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The Behavior of Real Rates of Interest in a Small, Opening Economy

Thomas J. Cunningham*
and
Rosemary T. Cunningham**

In contrast to many in the profession, Mishkin claims that, for the case of the U.S., movements in the real rate of interest are largely explainable by monetary policy. If this is true, we should see one of two things happen in a small, open economy. Either real interest rate movements should correlate with US real rate movements, making US monetary policy a major influence in world monetary policy, or real rate movements should respond solely to domestic monetary authority actions. We follow Mishkin's exploitation of rational expectations restrictions to construct a real rate series for Taiwan, which opened financially in 1987 and then see whether US and/or local monetary authorities have much influence on the real rate before and after the financial-openness regime change. Our results are consistent with both Mishkin and open economy macroeconomic theory: during the closed period, the domestic monetary authority does seem to have some influence over real rates and the U.S. has little, while after the change these roles are reversed.

I. Introduction

Empirical investigations of the behavior of the real rate of interest have proven quite problematic ever since Irving Fisher pointed out the distinction between the *ex post* real rate (observable but otherwise unimportant) and the *ex ante* real rate (unobservable but economically important).[1] The advent of the rational expectations methodology, however, allows the imposition of restrictions on observable time series data that, in effect, allows meaningful inquiry into real interest rate behavior.

Much of the recent work concerning the determinants of the real rate

* Senior economist, Federal Reserve Bank of Atlanta, Atlanta, USA.
** Associate Professor of Economics, Agnes Scott College, Decatur, GA 30030, USA.

[1] Irving Fisher (1930).

of interest has been done by Frederic Mishkin.[2] In contrast to many in the profession, Mishkin claims that movements in the real rate of interest in the United States are explained, in large measure, by changes in domestic monetary policy.

Among Mishkin's contributions to the literature on real interest rates are studies of the causes of high real interest rates in the United States during the 1980's, and investigations into the equality of real interest rates among countries. His paper with John Huizinga, "Monetary Policy Regime Shifts and the Unusual Behavior of Real Interest Rates" (1986), indicates that the source of high real interest rates in the U.S. has been monetary policy. In particular, they conclude that the high real interest rates of the 1980's have been the result of the Fed's disinflationary policy.

Mishkin's (1984) investigation into the equality of real interest rates across countries utilized data from the Euro-deposit market for seven developed nations. The results indicated that for these nations, real interest rates were not equal, nor did they move similarly over time. Mishkin explains that real interest rates may differ across countries because risk premiums may differ, and because transactions costs and the lack of perfect substitutability of goods imply violation of the conditions of purchasing power parity.

The question of co-movements of real interet rates in the United States and small, somewhat open, developing economies, is the subject of investigation in this paper, in contrast to the work done for the E.E.C., discussed above. In particular, if the Mishkin result for the U.S., that real interest rates are determined by U.S. monetary policy, is correct, then we should see one of two things happen in a small, somwhat open economy: either the movements in the real rate of interest correlate with U.S. movements in real interest rates, providing that the economy under investigation has a much closer trade and finance relationship to the United States than the E.E.C., in effect making U.S. monetary policy their own domestic monetary policy, or the movements in the real rate of interest respond solely to the actions of the domestic monetary authorities.

We examine the behavior of real rates for the Republic of China or Taiwan. Taiwan has recently moved from a financially closed to a more-or-less financially open economy, and thus provides an interesting case in which to examine the behavior of real interest rates. We offer Mishkin's use of rational expectations restrictions to construct a monthly real interest rate series for Taiwan for this period of financial reform. The data is then

[2] See, for example, Mishkin (1988), (1985), and (1984), and Huizinga and Mishkin (1986), (1985) and (1984).

employed to investigate whether the U.S. and/or the domestic monetary authorities influenced movements in the real interest rate in Taiwan before and after July, 1987, the time of the financial liberalization.

Our results indicate some support for Mishkin and, additionally, are generally in line with conventional theory: in the semi-closed period, the domestic monetary authorities seem to have some influence over real interest rates in Taiwan and the U.S. has little, while after the reform, only the U.S. real rate influences changes in the domestic real rate of interest.

