Real Interest Rates and Growth: Improving on Some Deflating Experiences

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Tests of the McKinnon-Shaw hypothesis typically investigate the relationship between real interest rates and growth. Recent work has concluded that this relationship may be non-monotonic. This article investigates the role of real interest rate mismeasurement in explaining these non-monotonicities. When such mismeasurement is systematically related to growth, it will produced biased empirical results. After addressing these biases, the article demonstrates that financial liberalisation may offer substantial economic gains. In an 'average' country, raising real interest rates from -25 per cent to five per cent will increase real annual per capita GDP growth from zero to a relatively robust rate of two per cent.

I. INTRODUCTION

Following seminal contributions to the field of finance and development by McKinnon [*1973*] and Shaw [*1973*], a large empirical literature has emerged purporting to test their prediction that financial liberalisation will benefit the economic performance of less developed nations. Many of these tests investigate the relationship between the level of real interest rates and real economic growth (for an excellent summary, see Fry [*1995: Ch. 8*]).

McKinnon and Shaw argued that *repression* of the domestic financial system – in the form of interest rate ceilings, directed credit programmes, punitive taxes on financial intermediation, and other government interventions in domestic capital markets, especially the banking system – hindered economic growth. Economic development requires investments to

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The Journal of Development Studies, Vol.34, No.1, October 1997, pp.85–110
PUBLISHED BY FRANK CASS, LONDON

be made in modern technologies. Such investment typically involves substantial start-up costs. Households close to the subsistence level face problems accumulating sufficient internal funds to meet these fixed costs, especially when financial repression precludes access to safe repositories for financial saving (such as bank deposits), yielding even a modest positive return. Denied access to credit, such households are caught in a development trap. Unable to overcome the technological indivisibilities, they cannot exploit more efficient modern technologies and are forced to continue with less productive traditional methods.

Financial liberalisation may solve these problems. The abolition of controls on the financial system allows bank interest rates to rise to equilibrium levels that reflect the productivity of the development activities that the banks finance. Three broad channels are at work. Banks wish to attract deposits to finance their credit expansion. They will offer households the opportunity to accumulate internally generated funds through saving in deposit accounts at an attractive return. Intermediation of such deposits raises the supply of credit, allowing other households to borrow and overcome technological indivisibilities. Finally, in the face of equilibrium interest rates, a liberalised financial system is better able to channel savings to their most productive uses, generating greater efficiency in investment projects.

This process can be summarised as follows. Financial liberalisation permits real interest rates to rise to modestly positive, equilibrium levels. Through a variety of mechanisms, higher real rates prompt financial activities that promote economic development and growth. Under the two implicit assumptions of the original McKinnon – Shaw hypothesis – namely that the financial system is well-behaved and the capital account of the balance of payments is closed – their model predicts a positive reduced form relationship between real interest rates and growth.

The early empirical results [*Lanyi and Saracoglu, 1983; Gelb, 1989*] were generally supportive of this hypothesis. They did find a positive relationship between real interest rates and growth. However, subsequent work has altered these conclusions. King and Levine [*1993*] showed the real interest rate effect disappeared in a larger cross section of countries that included mature industrialised nations, although the explanatory power of other financial variables remained significant. De Gregorio and Guidotti [*1995*] noted that the relationship between real rates and growth may be non-monotonic, and chose alternative measures of financial depth to evaluate the effect of financial liberalisation on growth performance. Fry [*1997*] estimates non-linear functional forms, allowing higher real interest rates to promote growth over some low range of values but then hinder it over a higher range. He suggests that these empirical models offer a better fit to the developing country data.

Market failure in the financial system has been offered as one explanation of the observed non-monotonicity in the relationship between real interest rates and economic growth. When public guarantees of bank deposits render moral hazard in the banking sector extreme – such as when under-capitalised banks are able to 'gamble for their own resurrection' – banks will make very risky loans at high interest rates [*Cho, 1986*]. In most cases, such behaviour eventually culminates in a banking crisis that precipitates poor general economic performance, suggesting high real interest rates coincide with periods of poor growth [*Hellman et al., 1994*]. The seminal experience of the Southern Cone countries in the early 1980s, especially Chile during 1978–82, is instructive in this respect [*McKinnon, 1982*].

Pill and Pradhan [*1995*] suggest the openness or otherwise of the capital account of the balance of payments will also affect the relationship between real interest rate and macroeconomic performance. With an open capital account, arbitrage broadly constrains real interest rates to world levels if *de facto* capital mobility is high. These rates may be below those that would obtain if domestic lending had to be financed solely from the relatively inelastic supply of domestic saving. Since the volume of lending can be much greater when access to the perfectly elastic international capital market is possible, growth performance may be improved if the credit constraints central to the McKinnon-Shaw hypothesis are important. Good growth performance may therefore be associated with modest real interest rates when the capital account is open. McKinnon's more recent work has encompassed the potential for financial market failure of various forms [*McKinnon, 1993*] and its interaction with inflows of foreign capital [*McKinnon and Pill, 1996*].

One significant 'puzzle' emerging from this empirical literature remains to be resolved. The successful East Asian 'tiger' economies typically appear as out-liers to the cross-country regression results. They enjoy a better growth performance than that implied by the simple reduced form relationship between real interest rates and economic growth.

This paper offers an alternative explanation for the non-linear relationship between real rates and economic growth reported by previous studies. It also addresses the 'East Asian puzzle'. By using the consumer price index as the price deflator to calculate real interest rates in developing countries with poorly developed or mal-functioning financial markets, the existing literature may have mis-measured the real rate faced by most domestic non-bank residents. Whatever the true relationship between real interest rates and economic growth, use of a correct measure of the real interest rate is necessary if estimated relationships are to be meaningful.

II. MEASURING REAL INTEREST RATES

The real interest rate is defined using the Fisher identity as follows:

$$(1+r) = \frac{(1+i)}{(1+\Pi^e)} \quad (1)$$

where: r = real interest rate.
i = nominal interest rate.
Π^e = expected rate of inflation.

In many contexts, this relationship is reduced to simply the difference between the nominal interest rate and the expected inflation rate, ignoring the cross product term. However, when inflation is high (as is the case in many developing nations prior to, and during, the implementation of structural reform and financial liberalisation), the cross product can be of first order magnitude and therefore cannot be ignored.

In principle, one would wish to construct an *ex-ante* measure of the real interest rate. However, the expected rate of inflation is not directly observable. In developing countries, regular surveys of price expectations are not undertaken.[1] Therefore, inevitably one is forced to use *ex-post* measures of the real interest rate.[2]

When measuring real interest rates in this context, the contentious issues therefore centre on the choice of nominal interest rate and inflation data used to construct the real rate measure. To address these questions, one must turn to the theoretical basis for the proposition being evaluated. McKinnon's [*1973: Ch. 6*] analysis highlighted the so-called *conduit effect* relating financial saving to physical investment. A large proportion of investment is financed out of retained earnings. Where indivisibilities exist in investment opportunities, desired capital expenditure is 'lumpy'. Firms need a safe and attractive repository in which to accumulate retained funds until they have sufficient to undertake the discrete investment. Hence, in the aggregate, physical capital and financial capital (in the form of deposit balances) can be complements over some range, while this conduit effect dominates. Moreover, Shaw [*1973*] emphasised that the resultant financial saving can be put to productive use if firms are able to borrow external funds from the banks to overcome technological indivisibilities and working capital constraints.[3] Since both explanations point to the importance of *financial deepening* and the accumulation of savings deposits for economic development, a short-term deposit interest rate is appropriate for an analysis of the relationship between real interest rates and growth.

