CREDIT Research Paper

No. 04/11

Measuring the Real Effective Exchange Rate (REER) in Ghana

by

Maxwell Opoku-Afari

Centre for Research in Economic Development and International Trade, University of Nottingham

The Centre for Research in Economic Development and International Trade is based in the School of Economics at the University of Nottingham. It aims to promote research in all aspects of economic development and international trade on both a long term and a short term basis. To this end, CREDIT organises seminar series on Development Economics, acts as a point for collaborative research with other UK and overseas institutions and publishes research papers on topics central to its interests. A list of CREDIT Research Papers is given on the final page of this publication.

Authors who wish to submit a paper for publication should send their manuscript to the Editor of the CREDIT Research Papers, Professor M F Bleaney, at:

Centre for Research in Economic Development and International Trade,
School of Economics,
University of Nottingham,
University Park,
Nottingham, NG7 2RD,
UNITED KINGDOM

Telephone (0115) 951 5620
Fax: (0115) 951 4159

CREDIT Research Papers are distributed free of charge to members of the Centre, and available free for download under Research Papers at www.nottingham.ac.uk/economics/credit/. Enquiries concerning copies of individual Research Papers or CREDIT membership should be addressed to the CREDIT Secretary at the above address.

CREDIT Research Paper

No. 04/11

Measuring the Real Effective Exchange Rate (REER) in Ghana

by

Maxwell Opoku-Afari

Centre for Research in Economic Development and International Trade, University of Nottingham

The Authors

Maxwell Opoku-Afari is in the Research Department of the Bank of Ghana (email: mafari31@gmail.com).

Acknowledgements

Maxwell Opoku-Afari is grateful to the Bank of Ghana for funding his PhD research, of which this paper is part, at the University of Nottingham. Helpful comments were provided by his supervisors, Professor Oliver Morrissey and Dr Tim Lloyd.

December 2004

Measuring The Real Effective Exchange Rate (Reer) In Ghana

by

Maxwell Opoku-Afari

Abstract

The focus of this paper is on how important the definitions and measurement of the concepts of real exchange rates are in analytical and empirical work. This paper seeks to identify, define and review measures of the real exchange rate for Ghana. We discuss methodological issues surrounding the measurement of real exchange rates, including choosing price and cost indices. The choice of trading partners to include, base year and the weighting scheme used are not very important; alternative measures with different trading partners and weights move very closely and share a common trend in the long run. However, the choice of price indices matters. Ghana seems highly competitive more recently based on the GDP-deflator index but much less so when the CPI index is used in the computation of the real exchange rate.

JEL Classification: F31, O55

Keywords: Real Effective Exchange Rate, Ghana

Outline

1. Introduction
2. Real Exchange Rates
3. Computation of REER for Ghana
4. Results
5. Comparing Alternative REER for Ghana
6. Conclusions

1. INTRODUCTION

Analysis of the impact of policy variables on the real exchange rate of an economy is sensitive to the type of real exchange rate index chosen. There are alternative ways of measuring the real exchange rate and the choice of index depends very much on the objective of study. According to Edwards (1989), the choice of price index is crucial in computing real exchange rates, making it necessary to determine which of them is more appropriate for different policy objectives. For example, to capture the effect of a productivity shock on real exchange rates, the GDP based real exchange rate index seems ideal since that incorporates changes in productivity. However, if the objective is to measure the impact of capital inflows on the economy as well as the international competitiveness of the home country, then the trade weighted CPI based index is more appropriate. This is mainly due to the fact that capital inflows are assumed to be distributed between the tradables and the non-tradables sector of the receiving economy and will affect the relative prices of tradables and non-tradables, and thereby impact on the real exchange rate of the home country. Also, depending on whether we are interested in export competitiveness, import competitiveness or total international competitiveness, we can either decide to use the export weighted, import weighted or total trade weighted indices respectively.

This paper will estimate the real effective exchange rate (REER) using a number of indices for Ghana. In the paper, REER is defined as the measure of nominal exchange rates adjusted for price differentials between the home country (Ghana) and its trading partners, and will be examined over a period of time. This is also referred to, in the literature, as the multilateral real exchange rate. This is different from the bilateral real exchange rate between a home country and a specific trading partner.

To compute the REER we will have to identify the following: the range of foreign countries to be covered as trading partners, their relative weights and the price indices to be compared. The appropriate definition of REER varies for different policy issues (with regards to effective exchange rate, choice of trading partners, weights and price indices). The merits and shortcomings of the various REER indices computed for Ghana will be discussed. Finally the statistical properties of these indices will be analysed.

The paper is structured as follows; section 2 will look at the concepts of real exchange rate and real effective exchange rates, while section 3 describes the computation of REER for Ghana (in particular looking at the choice of weights, indices and methods of averaging). Results and discussions will be presented in section 4, with sections 5 and 6 looking at comparison of our estimates with alternative measures of REER for Ghana and presenting the conclusions respectively.

2. REAL EXCHANGE RATES

Theoretically, there are two principal definitions of real exchange rate:

- In external terms, defined as the nominal exchange rate adjusted for price level differences between countries, i.e as the ratio of the aggregate foreign price (or cost) level to home country's aggregate price (or cost) level measured in a common currency.
- In internal terms, as the ratio of the domestic price of tradable to non-tradable goods within a single country.

The concept of external real exchange rate is derived from the purchasing power parity (PPP) theory that compares two countries and the relative prices of baskets of goods produced (or consumed). The internal real exchange rate is an indication of domestic resource allocation incentives in the home country. Within these two broad real exchange rate concepts we can have several alternative formulations or measures under different analytical frameworks.

The external real exchange rate has been defined in three different ways in the literature:[1]

- That based on PPP theory. This external real exchange rate compares the relative value of currencies through the measurement of the relative prices of foreign and domestic consumption or production baskets (Hinkle and Nsengiyumva, 1999), making it expenditure based.

1 Recently there has been a focus by the IMF on the use of relative labour cost expressed in foreign currency (Hinkle and Montiel, 1999).

- The Mundell-Fleming "one composite good" model involves the estimation of external real exchange rate by defining PPP in terms of aggregate production cost of all goods, both traded and non-traded. This makes the price index from this definition an output price or production cost index for the economy, which is composed of exports and goods for the domestic market, rather than the expenditure based price index suggested by the PPP theory.
- The law of one price and competitiveness in the pricing of internationally traded goods approach is also referred to as the external real exchange rate for traded goods (Hinkle and Nsengiyumva 1999). This is defined as the relative cost of producing traded goods, measured in a common currency, in the home and foreign country. This is done by adjusting the nominal exchange rate to reflect relative prices or costs in the traded goods sector in both home and foreign country.