II. Rational Expectations and the Real Rate of Interest

Rational expectations provides a simple restriction that allows the construction of a real interest rate series. The methodological problem in testing hypotheses about the real rate is that the researcher never gets to observe the *ex ante* real rate of interest,

$$(1) \qquad rr_t = i_t - \pi_t^e$$

where rr is the real rate of interest, i is the nominal rate, and π^e is the relevant expected inflation rate, all at time t. The *ex post* rate, however, is readily observed as

$$(2) \qquad eprr_t = i_t - \pi_t^a$$

where eprr is the *ex post* real rate of interest, and π^a is the actual rate of inflation. The difference between these two real rate expressions is the inflation forecast error,

$$(3) \qquad \varepsilon_t = \pi_t^a - \pi_t^e.$$

Combining equations (1) through (3) yields

$$(4) \qquad eprr_t - rr_t = i_t - \pi_t^a - (i_t - \pi_t^e)$$

$$(4') \qquad eprr_t = rr_t - \pi_t^a + \pi_t^e = rr_t - \varepsilon_t.$$

Rational expectations imposes the condition that the forecast error of inflation is, itself, unforecastable given currently available information, ϕ_{t-1},

$$(5) \qquad E(\varepsilon_t | \phi_{t-1}) = 0,$$

which in turn implies that

$$(4'') \qquad rr_t - E(eprr_t|\phi_{t-1}) = 0.$$

As a result, rational expectations provides a motivation for the very convenient construction of a real rate of interest series by the simple substitution of the *ex post* for the *ex ante* real rate of interest. This comes at the price, however, of making all hypothesis tests joint tests of both the hypothesis in question and rational expectations.

III. The Tests

A. The Hypotheses

The small opening economy we choose to investigate is the Republic of China (Taiwan). As one of the leading "Newly-Industrialized Countries," Taiwan has long been an active, though small, participant in world goods markets. While on a consumer level some firms and industries have received, and may still receive, domestic protection from import competition, the simple need to trade manufactured goods for virtually all raw materials, opens the economy, more-or-less, on the real side.

On the financial side, however, Taiwan was essentially closed until 1987. Foreign investment was limited to some direct investment in manufacturing. In July of 1987, reforms were enacted that opened the economy financially, in particular, loosening foreign exchange controls to permit capital flows.[3]

After constructing a real interest rate series for Taiwan, we then ask how that series behaves as the economy opens financially. There are three possibilities:

First, it could be the case that domestic real rates of interest were determined by international forces, even before the economy opened financially. That is, the relative openness on the real side of the economy could have brought the domestic marginal product of capital in line with the world marginal product of capital, so that changes in the "world real rate" would correlate with changes in the domestic real rate.

Second, the financial opening of the economy could fundamentally change the behavior of domestic real interet rates, so that prior to the

[3] Most significantly, capital outflows were permitted. See "Opening the Floodgates," Far Eastern Economic Review, July 23, 1987, pp. 52-54.

reform real rates were disturbed solely by domestic developments, while after the reform domestic real rates would change along with world real rates.

Third, and finally, it could be the case that the financial opening of the economy does not do anything to the real interest rate process. Just as Mishkin finds for the U.S., and also implies for some of the E.E.C. countries, that domestic monetary policy determines domestic real interest rates, so, too, it may be the case that domestic real rates in Taiwan are determined by the actions of the Central Bank of China both before and after the financial reform.

The tests we perform are therefore quite simple. First we construct real interest rate series for Taiwan and the United States. We then regress measures of domestic monetary policy and the U.S. real rate series on the domestic real rate series. To distinguish among the three hypothesis: If the first hypothesis is correct, U.S. real interest rates should be significant both before and after the financial reform. If the second hypothesis is correct, U.S. real rates should only be significant after the reform. If the third hypothesis is correct, U.S. rates should never be significant, and only domestic measures should matter both before and after the reform.