Existing analyses have used the consumer price index (CPI) to construct an *ex-post* measure of expected inflation. This appears plausible: ultimately,

households are saving for future consumption and therefore the expected price of consumption goods would appear to be the appropriate deflator. However, in so doing, existing studies have implicitly assumed the existence of a 'Keynesian bond market' that correctly embodies expected changes in the cost of living faced by bond holders. The CPI is a good proxy for such expectations because it captures the price of a broad basket of goods and services, representative of the consumption bundle of an average consumer. Where such 'Keynesian bonds' are available to wealth-holders as alternatives to bank deposits, the CPI-based measure of real interest rates is the appropriate measure for an investigation of the relationship between real rates and growth, since it is related to the return available on alternative assets.

However, in most developing countries, financial markets are relatively undeveloped. Because of information and monitoring problems, few firms have access to capital markets. Banks dominate the domestic financial system. Only recently have equity and bond markets been established in 'emerging market' economies; of these, equity markets have been most important [*Singh, 1995*]. In most cases, individual domestic residents have little access to such markets and remain heavily dependent on the banking system. If individuals cannot buy 'Keynesian bonds' bearing an implicit real return related to CPI inflation, the alternative to holding bank deposits is the accumulation of non-productive assets, notably foreign currency or excess inventory holdings of intermediate goods. The nominal return on the competing asset is thus the depreciation of the nominal exchange rate (in the former instance) or the inflation rate for intermediate goods (less some allowance for storage costs and physical depreciation) in the latter. These returns may not be closely related to the CPI. This is likely to have implications for the construction of an *ex-post* real interest rate.

In the empirical analysis that follows, I construct alternative measures of the real interest rate using the wholesale price index (WPI).[4] The WPI is the preferred price measure for excess inventories held as inflation hedges. It represents the prices of goods 'at the factory gate' and is thus a good proxy for the value of inventories of intermediate goods or manufactures. The CPI includes a large services component. Services, by their very nature, are intangible and cannot be held through time as hedges against inflation. Therefore, the CPI is an inappropriate basis for measurement of *ex-post* real interest rates in conducting this type of analysis. The performance of WPI-based real interest rate measures in explaining cross country growth is then evaluated and the results compared with the conventional analysis using real rates constructed from the CPI.

Unfortunately, availability of WPI data is much more limited than for the CPI. In practice, one therefore faces a difficult trade-off: should one

exploit the advantages of greater data coverage, or alternatively ensure a better correspondence between the underlying conceptual framework and its empirical implementation?

Before turning to the empirical analysis, I first demonstrate why use of the wrong deflator may have resulted in biased estimates of the relationship between economic growth and the real interest rate constructed from CPI data. The issue of which price index to use when constructing *ex post* real interest rate measures would be irrelevant if the CPI, WPI and nominal exchange rate all moved together. Indeed, to explain a systematic non-monotonicity in the relationship between real interest rates and growth, such as that reported by Fry [*1997*], differences in the behaviour of the CPI and WPI must vary systematically across countries in a way closely related to those countries' growth performance. There are two broad theoretical explanations for precisely such systematic variation – the well-known Balassa-Samuelson effect [*Balassa, 1964*]; and, the financial market failure hypothesis offered by McKinnon and Pill [*1996, 1997*]. These two issues are discussed in more detail in the following sections.

III. REAL INTEREST RATE MEASURES AND THE BALASSA EFFECT

The Balassa effect attributes the differences between inflation measured on a CPI and WPI basis to differential productivity growth in the tradable and non-tradable sectors. Consider a small two-sector open economy producing tradable and non-tradable goods. For simplicity, assume that all tangible manufactured and intermediate goods are tradable, whereas all non-tradable goods are intangible services. This economy is a price taker on world markets so relative purchasing power parity in tradable goods holds at all times:

$$\dot{p}_{tradables} = \dot{e} + \dot{p}^* \tag{2}$$

where all variables are expressed in natural logarithms, p is the domestic price level, p^* is the world price level and e is the nominal exchange rate (conventionally defined as the domestic currency price of one unit of foreign exchange).

Assuming the profit share is constant,[5] the growth rate of the nominal wage (W) paid by the tradables sector is determined by developments in world prices, the exchange rate and productivity growth ($\dot{\eta}$):

$$\dot{W}_{tradables} = \dot{p}_{tradables} + \dot{\eta}_{tradables} \tag{3}$$

$$= (\dot{e} + \dot{p}^*) + \dot{\eta}_{tradables}$$

If the tradables sector is dominant, in the sense that it determines wage setting behaviour for the economy as a whole, then nominal wages in the non-tradable sector will grow at the same rate as those in the tradable sector:

$$\dot{W}_{tradables} = \dot{W}_{non-tradables} \tag{4}$$

Therefore, again assuming a constant profit share, the price of non tradables is determined by:

$$\begin{aligned} \dot{p}_{non-tradables} &= \dot{W}_{non-tradables} - \dot{\eta}_{non-tradables} \\ &= (\dot{e} + \dot{p}^* + \dot{\eta}_{tradables}) - \dot{\eta}_{non-tradables} \end{aligned} \tag{5}$$

The manufactured goods, whose prices are included in the WPI, are largely tradable. In contrast, the prices in the CPI include those of services that are conventionally assumed to be non-tradable. If the tradable sector constitutes γ of the economy:

$$\begin{aligned} \dot{p}_{CPI} &= \gamma\, \dot{p}_{tradables} + (1-\gamma)\, \dot{p}_{non-tradables} \\ &= \dot{e} + \dot{p}^* + (1-\gamma)\,(\dot{\eta}_{tradables} - \dot{\eta}_{non-tradables}) \end{aligned} \tag{6}$$

$$\begin{aligned} \dot{p}_{WPI} &= \dot{p}_{tradables} \\ &= \dot{e} + \dot{p}^* \end{aligned} \tag{7}$$

It is apparent from expressions (6) and (7) that the difference between CPI and WPI measures of inflation is related to relative labour productivity growth in the production of tradable and non-tradable goods. Balassa argued that productivity growth in the non-tradable services sector would be relatively slow. In developing countries, the labour productivity gains associated with good growth performance will be concentrated in the tradable manufacturing sector. Consequently, rapidly growing economies will tend to have bigger differentials between CPI and WPI inflation rates than economies that are growing more slowly.

IV. MISMEASUREMENT AND FINANCIAL MARKET FAILURE

In addition to real interest rate mismeasurement caused by the Balassa effect in high growth economies, use of the CPI may result in mismeasurement of

real rates for other reasons, especially in countries prone to various kinds of macroeconomic mis-management that produce poor overall growth performance. For example, high real interest rates (appropriately defined) may be indicative of market and institutional failures in the financial system that are ultimately likely to promote a poor general economic performance. As reported by McKinnon and Pill [*1996*] and Schadler *et al.* [*1993*], those countries afflicted by such financial market failure (especially when the capital account of the balance of payments is open) are prone to large 'boom–bust' cyclical fluctuations. During the initial 'boom' phase, domestic price inflation is concentrated in non-traded goods sectors, such as property and services. In essence, non-tradable goods inflation must exceed tradable goods inflation to produce the real exchange rate appreciation required to maintain goods market equilibrium as aggregate domestic consumption expands, prior to the onset of financial crisis.