Similarly, we can have different definitions of the 'internal real exchange rate' based on whether we are looking at two or multi-good models. The internal real exchange rate in this instance is defined as the internal relative price incentive for producing (or consuming) tradable goods as opposed to non-tradable goods, which makes it an indicator of domestic resource allocation incentives in the home country. The objective of this paper is to generate measures of the real exchange rate for assessing the macroeconomic impact of external shocks (capital inflows and/or productivity shocks) and measuring external competitiveness of the home country. These objectives clearly rule out the internal real exchange rate concept. The paper will be limited to the concepts, definitions and measurements of the external real exchange rate in Ghana.

Due to different theoretical underpinnings of the measurement of real exchange rate, one encounters several measurement problems. Key among these is the need to use different empirical price and cost indices in computing the real exchange rate. These problems are common to both industrial and developing countries, but tend to be more severe in developing countries. Edwards (1989) noted that issues such as the existence of parallel foreign exchange markets, substantial smuggling and unrecorded trade and wide fluctuations in the terms of trade, trade policies and patterns, introduce complexities in the measurement

of real exchange rate in developing countries, which are not commonly encountered in industrial countries.

The focus of this paper is on how important the definitions and measurement of the RER is in analytical and empirical work. This paper seeks to:

- Identify, define and review the appropriate real exchange rate for Ghana.
- Identify the various components that go into the measurement of real exchange rate alongside methodological issues.
- Generate different measures of real exchange rate for Ghana.

To be able to generate these indices we need to identify and select:

- the formula to be used.
- the appropriate measures of the nominal exchange rate to be used.
- the country weights and averaging method to be used. In the case of a multilateral real exchange rates, the trading partners and their appropriate weights.
- empirical counterparts of the desired theoretical (price and cost) indices.[2]

2.1 Real Effective Exchange Rates (REER)

Acknowledging the existence of different definitions of REER in the literature, we define REER as the product of the nominal effective exchange rate (NEER) and the effective relative price indices (in this instance the weighted wholesale price index of trading partners and the consumer price index for the home country). This is defined in domestic currency terms using the Arithmetic Mean (AM) method of averaging as:

$$\text{REER}_{j\,t} = \sum_{i=1}^{k} (NEER_{jit})(P^{*}_{it} / P_{jt}) \qquad \textbf{(1)}$$

where subscripts j, i and t represent country, trading partner and period respectively. P^{*}_{it} is the total trade[3] weighted wholesale price index of the trading partners representing the price of tradables, and P_{jt} is the CPI of the domestic country (a proxy for price of non-tradables).

2 The first three elements are common to all approaches of defining REER but the price/cost varies with the version of REER to be estimated.

The $NEER_{jit}$ denotes the nominal effective exchange rate for the home country with respect to each partner i. This is defined as an index reflecting movements in the nominal exchange rate between a home country and trading partners adjusted for by the respective weights of the trading partners. Like the REER, the NEER is also a measure of the multilateral nominal exchange rates. The nominal effective exchange rate is also defined in domestic currency terms using the AM as:

$$NEER_{jit} = \sum_{i=1}^{k} w_{it} * E_{it} \qquad \textbf{(2)}$$

where E_{it} is the period average (see Appendix for estimates using end of period) nominal exchange rate between the home country and each trading partner in period t, and w_{it} is the appropriate total trade weight for each trading partner $i(i = 1,.....,k)$.

This choice of definition of the REER is made over the alternative definition of measuring the multilateral rate as the product of the weighted average of the relative price indices and the bilateral nominal exchange rate. This is done due to the attractiveness of the NEER (over the bilateral nominal exchange rate) which allows for nominal exchange rate to reflect all movements in exchange rates of trading partners relative to the domestic currency.

Alternatively, the REER using the Geometric Mean (GM) method of averaging can be defined as the product of the nominal effective exchange rate and the effective relative price indices, following Hinkle and Nsengiyumva (1999):

$$REER_d = \frac{NEER_{jit} * EP_{gft}}{P_{gdt}} \qquad \textbf{(3)}$$

where $NEER_{jit} = \prod_{i=1}^{k} E_{di}^{w_{it}}$, with E_{di} defined as the index of nominal exchange rate (period average rates) in units of domestic currency per unit of foreign currency for home country j.

---

3 Other weights could be used depending on whether you want to capture export weighted index or import weighted index.

P_{gft} and P_{gdt} are the foreign price index (using WPI as a proxy) and the domestic price index (using CPI as a proxy) respectively, with w_{it} as the appropriate weights for each country and $\prod$ denotes the product of the variables. Also $EP_{gft} = \prod_{i=1}^{k} P_{gfi}^{w_{it}}$, where EP_{gft} is the GM weighted average (or effective) foreign price index at time t, and P_{gfi} is the WPI of trading partner i at time t with other notation as defined as above.

The trading partner's weights are defined to allow for time variation in the weights and so that weights sum to unity:

For exports: $x_{it} = \dfrac{X_{it}}{\sum_{j=1}^{k} X_{jt}}$ **(4)**

For imports: $m_{it} = \dfrac{M_{it}}{\sum_{j=1}^{k} M_{jt}}$ **(5)**

For total trade we have: $w_{it} = \dfrac{X_{it} + M_{it}}{\sum_{j=1}^{k} (X_{jt} + M_{jt})}$ **(6)**

where $\sum_{j=1}^{k} X_{jt}$, $\sum_{j=1}^{k} M_{jt}$ and $\sum_{j=1}^{k} \left(X_{jt} + M_{jt} \right)$ are total exports from the domestic country to all the trading partners, total imports of the domestic country from all the trading partners and total trade between the domestic country and all the trading partners respectively. Similarly, X_{it}, M_{it} and $X_{it} + M_{it}$ represent exports to trading partner i by the domestic country, imports from trading partner i by the domestic country and total trade between trading partner i and domestic country respectively. The subscript t represents the time period in all definitions.

One strong point in favour of this approach to computing the weights is the time variation component (rolling weighting system). Since what we are trying to capture with these indices change over time (macroeconomic effect of external shocks like capital inflows and

productivity shocks), a fixed weight index will misrepresent the dynamics and hence the impact on the real exchange rate (Chinn 2002).

The difference between these two alternative ways of defining the REER index is the method of averaging used (i.e. the GM and the AM). Since the different ways of averaging impact significantly on the index, we discuss briefly their advantages and disadvantages. The major strength of the AM is its ease of computation, which makes it more appealing to researchers and practitioners. The GM also has certain useful properties (even though not as easy to compute as the AM) such as its symmetry and consistency. The AM is influenced greatly by the base year chosen in the computation of the index and one has to re-base when trend analysis needs to be done. The analysis of misalignment is relative to the base year and therefore limited when the AM index is used. However, the GM indices are not influenced by the base period chosen. While the AM gives larger weights to currencies which have appreciated or depreciated to a significant extent alongside the home country currency, the GM treats depreciation and appreciation symmetrically. This makes the GM more efficient in capturing trends in REER. This paper reports the indices based on the GM method of averaging due to its obvious advantages (see Appendix for results using AM).