B. The Data

In performing our tests we use four data series: a real interest rate series for Taiwan, a real interest rate series for the United States, high-powered money in the form of bank reserve money, and an index of industrial production. All data is at monthly frequency. The real rate series was constructed using consumer price indices as the measure of inflation.[4] The latter two variables jointly proxy for domestic monetary policy and economic conditions. Individually, the coefficients on these variables may provide little information, since specifying Central Bank behavior is beyond the scope of this paper. We are only interested in whether the net actions of the Central Bank influence the real rate of interest, and whether that ability changes as the economy opens financially. A test of these variables was unable to reject the presence of a unit root at conventional levels of significance and thus data are expressed as month to month changes of year over year growth rates for the price level, money, and industrial production, and as percentages for interest rates.[5] These time

[4] While implicit deflators would be preferable, they are not available monthly. Producer price mesures produce similar results.

[5] The procedure used was the RATS variation of the Stock-Watson unit root test. Both Stock-Wason and Dickey-Fuller tests were unable to reject a unit root at even the 10% level of significance.

series are plotted in figures 1 through 4.

As is the case with many protected economies, government regulation of Taiwan's financial market did not stop solely with the restriction of foreign participation in financial markets. Financial market development itself was hindered by government regulation. As a consequence, formal and active secondary debt and equity markets (and thus data series) were not established until the mid-1980s, and the number of active financial instruments, while growing, is still quite small. The New Taiwan Dollar's exchange rate has not been officially pegged since 1979, though restrictions on the domestic transactions in foreign currency somewhat dirtied the float,[6] though by the time of our sample period the NT dollar is clearly floating.

Since we are using data at a monthly frequency, we need a financial instrument with a one-month maturity; of the series available, the instrument we choose to use is the one-month banker's acceptance. Our alternative was a one-month certificate of deposit series. Prior to the mid-1980s, returns to savings instruments in Taiwan were administered in a manner analogous to the U.S. prime rate, and thus while a one-month time deposit rate series is available for a much longer period of time, we opt instead to use a market-determined rate, in this case the most appropriate one-month series available is that for one-month bankers acceptances, though at the cost of a much shorter time series. On the corresponding U.S. side, we choose to use a one-month commercial paper rate, which seems to best approximate the institutional attributes of the corresponding Taiwan series.

Our data set begins at 1985:10 and runs though 1991:03, for a total of 64 observations. We take the break point in the series to be 1988:01. While the financial reforms were enacted in 1987:07, foreign investment vehicles were not immediately operable; hence, we allow six months for their full effects to become evident, taking the break to be 87:12.[7] We also include a dummy for the recent U.S. recession, which the NBER dated as starting in 1990:07.

C. The Results

The results of our tests are consistent with the second hypothesis

6 See Kuo (1983), especially pp. 218-219.

7 This is a somewhat arbitrary adjustment to the issue of institutional development. Our results are robust as we move the break from December back towards July, though the significance of the U.S. real rate in the post-opening period diminishes.