McKinnon and Pill [*1996*] have investigated this phenomenon in a very simple two period Fisherian model. Financial market failures induce excess demand, as domestic credit expansion is excessive. In the tradables sector, excess demand results in a larger than optimal trade deficit (or, equivalently, excessive borrowing from abroad). Tradable goods prices are constrained to world levels by arbitrage pressures. In contrast, excess demand for non-tradables has to be met by domestic output. In the absence of international competition, non-tradables prices are not constrained by world market pressures and rise in response to strong aggregate demand. Therefore, the financial market failure generates inflation in the non-tradable goods sector (largely services, excluded from the WPI), but does not effect prices in the tradable goods sector (largely manufactured and intermediate goods included in the WPI goods basket).

Consequently, real interest rates measured on an *ex-post* CPI basis will tend to systematically under-estimate the economically relevant (WPI based) real rate. Eventually, the financial market failure will culminate in banking and balance of payments crises leading to poor growth performance. Countries with a poor economic record for this reason will systematically have lower real interest rates measured on a CPI basis than they would on a WPI basis. Thus the measurement issue is important even if the existing main explanation of non-monotonicities in the real interest rate and growth relationship is correct. For countries with the high real rate/poor growth performance combination, the CPI-based measure of the real interest rate will systematically under-estimate the true WPI-based measure, thereby giving rise to biased estimates of the degree of non-monotonicity.

V. BIASES INTRODUCED BY REAL RATE MISMEASUREMENT

What implications do these two sources of real interest rate mismeasurement entail for regressions purporting to evaluate the McKinnon-Shaw hypothesis? Assume for the moment that there is a positive monotonic reduced form relationship between real interest rates and growth when the former is measured correctly using *ex-post* expected inflation based on the WPI. If the real rate is mis-measured using the CPI, this relationship may disappear. In cross-country data, countries with very negative real rates will stagnate because of the deleterious effects of financial repression. However, countries with very rapid growth will have relatively high consumer price inflation (due to the Balassa effect) and therefore only modestly positive real interest rates measured on a CPI basis. Countries with more moderate growth will have lower CPI inflation because the Balassa effect will not operate. Their real interest rates measured on a CPI basis will be high. Therefore moderate growth countries will have high real interest rates – possibly higher than the CPI-based real rates for the high growth nations. If this is the case, mismeasurement of the real rate introduces a non-monotonicity into the estimated relationship, even though the true underlying semi-structural form is monotonic.

To state this proposition a little more formally, consider the following semi-structural economic model, which allows for non-monotonicity in the real rates and growth relationship:

$$\dot{Y}_s = \alpha + \beta_1 RR_s^{WPI} + \beta_2 (RR_s^{WPI})^2 + \varepsilon_{1s} \quad (8)$$

$$A_s = f(\dot{Y}_s) + \varepsilon_{2s} \quad (9)$$

where: $\dot{Y}_s$ = growth rate of country s.

RR_s^{WPI} = real interest rate (measured using WPI) in country s.

$A_s = (\dot{\eta}_{tradables} - \dot{\eta}_{non-tradables})$ in country s.

For this to be a meaningful structural model, I impose the orthogonality conditions $RR_s^{WPI} \perp \varepsilon_1$ and $\dot{Y}_s \perp \varepsilon_2$.

Expression (8) is the semi-structural relationship between real interest rates (correctly measured) and economic growth. Following Fry [*1997*], it allows for the existence of a non-monotonicity in the relationship by including a quadratic term. With $f' > 0$, expression (9) summarises Balassa's [*1964*] assertion that countries enjoying higher growth rates will have a greater difference between productivity growth in tradable manufacturing

and non-tradable service sectors. In developing countries, productivity growth is initially concentrated in the former.

Contrast the structural model summarised by equations (8) and (9) with the standard expression estimated in the existing literature:

$$\dot{Y}_s = \tilde{\alpha} + \tilde{\beta}_1 RR_s^{CPI} + \beta_2 (RR_s^{CPI})^2 + \tilde{\varepsilon} \quad (10)$$

where RR_s^{CPI} = real interest rate (measured using CPI) in country s. From expressions (6) and (7) above, it is apparent that:

$$RR_s^{CPI} = RR_s^{WPI} - (1-\gamma) A_s \quad (11)$$

Therefore estimates of β_1 and β_2 based on an OLS regression like (10) will be subject to two forms of bias: a measurement error bias, due to the use of a CPI based real interest rate; and, a simultaneity bias, due to the endogeneity of this measurement error (A_s is determined by $\dot{Y}_s$ that is correlated with the structural error term ε_{1s}). The overall effect of these two biases on the estimated value of β_1 and β_2 is ambiguous. Specifically, the biases may produce an estimate of β_2 that is significantly different from zero, although the true value of the parameter is zero – that is, measurement errors associated with mismeasurement of real interest rate could introduce a spurious non-monotonicity into the relationship between real rates and growth.

The same problems arise when mismeasurement of real interest rates results from macroeconomic mis-management rather than the Balassa effect. The McKinnon and Pill [*1996*] model implies that the difference between CPI and WPI inflation will be inversely related to growth performance.

$$\dot{p}_s^{CPI} - \dot{p}_s^{WPI} = g(\dot{Y}_s) + \varepsilon_{3s} \quad g' < 0 \quad (12)$$

Using this expression, it is straightforward to show that the measurement error arising from use of a CPI rather than WPI-based real interest rate will be related to economic growth.

$$RR_s^{CPI} = RR_s^{WPI} - g(\dot{Y}_s) - \varepsilon_{3s} \quad (13)$$

Therefore, measurement error and endogeneity biases will again enter estimates of the relationship made using CPI-based real interest rates. The directions of these biases are ambiguous *ex ante* and may obscure the underlying semi-structural relationships that are of prime interest from a policy perspective.

VI. EMPIRICAL ANALYSIS

Data

The data set was constructed for eighty-seven developing nations using the International Monetary Fund's (IMF) *International Financial Statistics* (March 1997) and the Penn World Tables (updated 1995). Interest rate and price data were obtained from the IMF, while activity variables are from the Penn Tables.[6] Following the conceptual discussion above, a bank deposit interest rate was used for the analysis. The activity variable was a per capita measure of real gross domestic product at international prices. The robustness of the analysis presented here to changes in the definition of the activity variable was examined. The conclusions drawn below are unchanged when alternative measures of 'economic growth' are used.[7] A full description of the data's availability and source is contained in the data appendix. Of the 87 countries, only 35 produce a wholesale price index, illustrating the practical problem of obtaining WPI data. In many cases, the temporal coverage of the WPI data is shorter than for the CPI data, further limiting the scope for comparison between the two possible real interest rate measures.

Mismeasurement of Real Interest Rates

Before investigating the relationship between economic growth and real interest rates on various measures, I first demonstrate the empirical relevance of the mismeasurement issue. This can be illustrated straightforwardly using a small number of case studies. Consider Figure 1, a scatterplot of annual data for CPI and WPI-based real interest rates in Morocco. Morocco is chosen as a benchmark case: it is a country that has neither exhibited an exceptionally strong growth performance nor suffered dramatic financial crisis. Therefore, Moroccan CPI-based real interest rates are unlikely to be subject to the measurement biases introduced by either the Balassa [*1964*] or McKinnon and Pill [*1996*] effects. The sloping line in Figure 1 is a 45 degree line – it represents equality between CPI and WPI-based rates. For Morocco, the data are evenly distributed around this 45 degree line. There is no systematic tendency for the WPI-based real rate to exceed the CPI-based rate, *or vice versa*. These data therefore correspond to theoretical prediction. The CPI-based rate does not systematically mismeasure the 'true' WPI-based rate.