Finally, the REER indices will be computed using imports, exports and total trade shares of trading partners as weights as defined above. This has the obvious advantages of decomposing total trade and separating imports from exports. This is advantageous for computing indices for developing countries whose export trade is dominated by primary commodities whose prices are determined on the international market (like Ghana). In this case, total trade share may not completely measure international competitiveness. This decomposition is justified since the inter-country pattern of trade is significantly different for imports and exports.

3. COMPUTATION OF REER FOR GHANA

Our choice of definition and methodology, weights and indices used in the computation of REER for Ghana was heavily influenced by data availability and the objective for this study. Various REER indices were computed for Ghana taking into consideration the theoretical and operational (empirical) discussions. We estimate REER indices using the GM method of

measurement in all cases applying equations (3) to (6). We also considered both end-period and period-average exchange rates in computing the nominal effective exchange rates.

3.1. Choice of Weights and Price Indices

As noted in the literature and used by Edwards (1989), the choice of countries as trading partners and the base year chosen in the computation of REER index may not really be important since indices using different base years and different countries tend to be highly correlated (suggesting that they can be used interchangeably or capture almost the same information). We chose nine trading partners (United Kingdom, United States, Germany, Netherlands, France, Italy, Switzerland, Japan and Nigeria), as a fair representation of the major trading partners of Ghana that covers all trading blocs.[4] As noted earlier, since the inter-country pattern of trade is different for exports and imports, different indices were computed for exports, imports and a common index representing total trade. This level of decomposition also supports the idea of exports and imports having different levels of competition, which may not be easy to determine from the total trade index. Following from this, the import, export and total trade shares were used to calculate the weights for the trading partners in our computations (as described by equations 3-6).[5]

There are few price indices that can be used. The unavailability of monthly and quarterly data for some of the trade data and price indices compelled us to use annual data in our estimations. For the price of tradables, the wholesale price index (and in some cases the producer price index) are used. The choice of the wholesale price index was influenced by it being heavily weighted with traded goods thus representing a greater proportion of traded goods (Edwards, 1989). It has been argued that this proxy may include a large component of imported intermediate goods, so the resulting REER may not reflect true direction of competitiveness (Chinn, 2002). In the case of non-tradable goods, the consumer price index (CPI) for Ghana was used. This index broadly represents both tradable and non-tradable goods but using it as a proxy for the price index of non-tradable goods was a matter of

4 Some of the recent trading partners of Ghana were dropped due to the lack of time series data to suit the study (e.g. South Africa and India).

5 These weights are affected by the degree of unrecorded trade in the home country, which is probably high in Ghana. However, data are (by definition) not available to account for this.

expediency and data availability rather than a perfect (or better) representation of the price of non-tradables.[6]

3.2 Definition of variables

The NEER is the Nominal Effective Exchange Rate, REER is Real Effective Exchange Rates, WWPI is Weighted Wholesale Price Index. The subscripts *x*, *m*, *T* indicate the index with Export, Import and Total trade shares as the weights respectively in the computations while *cpi* and *gdp* subscripts indicate the index computed using Ghana CPI and GDP-deflator as the proxy for the prices of non-tradables. The REER is defined such that an increase (decrease) in the value represents depreciation (appreciation). By also assuming that the base year reflects a period where we believe that the exchange rate was in equilibrium, a value larger (lower) than the base value represents an undervaluation (overvaluation).

4. RESULTS

Results from Figures 1 to 5 show that indices have moved broadly together and are highly correlated starting from the mid-1980s (largely as a result of the corrective measures introduced by the Structural Adjustment Programme). Differences are apparent, however, during the later years of the 1990s depending on which type of price index is used, suggesting that the choice of price index is not trivial. After 1997, the *gdp*-deflator based index indicates depreciation, but the *cpi*-based index is appreciating. This is supported by the comparison of the indices based on the same weights but different types of price indices (Figures 3-5 and Appendix). Judged by the experience of the late 1990s, the choice of price index matters. Ghana seems highly competitive more recently, based on the *gdp*-deflator index but much less so when the *cpi* index is used in the computation of the REER. One possible explanation for this difference in revealing the extent of competitiveness by different price indices may be due to the transmission mechanism of fundamentals affecting the real exchange rate.

An overview of the fundamentals shows that aid has been very persistent during this period of the study. According to the Dutch Disease theory, capital inflows affect real exchange rate

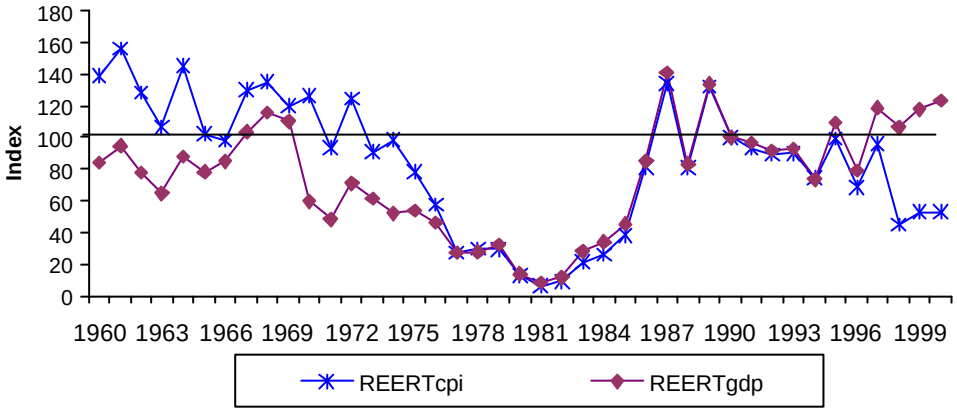
6 The GDP deflator was also used and the results are presented.

through the tradable and non-tradable sectors of the economy and through that extends to affect the level of international competitiveness. Hence, using *cpi* as a measure of price index is able to capture the effect of capital inflows on real exchange rate through the non-tradables sector (capturing mostly prices of non-tradables). However, using *gdp*-deflator as a measure of the price index may not be able to capture the complete effect of capital inflows on real exchange rate as outlined in the Dutch Disease theory. Hence, it is not surprising that the *cpi* based measure is showing a fall in the level of competitiveness as against the *gdp*-deflator based measure. The *gdp*-deflator based measure is clearly not capturing the full impact of the increased capital inflows in the late 1990s (see Opoku-Afari *et al*, 2004). Following from this argument and also from the fact that REER is not a variable but actually a relation influenced by some fundamentals, it is important that one analyses these results by taking into consideration how best a measure captures the effects of each of the fundamentals. The majority of the fundamentals are trade related, with an impact on REER either through the tradable or the non-tradable sector, implying that the *cpi* based measure of REER is a better measure of trends in REER in Ghana (with most of its fundamentals being trade related) than the *gdp*-deflator based measure.