Figure 1

Taiwan Real Rates, Differenced

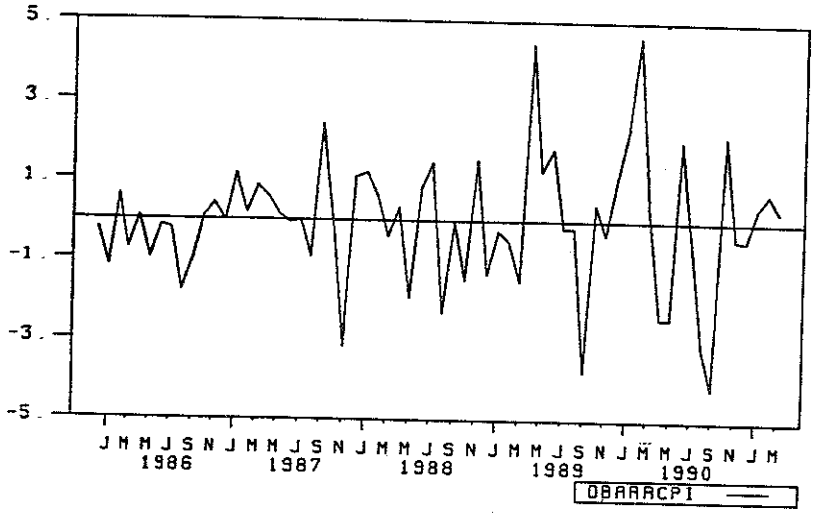


Figure 2

US Real Rates, Differenced

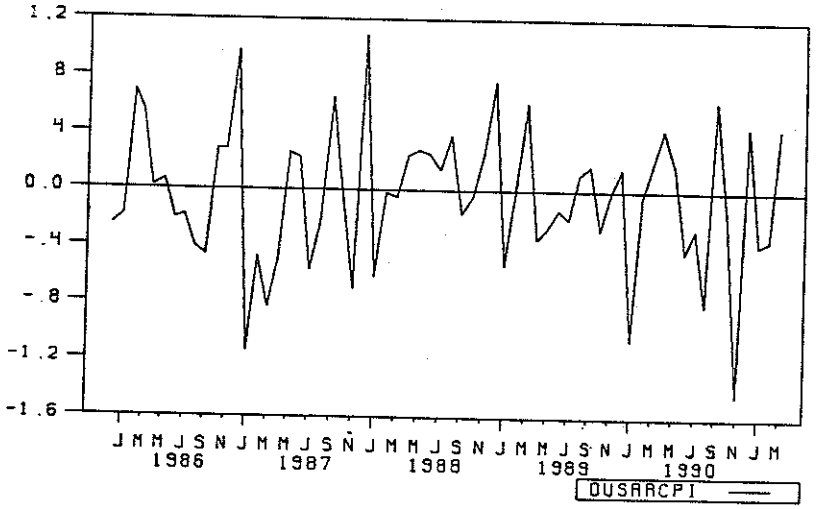


Figure 3

Industrial Production Growth, Differenced

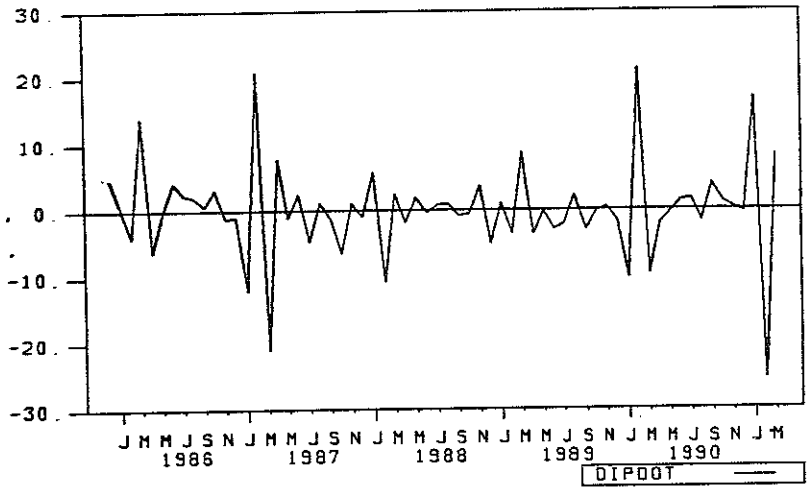
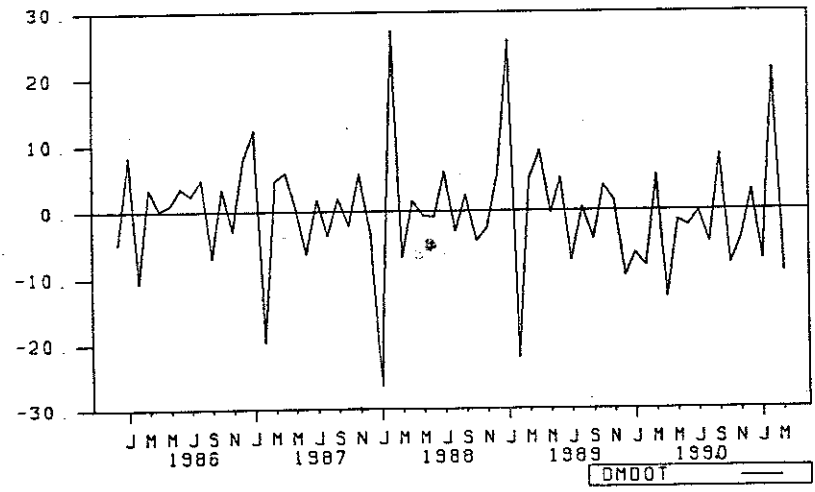