Such equality between the various real interest rate measures is absent in Singapore, a high growth East Asian 'tiger' economy likely to exhibit the Balassa effect. This is clear from the scatterplot for Singapore, shown in Figure 2. The data are grouped to the right of the 45-degree line, indicating that the WPI-based real interest rate generally exceeds the CPI-based rate in

FIGURE I

SCATTERPLOT OF CPI AND WPI-BASED REAL INTEREST RATES

MOROCCO 1978–91

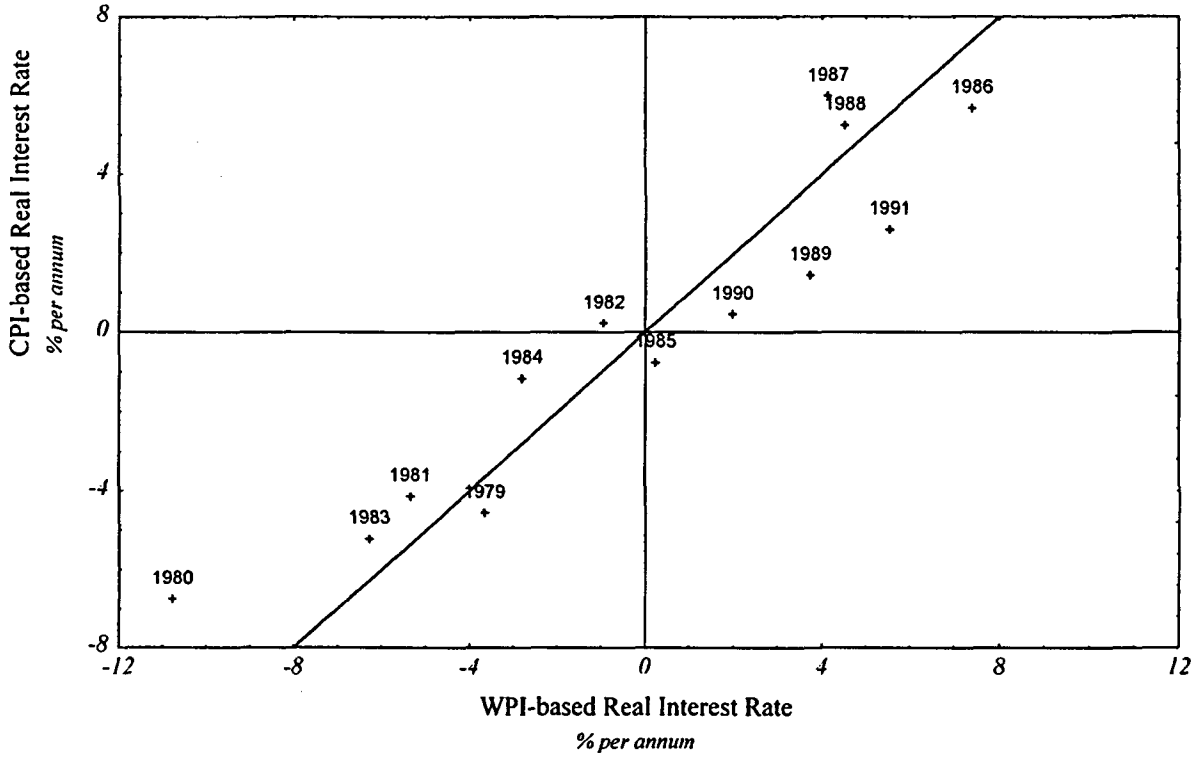
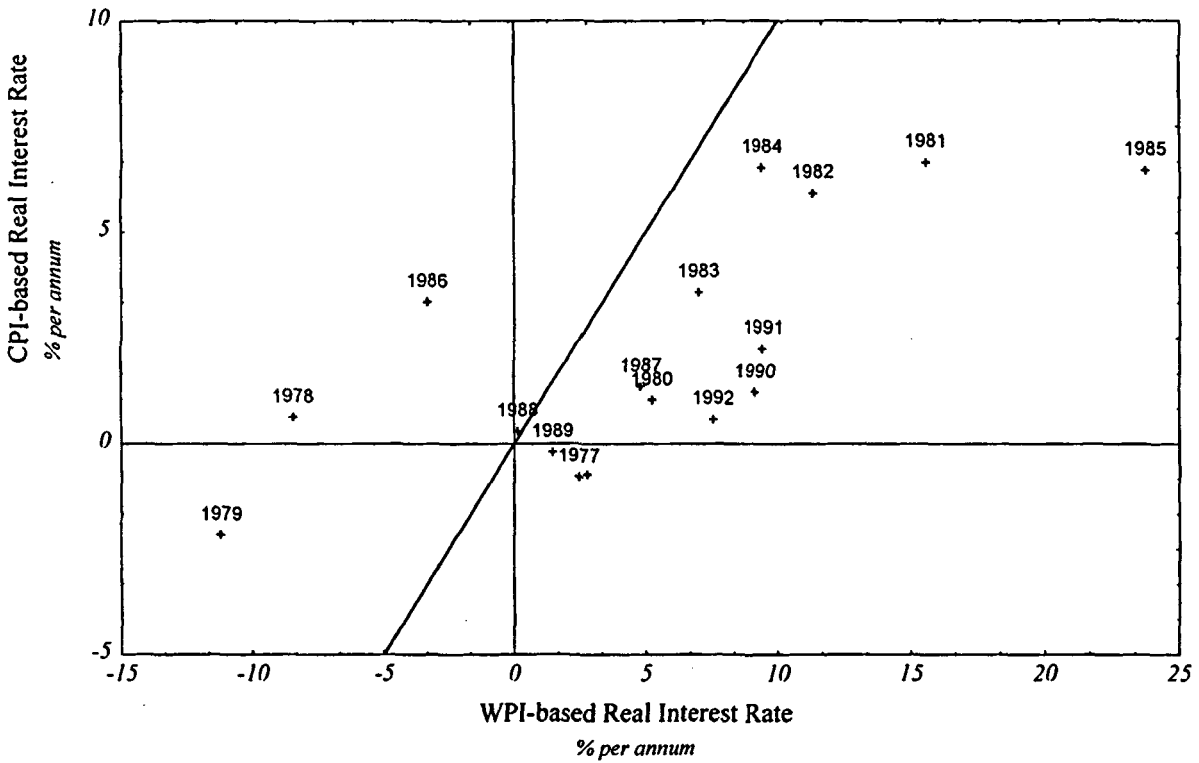


FIGURE 2

SCATTERPLOT OF CPI AND WPI-BASED REAL INTEREST RATES

SINGAPORE 1977–94



these high growth nations, as theoretical discussion of the Balassa effect would predict.