Casual inspection of the Figures suggests that trends in REER in Ghana show steep depreciation from the period after the Structural Adjustment Programme (SAP) in 1983, which included exchange rate reforms until 1987-90. From 1990 to 2000, while the nominal exchange rate depreciated by about 228 per cent (as measured by the NEER), the REER appreciated by 47 per cent (as measured by $REER_{Tcpi}$).[7] For the greater part of the period before adjustment, the cedi was undervalued (assuming the strong PPP interpretation of equilibrium exchange rates). In terms of competitiveness, although in nominal terms the cedi was seen as depreciating and thus favourable for export promotion, Ghanaian exports were not competitive due to appreciation in real terms, which is supported in the literature on export promotion in Ghana (Dennis, 2002). A careful examination of the export weighted index (figure 3) shows almost the entire period being overvalued, an indication of real appreciation of the exchange rate, and moves in tandem with the considerable decline in the

export sector that has been witnessed in Ghana (see Dennis, 2002 for details on the decline of the export sector in Ghana). The import weighted index however, follows a similar trend to that of the total trade weighted index. This conclusion is subject to the limitations of using the PPP concept of equilibrium. A more dynamic concept (dynamic equilibrium path of REER) will be more appropriate.

Figure 1:Trade Weighted REER for Ghana (1990=100)



Note: An upward movement here represents depreciation and a downward movement represents an appreciation. See Appendix for source of data and definition of variables, and more graphs of the various measurements of NEER and REER and the Weighted Price Indices

7 Alternatively the REER as measured by the GDP index depreciated by 23.5 per cent within the same period.

Figure 2: Import Weighted REER for Ghana (1990=100)

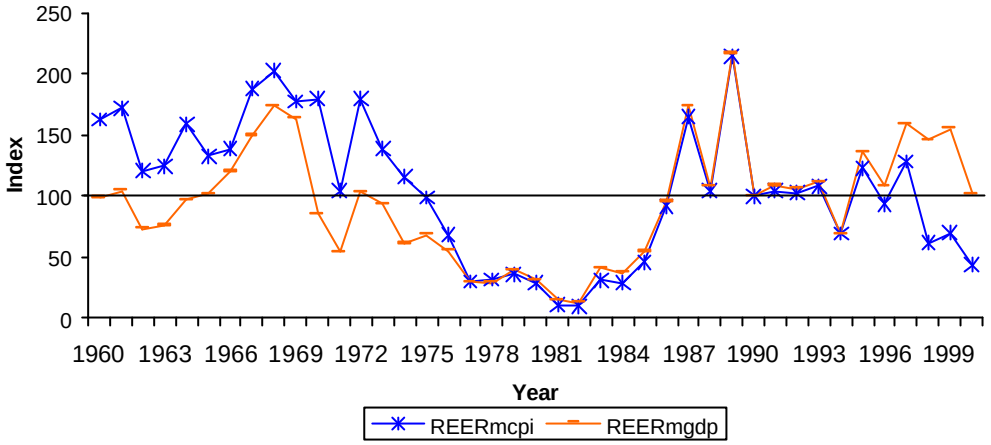


Figure 3: Export Weighted REER for Ghana: (1990=100)

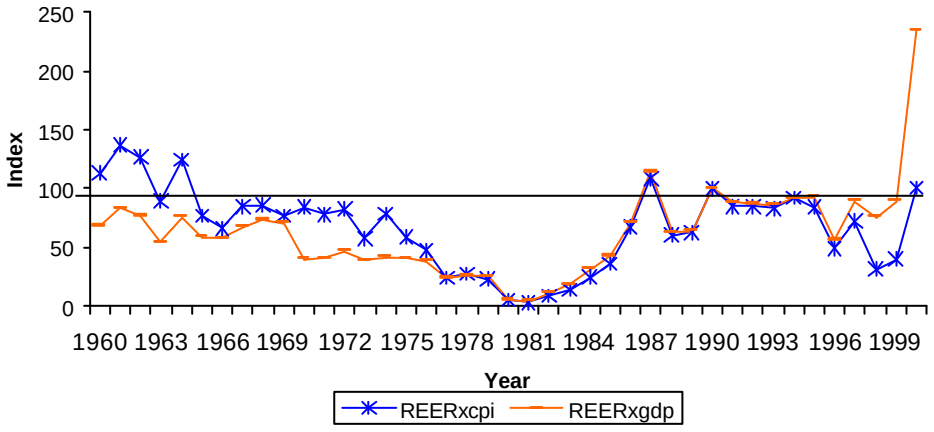
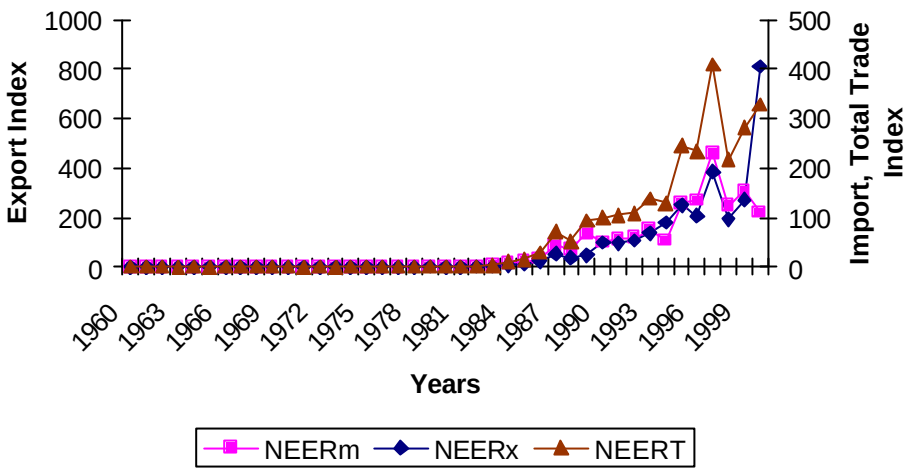


Figure 4: Weighted NEER for Ghana (1990=100)



