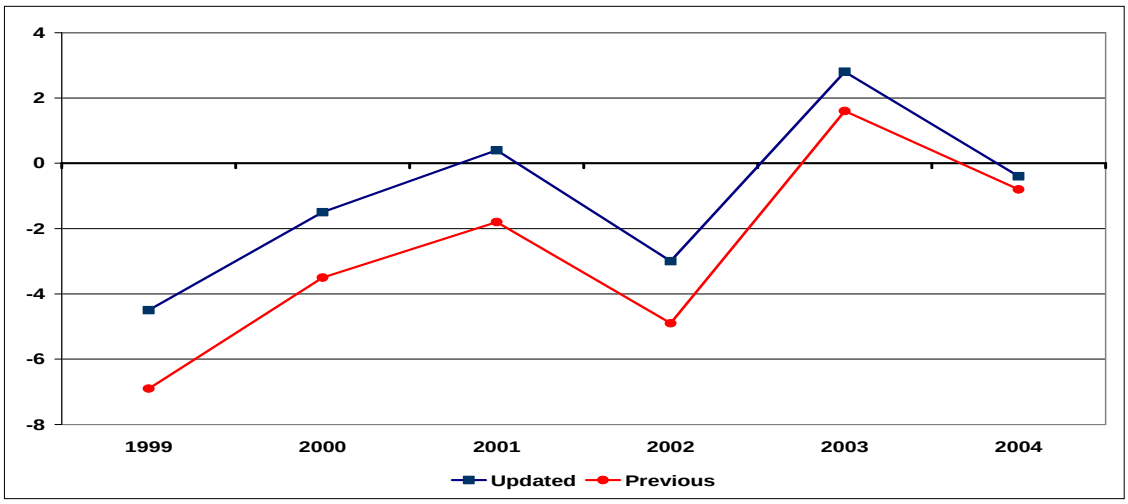


CHART 6.8: DEVIATION FROM ERER USING THE GDP DEFLATOR



The results showed minor differences between the updated estimation based on the 1970 - 2004 sample and the previous one based on the 1970 - 2002 sample. This was true both when the estimations were based on the HICP and when they were based on the GDP deflator.

The updated results showed that when the HICP was used as the relative price variable, there was a deviation from the ERER of +4.1% in 2004. On the other hand, when the GDP deflator was used to measure relative prices, the deviation from the ERER was -0.4%.[93]

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[93] In parallel with the investigation described in Footnote 91 above, this study also explored an alternative method of estimating the constant for the purposes of replicating the Maeso-Fernandez two-step procedure.

First the Maeso-Fernandez slope estimates were applied to the Maltese data to obtain $\hat{\beta}X_t$ where $\hat{\beta}$ represents the Maeso-Fernandez slope estimates and X_t represents the regressors for Malta. A constant was then constructed as the average of the residuals obtained by subtracting $\hat{\beta}X_t$ from Y_t, the regressand for Malta.

$$Y_t = \hat{\beta}X_t + u_t \qquad t = 1, \ldots T$$

$$\hat{\alpha} = \frac{1}{T}\sum_{t=1}^{T} u_t$$

Unlike what was proposed in Footnote 91, this method generates residuals that sum up to zero. However, while it is consistent with the least squares approach, this method suffers from the limitation that slope estimates for industrialised countries are likely to be different from those for developing countries, as in the case of Malta, which is still in the process of achieving real convergence with the industrialized countries. In fact, as shown in Table 5.1, the slope estimates for Malta differ substantially from those found by Maeso-Fernandez from their sample of industrialised countries. This deficiency is especially problematic for the purpose of measuring Malta's divergence from ERER in the short and medium terms. Because of this reservation, this line of inquiry was not pursued further.

6.4 Summary

In the light of a new source of price statistics and following an update of Maltese data, this chapter re-tested some of the relationships explored in previous chapters. The update covered two types of tests: one using the modified-PPP method and the other using the Maeso-Fernandez *et al* (2004) variant of BEER. The results depended on the choice between the GDP deflator and the HICP as the measure of prices. Tests using the former found the exchange rate deviation from ERER ranging between -2% and -0.4% in 2004, while tests using the HICP estimated a deviation ranging from +4.1% to +6.2% in the same year.

TABLE 6.2: ESTIMATED DEVIATION FROM EQUILIBRIUM: UPDATED MODIFIED-PPP AND MAESO-FERNANDEZ APPROACHES

	Deviation in 2004
Price measure: GDP deflator	
Updated modified-PPP approach	-2.0%
Updated Maeso-Fernandez approach	-0.4%
Price measure: HICP	
Updated modified-PPP approach	+6.2%
Updated Maeso-Fernandez approach	+4.1%

Chapter 7: General conclusion

The review in Chapter 1 presented the theory and estimation methods relating to the ERER. The subsequent chapters applied econometric techniques to estimate the level of the ERER and possible deviations of the Maltese lira from this rate. The results of each methodology are summarised below:

TABLE 7.1: SUMMARY OF FINDINGS

Chapter	Method	Finding	Year
2	Basic PPP approach	+2.6% to +3.1%	2002
3	Modified PPP approach	-0.1% to +0.2%	2002
4	BEER	-0.5% to +0.1%	2002
	BEER (SF)	+2.0%	2002
5	Maeso-Fernandez approach	+1.0%	2003
6	Price measure: GDP deflator		
	Updated modified-PPP approach	-2.0%	2004
	Updated Maeso-Fernandez approach	-0.4%	2004
	Price measure: HICP		
	Updated modified-PPP approach	+6.2%	2004
	Updated Maeso-Fernandez approach	+4.1%	2004

Most of these approaches suggested a minor degree of deviation from ERER, ranging from an undervaluation of -1% to an overvaluation of around +3%.

A larger deviation, however, emerged from the update in Chapter 6, which pointed to an overvaluation ranging from +4.1% to +6.2% when the HICP was used as the price measure. The reliability of this result is diminished by the limitations of the HICP as a price measure. These shortcomings were discussed in Chapter 6.

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