Events in the Southern Cone during the early 1980s are widely regarded as the archetypal examples of 'boom–bust' cycles associated with financial market failure [*McKinnon, 1982*]. Chile is representative of this experience. A scatterplot of Chilean CPI and WPI-based real interest rates is shown in Figure 3. It is immediately apparent that the correlation between the two real interest rate measures is lower in these cases than for Morocco or Singapore. Financial market failure, and the associated balance of payments crises and large devaluations, cause significant dislocations to the economy. These introduce large differences between the inflation measures. Nevertheless, in 1980–81 – as financial market failure in these countries reached its peak, prior to the 1982 crisis – the WPI-based real interest rate is significantly larger than the CPI-based rate. Use of a CPI-based real rate in growth regressions is likely to produce the biases discussed above.

More systematic analysis of the data is problematic because of interactions between the two mismeasurement biases central to this article. Using pooled annual data for countries that produce both a CPI and WPI price measure during the period 1971–92, two simple regressions were estimated. First consider the Balassa effect. To control for the impact of financial market failure, analysis was limited to those data observations where the WPI-based real interest rate lay in the interval $-10 < RR^{WPI} = < 10$.[8] A regression of the difference between the two real rate measures and economic growth was then estimated.[9]

$$(RR_s^{WPI} - RR_s^{CPI}) = \underset{(0.422)}{0.302} + \underset{(0.067)}{0.079\ \dot{Y}_s} \qquad (14)$$

$n = 311$, $R^2 = 0.004$

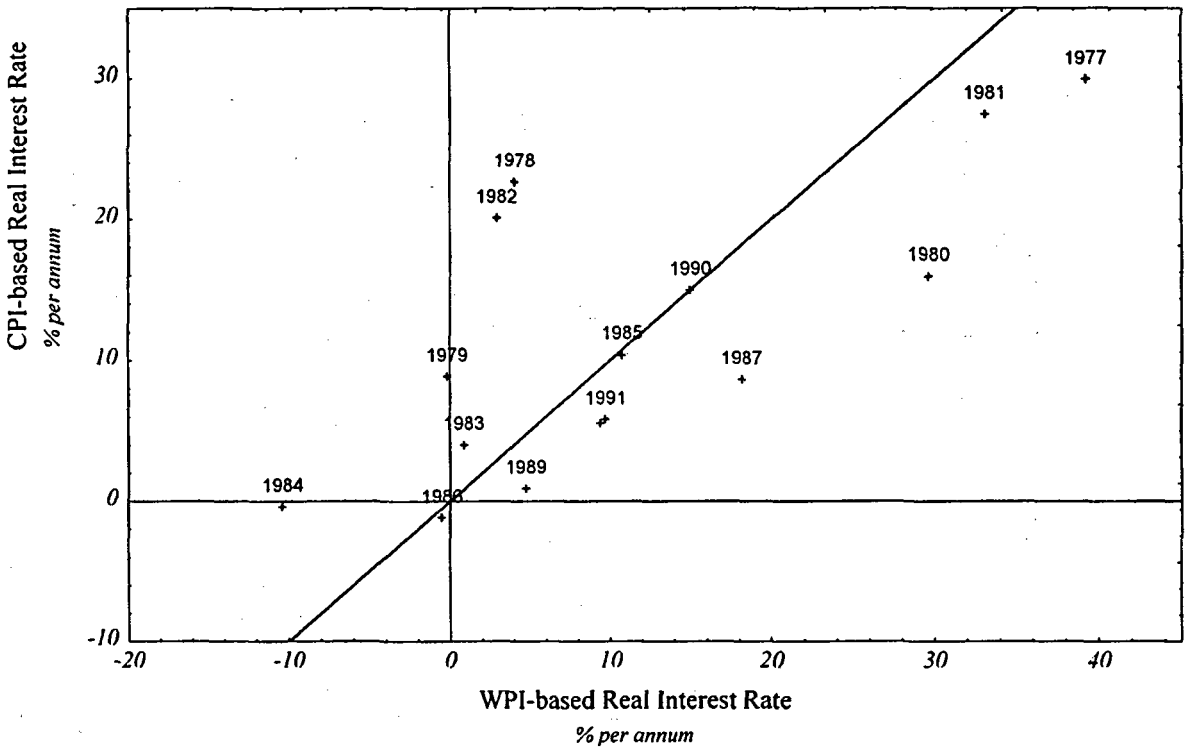
The fit of the regression is poor and the coefficients are not estimated with precision. However, the point estimates suggest that, in the absence of gross financial market failure, the difference between the WPI and CPI-based measures of the real interest rate are positively correlated with economic growth as models of the Balassa effect would predict.

An alternative simple regression analysis sheds light on the empirical relevance of the financial market failure effect. Here, all available annual data are used. The regression analysis is therefore heavily influenced by a small number of out-liers. However, this is precisely what the exercise is intended to reveal. Gross financial market failure will result in real interest rates that are out-liers from the sample as a whole. The regression shows the statistical relationship between such dis-equilibrium rates and the real rate mismeasurement.

FIGURE 3

SCATTERPLOT OF CPI AND WPI-BASED REAL INTEREST RATES

CHILE 1977–95



$$(RR_s^{WPI} - RR_s^{CPI}) = \underset{(1.390)}{-0.794} + \underset{(0.013)}{0.785\ RR_s^{WPI}} \quad (15)$$

$n = 438$, $R^2 = 0.894$

As the McKinnon and Pill hypothesis predicts, high real interest rates, that are indicative of financial market failure, are correlated with large differences between the real interest rates measured on a WPI and CPI basis.

Both the case studies shown in the scatterplots and these simple regression results point to the empirical relevance of the real interest rate mismeasurement issues raised in this article. These are now evaluated in the context of regressions between real interest rates and economic growth.

Real Interest Rates and Growth

I now turn to regression analysis of the data. In Table 1, I report regressions of economic growth on real interest rates measured using both WPI and CPI price measures. These regressions take the form:

$$GROWTHs = \alpha + \beta_1\ REAL\ RATEs + \beta_2\ (REAL\ RATE)_s^2 + \varepsilon_s \quad (16)$$

where the quadratic term allows for possible non-monotonicities in the relationship, as in Fry [*1997*]. The conventional interpretation of the McKinnon-Shaw hypothesis would imply $\beta_1 > 0$, $\beta_2 = 0$. Financial liberalisation allows banks to set modestly positive, market clearing real interest rates that promote economic growth in both the short and medium terms as the level and quality of investment rise. The 'market failure and financial crisis' explanation of non-monotonicity (as suggested by Hellman *et al.* [*1994*], *inter alia*) implies $\beta_2 < 0$. Very high real interest rates are symptomatic of moral hazard and adverse selection market failures in the lending decisions of banks. Eventually, these are likely to precipitate a financial crisis with adverse growth implications. The relationship between real rates and growth will therefore have an inverted-U shape, implying a negative coefficient on the quadratic term.