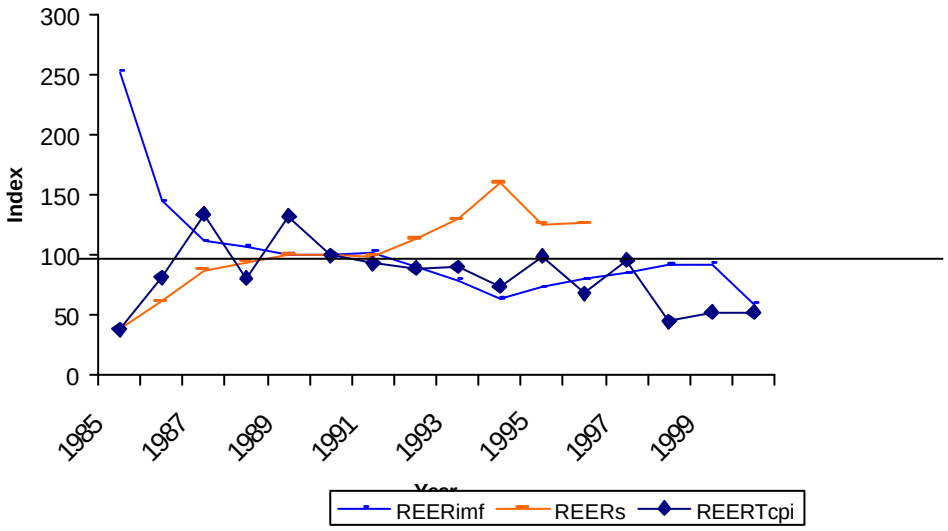
5. COMPARING ALTERNATIVE REER FOR GHANA

The IMF defines the REER index for Ghana as a nominal effective exchange rate (NEER) index adjusted for relative movements in national price or cost indicators (CPI) of the home country and selected countries and the Euro Area. They also define the NEER to represent the ratio of an index of the period average exchange rate of the currency in question (in this instance the cedi) to a trade weighted geometric average of exchange rates for the currencies of selected countries and the Euro Area. Like our estimate, the IMF used the CPI index as a measure of domestic costs and prices. The IMF defines the REER to reflect an increase as appreciation while in our definition appreciation is a decrease in the index.

Sackey (2001) defined the real effective exchange rate for Ghana as $REER = \Delta w_i BNER_i P^*_i / P$ where REER is the trade weighted real effective exchange rate, w_i, BNER, P_i^* and P are the weights for country i; bilateral nominal exchange rate; country i's wholesale price index; and domestic country's consumer price index. In this case, a decrease in the index implies an appreciation while an increase indicates depreciation. In contrast to our method, Sackey (2001) used the Arithmetic Mean method of weighting as well as bilateral nominal exchange rate (instead of nominal effective exchange rate in our case).

Our computed REER index ($REER_{Tcpi}$) can be compared with these selected alternative measures reported by the IMF ($REER_{imf}$) and by Sackey ($REER_{s}$). Casual inspection of Figure 5 shows that, in the 1990s, our measure and that of the IMF have moved broadly together and are highly correlated. The negative correlation between our estimates and that of the IMF is a matter of definition and does not affect our conclusions. However, that of Sackey (2001) drifts significantly. This may be due to Sackey's use of bilateral nominal exchange rate in his measure of real exchange rate instead of the nominal effective exchange rate (NEER) employed in our computation as well as that of the IMF. This observation confirms our statement earlier that the country coverage and the nature of the weighting schemes are generally of secondary importance for countries whose external trade is highly concentrated such as Ghana, and that it is the choice of price index that matters. This claim is based on the fact that country coverage and weights differ between our estimates and that of the IMF, but both cointegrated indices sharing a common trend as shown by the bi-variate cointegration test in Table 2. The difference between our estimates and that of Sackey (2001) may stem from differences in nominal indices used as well as method of averaging.

Figure 5: Alternative REER Indices for Ghana (1990=100)



5.1 Cointegration Analysis

Prior to estimating the bi-variate cointegration for our real exchange rate measures, we tested the stationarity properties of all the measures. All our computed real exchange rate

indices were non-stationary (see appendix) with the exception of the nominal effective exchange rate index for imports ($LNEER_m$) which was found to be stationary about a trend and a break (using the Perron unit root test with presence of structural break in 1983, as reported in the Appendix).

Tables 1 and 2 below give simple bi-variate cointegration analyses of our different measures of real effective exchange rate as well as nominal effective exchange rates. Since it has been established that these measures are non-stationary, using correlation to ascertain evidence of co-movements may lead to spurious conclusions. Hence, we adopted simple bi-variate residual-based cointegration test to check whether there is some evidence of co-movement between these measures. We employed the Engle-Granger two step approach for testing cointegration in establishing whether these measures share common trends.

Results in Table 1 indicate that all the measures share a common trend in the long run, evidence of co-movement. This implies that, using these measures interchangeably may lead to the same conclusions in the long run. The co-movement was found irrespective of whether we are using the *cpi*-based index or the *gdp*-deflator based index. This corroborates results of Falck (1997) for Tanzania and Edwards (1989) for various countries. Even though graphical evidence show some divergence between the *cpi* based index and the *gdp*-deflator based index (that is, for recent years, late 1990s, the choice of price index and weights were significant in determining the magnitude and direction of the indices), this could be a short run phenomenon as establishment of cointegration implies in the long-run they will be moving together.

Table 1: Bivariate Residual-Based Cointegration Tests (REER)

LREER	*tcpi*	*tgdp*	*mcpi*	*mgdp*	*xcpi*
tcpi	n/a				
tgdp	-4.643***				
mcpi	-4.735***	-5.209***			
mgdp	-3.801***	-4.876***	-3.196**		
xcpi	-3.886***	-3.100**	-4.036***	-3.701***	

xgdp	-3.549***	-4.213***	-3.507**	-4.500***	-4.118***

Notes: ADF critical values for the rejection of the null of no cointegration are –3.60 (1%) and –2.94 (5%). ****** and ******* represent 5% and 1% respectively. Based on the GM method of measurement and 1990 as base year as well as period average exchange rates. The results for different base years and end period exchange rates are not noticeably different.

There was no evidence of cointegration for the nominal effective real exchange rate with the exception of co-movement noticed between import-based measures and total trade measures. An indication that movements in the nominal exchange rate in Ghana is mainly driven by variations in imports.

Interestingly, when we compared our estimates with those of the IMF and Sackey (2001), we found that there was strong evidence of co-movement between our measure of real effective exchange rate and that of the IMF (Table 2). However, this was not the case between our measure and that of Sackey (2001) and also between Sackey and the IMF. A possible explanation could be differences in the way nominal exchange rates are measured. While we used nominal effective exchange rate, Sackey (2001) used bilateral nominal exchange rate. As noted by Edwards (1989), whereas the choice of base year and trading partners may be of secondary importance in the computation of REER, the choice of price index and other indices are very important.

Table 2: Bi-variate Residual-Based Cointegration Tests for Alternative Indices

	REERimf	REERs
REERimf	N/a	
REERs	-2.183	N/a
REERTcpi	-3.501**	-2.654

Notes: The ADF critical values for the rejection of the null of no cointegration are –3.60 (1%) and –2.94 (5%). ****** and *** represent 5% and 1% respectively.

6 CONCLUSIONS

The paper has sought to measure the real effective exchange rate (REER) for Ghana, using various measures (export weighted, import weighted, total trade weighted and in terms of price indices). In addition, it compared different measures of price indices, that is, the *gdp*-deflator and the *cpi*-based index. These different measures were compared to determine whether the choice of components in the REER index is crucial in computing the index and which measures are most appropriate for different policy objectives.

In the light of the above, our study was able to establish the following:

- Results show that country coverage, base year and the nature of the weighting schemes are generally of secondary importance for countries whose external trade is highly concentrated such as Ghana. However, the choice of price indices matters. Ghana seems highly competitive more recently, based on the *gdp*-deflator index but much less so when the *cpi* index is used in the computation of the REER. This implies that the *gdp*-deflator based index under-estimates the extent of depreciation of the real exchange rate from the impact of certain fundamentals (including capital inflows, openness and government consumption of tradables and non-tradables). The *cpi*-based index on the other hand, gives a good reflection of the dynamics from these identified fundamentals to REER as per the Dutch Disease theory. This result was drawn from the fact that the fundamentals determining REER in the literature are mostly trade related and thus the CPI gives a better reflection of prices of both tradables and non-tradables than the *gdp*-deflator .
- We also established that choice of trading partners, and choice of weights are not really important in capturing the dynamics in the REER relation in Ghana, since comparison of alternative measures with varying trading partners and weights moved very closely together and were highly correlated. This result is in line with those of Edwards (1989).

Our study has also contributed to the empirical literature on real effective exchange rate measurement in the following ways:

- It has considered alternative measures of REER and has analytically compared them to assess which measure is appropriate for different policy objectives.

- We also established that there are some co-movements among the different measures of real effective exchange rate. An indication that they may under certain circumstances be used interchangeably.
- This also serves as a major contribution to empirical measurement of REER in Ghana as the existing measures are based on bilateral real exchange rate without policy specific measures. This means one measure of REER is used as a universal measure of REER for different policy objectives thus undermining the importance of the dynamics.

REFERENCES

Aron, J, Elbadawi, I.A and Kahn, B (1997) 'Determinants of the Real Exchange Rate in South Africa', *Centre for the Study of African Economies*, WPS/97-16, Oxford.

Baffes, J., Elbadawi, A., and O'Connell, A. (1999) 'Single Equation Estimation of the Equilibrium Real Exchange Rate' in Hinkle, L and Montiel, P, J (eds), *Exchange Rate Misalignment, Concepts and Measurements for Developing Countries*, A World Bank Research Publication, Oxford University Press.

Bank of Ghana Annual Reports and Economic Bulletins (Various Editions), Information, Documentation and Publication Department (IDPS), Bank of Ghana.

Chinn, M.D (2002) '*The Measurement of Real Exchange Rates: A Survey and Applications to East Asia'*, NBER, May 2.

Cottani, J. A, Cavallo, F.D and Khan, M.S (1990) 'Real Exchange Rate Behaviour and Economic Performance in LDCs', *Economic Development and Cultural Change*, **39**, 61-76.

Dennis, A (2002), 'Determinants of Exports in Adjusting Sub-Saharan African Countries: Evidence from Ghana', Ph.D. Thesis, University of Nottingham, UK.

Edwards, S (1989) *'Real Exchange Rates, Devaluation, and Adjustment'*, Cambridge, Mass: MIT Press.

Edwards, S (1988) *'Exchange Rate Misalignment in Developing Countries'*, World Bank Occasional papers, New Series, Published for the World Bank by the Johns Hopkins University Press.

Falck, H (1997) *'Aid and Economic Performance-The Case of Tanzania'*, Department of Economics, University of Lund.

Ghana Economic Surveys, published by Statistical Service of Ghana.

Ghura, D and Grennes, T. (1993) "The Real Exchange Rate and Macroeconomic Performance in Sub-Saharan Africa". *Journal of Development Economics* **42**, 155-74.

Hinkle, L. E. and Montiel, P.J (1999) (eds), *Exchange Rate Misalignment*, Oxford University Press/World Bank.

International Financial Statistics (various Editions), Publication of the International Monetary Fund (IMF).

International Monetary Fund (IMF) (1960-2000), *Direction of Trade Statistics Yearbook*, International Monetary Fund, Washington.

Opoku-Afari, M., O. Morrissey and T. Lloyd (2004) 'Real Exchange Rate Response to Capital Inflows: A Dynamic Analysis for Ghana' *CREDIT Research Paper 04/12*.

Sackey, A (2001) 'External Aid and Real Exchange Rates in Ghana', AERC, Nairobi, Kenya.

APPENDIX

Unit Root Analysis

We employed the Augmented Dickey Fuller (ADF) tests for unit roots to test the stationarity properties of the REER indices. We estimated the ADF model given below:

$$\Delta y_t = m + b\,T + g\,y_{t-1} + \sum_{i=1}^{r} d_i \Delta y_{t-i} + e_t \qquad \textbf{(A1)}$$

We initially estimated an over-parameterised model using the lag length of 6 and then by using the general-to-specific method, the model was reduced to a more parsimonious level. In cases where all the lags were not significant (using the 5% level of significance), it signified the absence of serial correlation and thus reducing the Augmented Dickey-Fuller tests to simple Dickey-Fuller test implying in those instances, ordinary AR(1) being a good representation of the Data Generation Process (DGP) of the indices. The result is reported in table A1.

Macroeconomic reforms in Ghana (that is the structural adjustment programme and the economic reform programme) are perceived to have a significant impact on the direction and movements in real and nominal effective exchange rates. In particular, we argued that they introduced a level shift in these variables due to the deliberate policies such as devaluation and trade liberalisation. In view of this, it would be proper to augment the ADF test for unit roots with a test that takes into account a shift in the levels of the variables (Perron, 1989). According to Perron (1989), a trend stationary series which exhibits a structural break either in the levels or the growth (trend) cannot easily be distinguished from a non-stationary series process. Using simulation methods, Perron simulated new critical values for unit root against the alternative of a trend stationary model with a structural break at a known point. A careful look at our real and nominal effective exchange rate variables show a break and level shift in the series at around the time of the introduction of the SAP. Hence we augment our ADF test with that of Perron (1989) and the results are reported in table A2 below. See Perron (1989) for details on this procedure.