All regressions are implemented using ordinary least squares (OLS) techniques. In consequence, they estimate reduced form relationships, simply summarising the observed correlations between real rates and economic growth. Most theoretical economic models predict that shocks to economic growth will also affect the real interest rate (real business cycle models being the most straightforward example). The 'independent variable' (*REAL RATE*) is therefore correlated with the error term (ε). Equation (16) is not identified and the estimated coefficients (β_1 and β_2) cannot be interpreted as structural parameters. In estimating reduced forms, I follow most of the existing literature in this field, notably the studies of

TABLE 1

REGRESSIONS IN POOLED ANNUAL DATA

	sample	*real rate measure*	*n*	α	β_1	β_2	R^2	*F*	*DW*
a	All countries, all years	*CPI*	1098	***0.911*** (0.226)	0.0060 (0.0084)	-	0.000	-	1.722
b	Allcountries, all years	*CPI*	1098	***1.044*** (0.228)	***0.0397*** (0.0132)	***-0.00014*** (0.00004)	0.010	***5.713***	1.718
c	Countries& years with CPI & WPI	*CPI*	438	***1.584*** (0.279)	0.0058 (0.0075)	-	0.001	-	1.737
d	Countries& years with CPI & WPI	*CPI*	438	***1.657*** (0.277)	***0.0438*** (0.0175)	***-0.00015*** (0.00005)	0.023	***5.231***	1.740
e	Countries& years with CPI & WPI	*WPI*	438	***1.610*** (0.278)	*0.0047* (0.0026)	-	0.007	-	1.745
f	Countries & years with CPI & WPI	*WPI*	438	***1.607*** (0.279)	- 0.0020 (0.0071)	- 0.00002 (0.00005)	0.007	1.699	1.747
g	Excluding Out-liers	*CPI*	432	***1.665*** (0.278)	***0.043*** (0.019)	-	0.011	-	1.757
h	Excluding Out-liers	*CPI*	432	***1.905*** (0.282)	***0.040*** (0.019)	***-0.0012*** (0.0003)	0.040	***8.844***	1.791
j	Excluding Out-liers	*WPI*	432	***1.713*** (0.276)	***0.061*** (0.017)	-	0.030	-	1.760
k	Excluding Out-liers	*WPI*	432	***1.936*** (0.285)	***0.050*** (0.017)	***-0.0009*** (0.0003)	0.047	***10.49***	1.788

Notes: The samples used to run each regression are described in more detail in the main text.

F is the F-statistic constructed to test the hypothesis that the coefficients estimated in the regression are jointly statistically significantly different from zero. ***DW*** is the Durbin-Watson statistic.

Standard errors of the coefficient estimates are reported in parentheses below the coefficient itself

Coefficients in ***italics*** are statistically significant (reject the null hypothesis that the coefficient equals zero) at the 10% level in a two-tailed test; coefficients in bold are statistically significant at the 5% level; and, coefficients in ***bold italics*** are statistically significant at the 1% level.

Lanyi and Saracoglu [*1983*], Gelb [*1989*] and Fry [*1997*]. One cannot claim, on the basis of these regressions, that raising the real interest rate exogenously will have a direct impact on growth performance. Rather, the regressions suggest exogenous shocks (say the implementation of financial liberalisation by the policy authorities) that increase interest rates towards plausible equilibrium levels will, on average, have a simultaneous positive effect on growth performance. This interpretation is wholly within the spirit of the McKinnon-Shaw hypothesis.

Table 1 reports the results of regressions using pooled annual data from the cross-country data set. An alternative approach, using period averages, may obscure precisely the effects highlighted in this article. For example, the 'boom–bust' gyrations associated with financial market failure and banking crisis produce large year-to-year fluctuations in both economic growth and real rates. When averaging over a period of (up to) 22 years, these gyrations – the source of the econometric problems with real interest rate mismeasurement – are smoothed out. The example of Chile used above is again illustrative. Figure 3 shows the large year-to-year changes in real interest rates and in the difference between WPI and CPI-based measures. Moreover, economic growth in Chile is very volatile: following the financial crisis, Chilean GDP fell by almost 15 per cent in 1982. However, for the period 1977–92 as a whole,[10] the data associated with this financial crisis are balanced by the generally much more successful Chilean economic performance of the late 1980s and early 1990s. The averaged Chilean data therefore conflate two very different periods. They do not illustrate the financial crisis that will generate the mismeasurement problems of concern.

Consequently, I undertake the analysis using pooled annual data. The results are reported in Table 1 as regressions (*a*) through (*k*). Equations (*a*) and (*b*) are linear and quadratic regressions respectively for a sample consisting of all available annual data for each of the 87 countries in the data set.[11] The total number of observations then available is 1098. Only CPI data are available for this large sample. The quadratic model produces a much better fit of the data than the simple linear model (although the R^2 statistic remains low, as one might expect in a data-set exhibiting such wide cross sectional and time series variation). The estimated coefficients are individually and jointly significant at the one per cent level. However, robustness checks of the reported results demonstrate that the regression coefficients are strongly influenced by a very small number of out-liers.

Using matching data-sets to facilitate comparison between the performance of CPI and WPI-based real interest rates in these regressions considerably reduces the sample's size. Because the availability of WPI is much more limited, the sample size is reduced to only 436 observations,

taken from 35 countries. Using this smaller data set, regressions (*c*) and (*d*) report the linear and quadratic models respectively for the CPI-based data, while regressions (*e*) and (*f*) do likewise for the WPI data. The best empirical model is obtained with the quadratic regression using CPI-based measures of the real interest rate, (*d*). In contrast to the estimates obtained in the two linear regressions, the coefficients are correctly signed. Moreover they are both individually and jointly significant at conventional levels, whereas neither is true of the parameter estimates from the WPI-based quadratic model (*f*). The fit of the data (as measured by the R^2) is also greater, although still low.

Once again, robustness checks demonstrate that the reported regression estimates are driven by a small number of out-liers. This confirms the importance of examining year-to-year variations in the data. Out-liers represent only one or two years data for each of the relevant countries. These years are highly atypical. Out-liers are associated with sharp changes in macroeconomic policy, performance and stability that introduce other important sources of mismeasurement. For example, the unexpected introduction of a macroeconomic stabilisation programme – or, equivalently, its unanticipated sudden demise – is likely to result in an outturn for inflation (on either the CPI or WPI basis) that is quite different from the a priori expectation of borrowers and lenders. The *ex-post* measures of the real interest rate used in this paper are likely to be poor proxies for the true *ex-ante* real rates that theory, in principle, demands. Sudden policy shifts may result in dramatic changes in inflation performance, producing very large measurement errors in inflation expectations. Those countries with the most extreme out-liers in the pooled annual data (Brazil, Argentina and Peru) have all experienced precisely these sudden, transient policy shifts. Such exceptional episodes are hardly representative of the underlying relationship between economic growth, real interest rates and financial liberalisation that is the central focus of this article.

To address these concerns, I exclude out-liers from the sample. Those observations where the WPI-based real interest rate exceeds 100 per cent per annum (only six country/year combinations in total) are therefore removed from the data set, and the linear and quadratic regressions are re-estimated for both CPI and WPI-based real interest rates.[12] The results are reported as regressions (*g*) through (*k*).

All four of these final regressions produce coefficient estimates that are statistically significant and correctly signed. For both the CPI and WPI-based data, the inclusion of a quadratic term considerably improves the model: not only is the coefficient on the quadratic term statistically significant at the one per cent level (both individually and jointly with the linear term), but in both cases it also greatly improves the models' fit of the

data. Comparing the preferred quadratic regressions, the WPI-based model (*k*) now appears to dominate the CPI-based version (*h*). Although the coefficient point estimates cannot be distinguished at conventional levels of statistical significance, the fit of the WPI-based model to the data is considerably better. A graphical representation of this preferred regression is offered in Figure 4.