Table A1: Unit Root Test for the Effective Exchange Rate Indices

ADF Model: $\Delta y_t = m + bT + g\, y_{t-1} + \sum_{i=1}^{r} d_i \Delta y_{t-i} + e_t$

Variable	$H_o : g = 0$	$H_0 : b = g = 0$ $\Phi_3 - test$	$H_0 : b = m = g = 0$ $\Phi_2 - test$	$H_0 : m = g = 0$ $\Phi_1 - test$	Lag Length	Inference
$LNEER_m$	-1.76 (-3.52)	1.559 (6.73)	3.139 (5.13)	3.033 (4.86)	0	I(1)
$LNEER_x$	-1.92 (-3.52)	2.833 (6.73)	4.794 (5.13)	4.038 (4.86)	0	I(1)
$LNEER_t$	-1.79 (-3.52)	1.895 (6.73)	4.488 (5.13)	4.471 (4.86)	0	I(1)
$LREER_{mcp}$	-2.70 (-3.52)	3.652 (6.73)	2.484 (5.13)	3.367 (4.86)	4	I(1)
$LREER_{xcpi}$	-1.66 (-3.52)	1.659 (6.73)	1.109 (5.13)	1.425 (4.86)	0	I(1)
$LREER_{tcpi}$	-2.81 (-3.52)	3.944 (6.73)	2.638 (5.13)	3.80 (4.86)	4	I(1)
$LREER_{mgdp}$	-2.40 (-3.52)	2.953 (6.73)	1.969 (5.13)	2.901 (4.86)	4	I(1)
$LREER_{xgdp}$	-1.34 (-3.52)	2.872 (6.73)	1.965 (5.13)	0.283 (4.86)	6	I(1)
$LREER_{tgdp}$	-2.11 (-3.52)	2.942 (6.73)	1.961 (5.13)	1.099 (4.86)	0	I(1)

Note: Based on the GM method of measurement and 1990 as base year as well as period average exchange rates. The results for AM method of measurement, different base years and end period exchange rates are not significantly different. Figures in parenthesis are the 5% critical values. The optimal lag length is the largest r for which d_i is significant at the 5% critical level.

Table A2: Unit Root Tests with Presence of Structural Break in 1983 for the Effective Exchange Rate Indices

Perron Model: $\Delta y_t = m + q\,Ds83_t + b\,t + a\,y_{t-1} + \sum_{i=1}^{k} c_i \Delta y_{t-1} + e_t$		
Variable	$H_0 : a = 0$	Inference
$LNEER_m$	-3.97	I(0)*
$LNEER_x$	-3.13	I(1)
$LNEER_t$	-2.73	I(1)
$LREER_{mcpi}$	-2.87	I(1)
$LREER_{xcpi}$	-2.55	I(1)
$LREER_{tcpi}$	-2.85	I(1)
$LREER_{mgdp}$	-3.05	I(1)
$LREER_{xgdp}$	-2.31	I(1)
$LREER_{tgdp}$	-2.85	I(1)

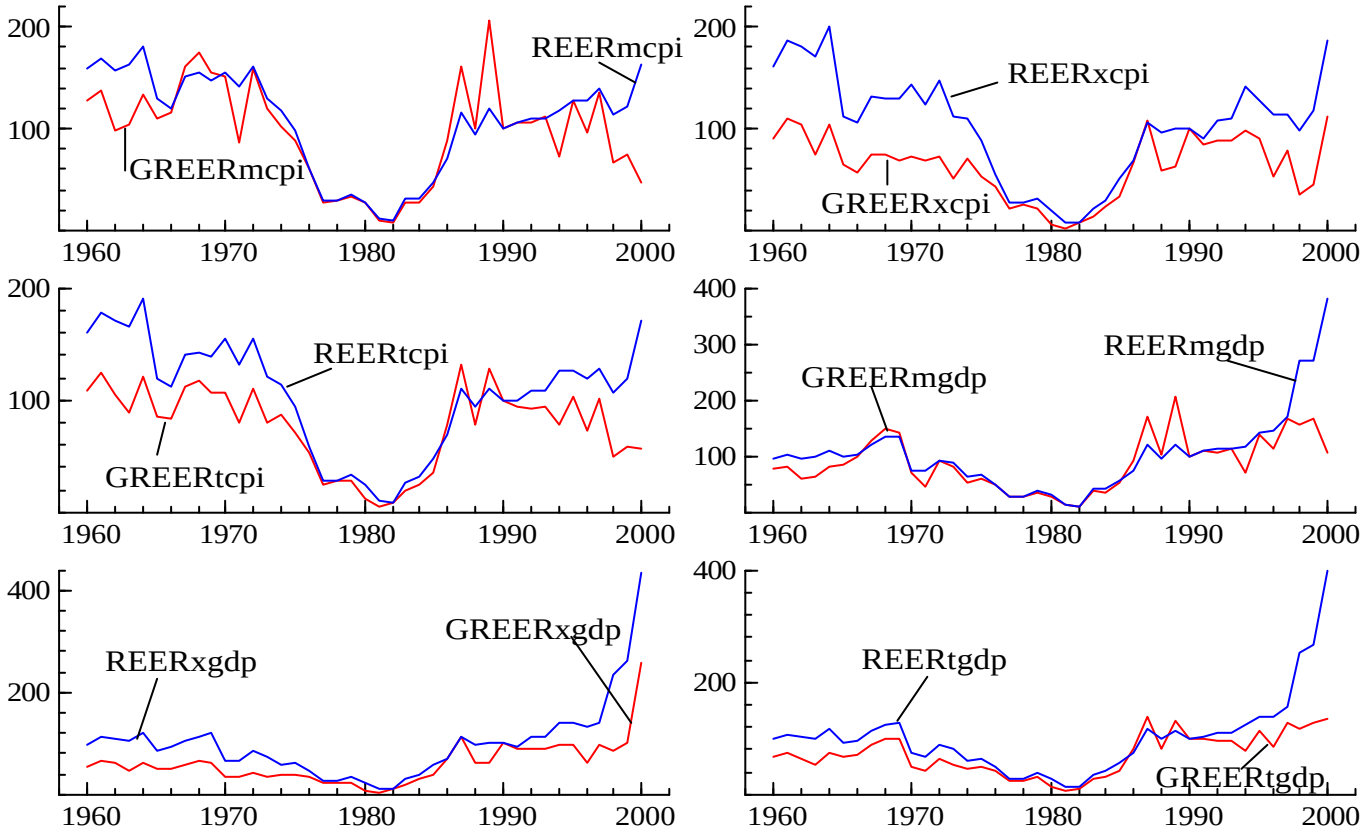
Notes: This model allows for the introduction of an exogenous break (T_B) point in the series. This point is 1983 in Ghana. We used the dummy Ds83 to capture this structural break. T_B/T (% Break fraction)=0.5 in our series. Critical values are**:** -4.49(1%), –3.93(5%) -3.65(10%). * indicates Stationary around a trend and break.

As is evident from the results, the ADF test on the indices computed using the GM method shows that all the variables were non stationary that is I(1) without any significant drift. The null hypothesis for a second unit root is rejected for all the I(1) variables even at 1% critical level implying only the first differencing of the indices is needed to correct for non-stationarity.

Results from the ADF test were also supported by the Perron test (table A2) which showed clearly that apart from the import weighted nominal effective exchange rate variable where we could reject the null of unit roots and thus accept the alternative of trend stationary series, we could not reject the null for all other real and nominal effective exchange rate series. Hence we concluded that the remaining series are indeed non-stationary. These results support that of the ADF test. This is not surprising for exchange rates as most work in the literature confirm this result.

APPENDIX III: Plots of Different Measures of REER

Figure III.1: REER (GM-based begin with G, and AM based Indices)



CREDIT PAPERS

03/01 **Stephen Dobson, Carlyn Ramlogan and Eric Strobl,** "Why Do Rates of Convergence Differ? A Meta-Regression Analysis"

03/02 **Robert Lensink and Habeab T. Mehrteab,** "Risk Behaviour and Group Formation in Microcredit Groups in Eritrea"

03/03 **Karuna Gomanee, Oliver Morrissey, Paul Mosley and Arjan Verschoor,** "Aid, Pro-Poor Government Spending and Welfare"

03/04 **Chris Milner and Evious Zgovu, "**Export Response to Trade Liberalisation in the Presence of High Trade Costs: Evidence for a Landlocked African

03/05 **Mark McGillivray and Bazoumana Ouattara,** "Aid, Debt Burden and Government Fiscal Behaviour in Côte d'Ivoire"

03/06 **José Antonio Alonso and Carlos Garcimartin,** "Poverty Reduction and Aid Policy"

03/07 **Salvador Barrios, Luisito Bertinelli and Eric Strobl,** "Dry Times in Africa"

03/08 **Sam Laird, Santiago Fernandez de Cordoba and David Vanzetti,** "Market Access Proposals for Non-Agricultural Products"

03/09 **Indraneel Dasgupta and Ravi Kanbur,** "Bridging Communal Divides: Separation, Patronage, Integration"

03/10 **Robert Osei, Oliver Morrissey and Tim Lloyd,** "Modelling the Fiscal Effects of Aid: An Impulse Response Analysis for Ghana"

03/11 **Lucian Cernat and Sam Laird,** "North, South, East, West: What's best? Modern RTAs and their Implications for the Stability of Trade Policy"

03/12 **Indraneel Dasgupta and Diganta Mukherjee,** "'Arranged' Marriage, Dowry and Female Literacy in a Transitional Society"

03/13 **Karuna Gomanee, Sourafel Girma and Oliver Morrissey,** "Aid, Public Spending and Human Welfare: Evidence from Quantile Regressions"

03/14 **Luisito Bertinelli and Eric Strobl,** "Urbanization, Urban Concentration and Economic Growth in Developing Countries"

03/15 **Karuna Gomanee, Sourafel Girma and Oliver Morrissey, "**Searching for Aid Threshold Effects"

03/16 **Farhad Noobakhsh, "**Spatial Inequality and Polarisation in India"

03/17 **Evious K. Zgovu,** "The Implications of Trade Policy and 'Natural' Barriers Induced Protection for Aggregate Demand for Imports: Evidence for Malawi"

03/18 **Normal Gemmell and Oliver Morrissey,** "Tax Structure and the Incidence on the Poor in Developing Countries"

03/19 **Alan Harding,** "Did the Tanzanian Manufacturing Sector Rebound in the 1990s? Alternative Sources of Evidence"

03/20 **Paul Mosley, Farhad Noorbakhsh and Alberto Paloni,** "Compliance with World Bank Conditionality: Implications for the Selectivity Approach to Policy-Based Lending and the Design of Conditionality"

03/21 **Evious K. Zgovu,** "Price Transmission, Domestic Relative Incentives and Inter-sector Resource Flow Analysis"

04/01 **Chris Milner and Verena Tandrayen,** "The Impact of Exporting and Export Destination on Manufacturing Wages: Evidence for Sub-Saharan Africa"

04/02 **Sam Laird, Ralf Peters and David Vanzetti,** "Southern Discomfort: Agricultural Policies, Trade and Poverty"

04/03 **Santiago Fernandez de Córdoba, Sam Laird and David Vanzetti,** "Trick or Treat? Development Opportunities and Challenges in the WTO Negotiations on Industrial Tariffs

04/04 **Santiago Fernandez de Córdoba, Sam Laird and David Vanzetti,** "Blend it like Beckham – Trying to read the Ball in the WTO Negotiations on Industrial Tariffs

04/05 **Bazoumana Outttara,** "Modelling the Long Run Determinants of Private Investment in Senegal"

04/06 **Indraneel Dasgupta and Sugata Marjit,** "Evasive Reform: Informalisation in a Liberalised Economy with Wage-setting Unions"

04/07 **Bazoumana Ouattara and Eric Strobl,** "Foreign Aid Inflows and the Real Exchange Rate in the CFA Franc Zone"

04/08 **Christophe Muller and Christophe Nordman,** "Which Human Capital Matters for Rich and Poor's Wages? Evidence from Matched Worker-Firm Data from Tunisia"

04/09 **David Lawson,** "Determinants of Ill Health in Uganda – Is it just the Wealthy that are more Healthy?"

04/10 **David Fielding and Anja Shortland,** "Are Americans more Gung-Ho than Europeans? Some Evidence from Tourism in Israel during the Intifada

04/11 **Maxwell Opoku-Afari,** "Measuring the Real Effective Exchange Rate (REER) in Ghana

Members of the Centre

Director

Oliver Morrissey - aid policy, trade and agriculture

Research Fellows (Internal)

Simon Appleton – household analysis, poverty, health
Adam Blake – CGE models of low-income countries
Mike Bleaney - growth, international macroeconomics
Indraneel Dasgupta – development theory
Norman Gemmell – growth and public sector issues
Ken Ingersent - agricultural trade
Tim Lloyd – agricultural commodity markets
Chris Milner - trade and development
Wyn Morgan - futures markets, commodity markets
Christophe Muller – poverty, household panel econometrics
Trudy Owens - survey analysis, poverty, employment
Tony Rayner - agricultural policy and trade

Research Fellows (External)

Manuela Francisco *(University of Minho)* – inflation and exchange rate regimes
David Fielding *(University of Otago)* – investment, monetary and fiscal policy
Ravi Kanbur (*Cornell*) – inequality, public goods – Visiting Research Fellow
Henrik Hansen *(University of Copenhagen)* – aid and growth
Stephen Knowles *(University of Otago)* – inequality and growth
Sam Laird (*UNCTAD*) – trade policy, WTO
Robert Lensink *(University of Groningen)* – aid, investment, macroeconomics
Scott McDonald *(University of Sheffield)* – CGE modelling, agriculture
Mark McGillivray *(WIDER, Helsinki)* – aid allocation, aid policy
Andrew McKay *(University of Bath)* – household poverty, trade and poverty
Doug Nelson *(Tulane University)* - political economy of trade
Farhad Noorbakhsh *(University of Glasgow)* – inequality and human development
Robert Osei *(GIMPA, Ghana)* – macroeconomic effects of aid
Alberto Paloni *(University of Glasgow)* – conditionality, IMF and World Bank
Eric Strobl *(University of Paris)* – labour markets
Finn Tarp *(University of Copenhagen)* – aid, CGE modelling