VII. CONCLUSIONS

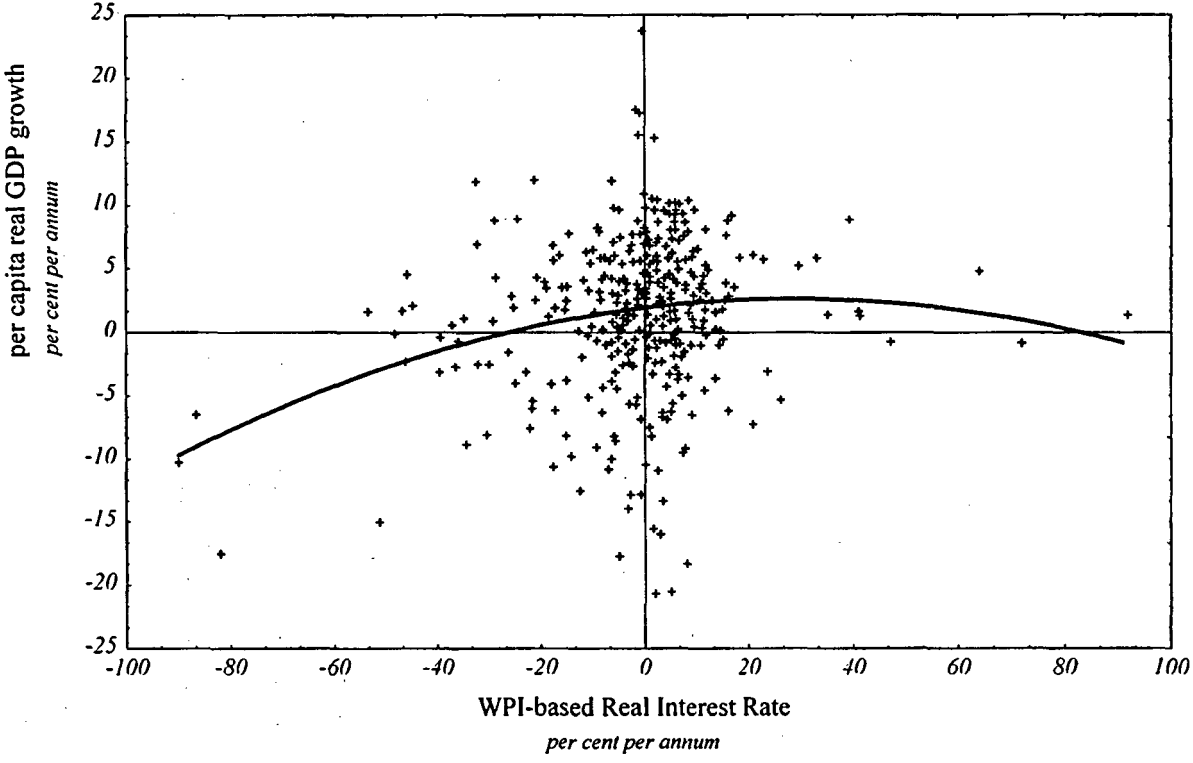
A considerable empirical literature has explored the reduced form relationship between real interest rates and economic growth as a simple test of the McKinnon-Shaw hypothesis. This hypothesis claims that liberalisation of the domestic financial system, that allows banks to raise real interest rates to plausible market-clearing levels, will stimulate higher economic growth as the level and quality of domestic investment in modern technologies increase. Therefore, one would expect to see a positive relationship between real rates and growth. More recent work has amended this claim to allow for the deleterious effects on growth performance of high real interest rates associated with market failure in the financial system. The real interest rate and growth relationship may be non-monotonic, taking the form of an inverted U-shape as very high rates precipitate financial crisis and poor growth performance.

The existing literature is flawed because it uses a measure of the real interest rate based on inflation in the consumer price index. In most developing countries, individuals do not have access to a well-behaved 'Keynesian bond market', the return on which is closely related to CPI inflation. Purchasers of 'Keynesian bonds' are saving for future consumption, the price of which will be reflected by the CPI. In developing countries, the alternative to holding bank deposits is not purchases of 'Keynesian bonds' but an accumulation of excess inventories of physical goods, the price of which is best measured by the wholesale price index. There are important conceptual reasons that suggest the CPI and WPI will behave differently in ways systematically related to economic performance. In successful developing countries with high growth rates, supply-side productivity gains are concentrated in the tradables sector (largely manufactures) rather than the non-tradable sector (including services). In countries suffering from financial market failure, price inflation is concentrated in non-traded goods during the initial 'boom' phase, since non-tradables producers are not subject to the discipline of international competition. Both these theories of unbalanced growth suggest the CPI (which includes a large non-tradable services component) will inflate more rapidly than the WPI. Since the WPI is conceptually the correct deflator to

FIGURE 4

REGRESSION (k)

n = 432



construct real interest rates in developing countries, existing studies using the CPI have employed downward biased measures of the real interest rate for certain groups of countries.

The empirical section of this paper compares growth regressions using CPI and WPI-based measures of real interest rates. These regressions pool annual data for a broad cross-section of developing countries. Contrary to the theoretical discussion of the mismeasurement issue, it initially appears that CPI-based real interest rates offer a better empirical fit of the data. However, investigation of the data demonstrates that these results are being driven by a very small number of out-liers associated with extreme cases of financial market failure and macroeconomic mis-management. The simple quadratic model proposed by Fry [*1997*] cannot deal with such extreme cases of financial market failure. Paradoxically, the mismeasurement of real interest rates using the CPI in these extreme cases may make it easier to fit the out-liers since the mismeasurement itself acts in a direction that reduces the extent to which these observations are distanced from rest of the data.

Exclusion of the out-liers allows the simple quadratic model to offer a much better description of the data. Moreover, the WPI-based real interest rate data now appear preferable to the CPI-based data, as the discussion of mismeasurement would suggest. The gains are perhaps marginal. In the preferred model estimated in this article, the parameter estimates are not statistically distinguishable in the CPI and WPI-based regressions. However, the fit of the WPI-based model is considerably better. Moreover, the point estimates suggest that the non-monotonicity in the relationship between real interest rate and economic growth is less pronounced than the conventional CPI-based regression imply.

Mismeasurement of real interest rates arising from the Balassa effect cannot explain all the observed non-monotonicities in the relationship between real rates and growth. As proposed by Fry [*1997*], financial market failure and macroeconomic mis-management are also extremely important explanations. Mismeasurement arising from use of the CPI is also likely to produce biases in these cases, albeit of a different form. This paper explains the potential source of bias in both cases and demonstrates their empirical relevance. Specifically, use of the conceptually correct WPI-based real rate measure supports the McKinnon-Shaw hypothesis by suggesting that the adverse effects of higher real interest rates are smaller than the conventional CPI-based regressions imply, once very extreme cases, correlated with many other distortions, have been excluded.

Dornbusch and Reynoso [*1989: 205*] argue that the financial liberalisation paradigm 'in some ways seems like supply-side economics – a kernel of truth and a vast exaggeration'. This article offers evidence refuting their view. The results demonstrate that financial liberalisation and

the establishment of equilibrium real interest rates can produce significant improvements in growth performance. For example, in an 'average' country, real interest rates of -25 per cent (appropriately measured) are associated with stagnation of real per capita incomes. If the implementation of financial liberalisation causes real rates to increase to five per cent per annum (a plausible equilibrium value if financial market failure is avoided), then this paper suggests that real per capita GDP growth will increase to more than two per cent per year. While such growth rates will not transform a country overnight, this improvement in growth performance need not be exaggerated to support the view that a well-designed programme of financial liberalisation is an important component of successful development strategy.

final version received May 1997

NOTES

1. Even where price expectation surveys are regularly undertaken (for example, Eurostat data from the European Union), they are usually in qualitative or ordinal form rather than the cardinal form required for calculation of real interest rates. Haldane and Pradhan [*1992*] suggest a method for obtaining inflation expectations from the Eurostat data.
2. This can be justified formally be appealing to the theory of rational expectations. If individuals are forming expectations rationally, the expectation can only deviate from the *ex-post* out-turn for inflation by a white noise error term that will not materially affect the empirical results.
3. In an inter-temporal context, Molho [*1986*] reconciles the McKinnon and Shaw positions – that had often been mis-represented in preceding work as competing 'money' and 'credit' views of the transmission mechanism of financial liberalisation on growth – in this way.
4. In some countries, alternative measures of 'producer' or 'wholesale' prices are produced. I use the term 'wholesale prices' (abbreviated to WPI) throughout the text.
5. This is a simplifying assumption that makes the presentation of the simple model more straightforward. It is sufficient, but not necessary, to obtain the results important for the empirical analysis in this article.
6. The Penn World Tables data were obtained from the internet site maintained by the University of Toronto: www.epas.utoronto.ca:5680/pwt/pwt.html.
7. The other activity variables considered in these robustness checks were the Penn Tables variables for per capita real GDP at international adjusted for terms of trade shocks and per capita real GDP at international prices constructed using a Laspeyres index (rather than the Chain index used to construct the series used for the analysis reported in the text).
8. Of course, the choice of ten per cent as a cut-off rate is arbitrary. The aim is to exclude those observations where real interest rates were too high or low to be consistent with a plausible well-functioning capital market. The results presented here are not sensitive to the choice of other cut-off values (5, 20 and 30 per cent were used for robustness checks).
9. In all reported regressions, the standard error of the estimated coefficient is shown in parentheses below the reported coefficient point estimate.
10. This is the period for which Chilean interest rate, CPI and WPI data are available from *International Financial Statistics*, as shown in the Appendix.
11. Regressions are run on the raw data treating each country/year combination as one data point. The data-set is therefore not a panel, and no attempt is made to correct for country or time effects (whether fixed or random). Because of the variations in data availability across

countries, any panel produced from this sample would be unbalanced, introducing a host of severe econometric problems.

12. The choice of a cut-off value of 100 per cent is obviously to some extent arbitrary. The conclusions presented here are robust to alternative values.

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APPENDIX

DATA SOURCE

Countries that produce both a CPI and WPI price measure are highlighted in bold.

Country	Code		Years	n_{CPI}	n_{WPI}
Malta	**MTA**		1977–89	13	
Turkey	**TUR**	*CPI*	1973–92	20	
		WPI	1981–92	12	
South Africa	**ZAP**		1977–92	16	16
Argentina	**ARG**	*CPI*	1977–90	14	
		WPI	1984–90	7	
Bolivia	**BOL**		1979–92	14	
Brazil	**BRA**	*CPI*	1980–92	13	
		WPI	1982–92		11
Chile	**CHL**		1977–92	16	16
Colombia	**COL**		1986–92	7	7
Costa Rica	**CRI**		1982–92	11	11
Ecuador	**ECU**		1983–92	10	10
El Salvador	**SLV**		1983–92	10	10
Guatemala	**GTM**		1978–92	15	
Honduras	**HND**		1982–92	11	
Mexico	**MEX**		1977–92	16	16
Nicaragua	**NIC**		1990	1	
Panama	**PAN**		1986–92	7	7
Paraguay	**PRY**	*CPI*	1990–92	3	
		WPI	1990		1
Peru	**PER**		1988–92	5	5
Uruguay	**URY**		1976–92	17	17
Venezuela	**VEN**		1984–92	9	9
Bahamas	**BHS**		1980–87	8	
Barbados	**BRB**		1980–89	10	
Grenada	**GRD**		1985–90	6	
Guyana	**GUY**		1974–90	17	
Belize	**BLZ**		1981–92	12	
Jamaica	**JAM**		1976–91	16	
Trinidad & Tobago	**TTO**		1981–91	11	11
Balirain	**BHR**		1976–88	13	
Cyprus	**CYP**	*CPI*	1971–92	22	
		WPI	1971–89		19
Israel	**ISR**		1983–92	10	10
Jordan	**JOR**		1990	1	
Kuwait	**KWT**		1981–89	9	9
Qatar	**QAT**		1981–89	9	
Egypt	**EGY**		1976–92	17	17
Myanamar	**BUR**		1971–89	19	
Sri Lanka	**LKA**		1978–90	13	13
India[1]	**IND**		1975–87	13	13
Indonesia	**IDN**		1971–92	22	22
Korea	**KOR**		1971–91	21	21
Malaysia	**MYS**		1984–87, 1989–91	7	7
Nepal	**NPL**		1975–86	12	
Pakistan[1]	**PAK**		1975–87	13	13
Philippines	**PHL**		1976–92	17	17
Singapore	**SGP**		1977–92	16	16
Thailand	**THA**		1977–92	16	16
Botswana	**BWA**		1981–89	9	
Burundi	**BDI**		1974–88	15	
Cameroon	**CMR**		1980–91	12	

APPENDIX (cont.)

Country	Code	Years	n_{CPI}	n_{WPI}
Cape Verde Islands	CPV	1985–92	8	
CentralAfrican Republic	CAF	1980–92	13	13
Chad	TCD	1983–92	10	
Congo	COG	1987–92	15	15
Ethiopia	ETH	1985–86	2	
Gabon	GAB	1978–92	15	
Gambia	GMB	1978–90	13	
Ghana	GRA	1978–89	12	12
Guinea–Buisseau	GNB	1988–92	15	
COte d'Ivoire	CIV	1979–92	14	
Kenya	KEN	1971–90	20	
Lesotho	LSO	1981–83, 1985–92	11	
Liberia	LBR	1980–86	7	
Malawi	MWI	1980–92	13	
Mali	MLI	1988–91	4	
Mauritania	MRT	1985–92	8	
Mauritius	MUS	1981–92	12	
Morocco	MAR	1979–91	13	13
Niger	NER	1971–89	19	
Nigeria	NGA	1971–92	22	
Zimbabwe	ZWE	1975–92	18	
Rwanda	RWA	1979–92	14	
Seychelles	SYC	1981–90	10	
Sierra Leone	SLE	1977–92	16	
Somalia	SOM	1971–87	17	
Namibia	NAM	1991–92	2	
Swaziland	SWZ	1973–89	17	
Tanzania	TZA	1974–88	15	
Togo	TGO	1971–92	22	
Tunisia	TUN	1983–88	6	6
Uganda	UGA	1981–92	12	
Burkina Faso	BFA	1971–92	22	
Zambia	ZMB	1971–90	20	20
Solomon Islands	SLB	1981–88	8	
Fiji	FJI	1976–90	15	
Vanuatu	VUT	1984–90	7	
Papua New Guinea	PNG	1980–92	13	
Western Samoa	WSM	1980–90	11	
China	CHN	1980–92	13	
TOTAL			**1098**	**436**

Notes: 1. The interest rate data for India and Pakistan are taken from Green and Villanueva [*1991*] rather than from *International Financial Statistics* (IFS). Bank deposit interest rates for these two countries are not reported in IFS.

IFS Data

Deposit interest rates	line 601
Consumer Price Index	line 64
Wholesale Price Index	line 63

Penn World Tables

Per capita real GDP at international prices code RGDPC