Figure 4

Reserve Money Growth, Differenced



discussed above, that real interest rates do not respond to world real rate changes until after the economy is opened financially. Details of the results are shown in the table below. In all cases the dependent variable is the change in the domestic real rate of interest, and the independent variables are the change in domestic reserve money growth (DMDOT), the change in the rate of industrial production growth (DIPDOT), and the change in U.S. real interest rates (DUSRRCIP), all with a concurrent and lagged observation.[8] Since the market in question did not exist before the beginning of the sample period and changed radically in the middle, heteroskedasticity should be a problem, and therefore the regressions are estimated using the White heteroskedasticity-consistent, least-squares estimation procedure.[9] This procedure forces us to use χ^2 tests for the significance of blocks of explanatory variables. Our sub-period estimates have a limited number of degrees of freedom, but Tauchen (1986) shows that a small sample property of our test statistic is a bias towards acceptance of the null, and thus we retain some confidence in our results.

In the pre-reform period, 85:12 to 87:12, our χ^2 test for significance of blocks of variables indicates that our domestic conditions and policy proxy, the change in money growth and the change in industrial output growth, significantly explain changes in real rates of interest, while our measure of U.S. real rates is not.

Most significantly, however, in the post-reform period, 1988:01 to 91:03, we find that world real rates of interest become a signficant variable in explaining the movement of real interest rates, while domestic conditions and policy lose their influence.[10]

We have also performed a Chow test (using dummy variables) for signicance of the break, which, not surprisingly, we find significant.

The interpretation of the individual coefficients is not as straightforward as the block test results. We take the domestic block jointly to proxy for policy effects, but the individual coefficients may simply be pieces of a larger Central Bank reaction function (which may be responding to some-

8 With a sufficiently long lag, the real rate of interest and industrial production should be simultaneous. Our short lag structure should avoid this problem. Performing the same tests with proxies that avoid simultaneity yield similar, though less significant, results, suggesting that our specification is adequate. Similarly, Granger-Sims causality tests indicated that, at least for our relatively short lag lengths, base money growth can be treated as exogenous to the real rate of interest.

9 See White (1980). This is the "robusterrors" option for linear regression in RATS.

10 If we shorten the post-opening period by a year, the domestic conditions block remains significant, suggesting a gradual decline in the influence of domestic policy, rather than a simple drop at the time of the opening.

thing other than real rate movements), and thus individually not especially interpretable.[11] For the first subperiod, we observe a significant relationship between our domestic conditions proxy and the real interest rate, which suggests that the domestic monetary authority may have some influence, consistent with Mishkin's work. In the second subperiod, when we do observe a significant relationship between U.S. real rate innovations and domestic real rate innovations, the sign is negative contemporaneously. This would seem to rule out the possibility that we are actually capturing the co-movement of *ex post* rather than *ex ante* real rates. A world inflation innovation responsible for an *ex post* real rate movement should result in a positive contemporaneous coefficient, which we clearly do not have. This negative relationship, while disturbing, may simply be evidence of convergence in real rates of interest after the opening, and is not inconsistent in scale with the relative volatilities of the two series depicted in figures 1 and 2.

V. Conclusion

If we accept the tenets of rational expectations as a reasonable and realistic way of viewing the world, we can construct real interest rate series from directly observable data. If we do this for the recent history of Taiwan, we can observe the behavior of the real rate of interest as the economy makes the transition from a small economy that is more-or-less open on the real side but closed on the financial side, to one that is more-or-less open in both real and financial trades and transactions.

The behavior of this real interest rate series seems to indicate that before the economy opens financially, the domestic monetary policy conditions have significant influence over its behavior. Before the economy is opened financially, however, the domestic economy is insulated from innovations in U.S. real interest rates. When the economy opens financially, it loses its insulation from outside innovations in real interest rates, though the domestic monetary authority retains some of its influence.

Perhaps more importantly, however, our results suggest that at least for the case of small open economies, U.S. real interest rates are significantly associated with local real interest rates. If we take Mishkin's finding of innovations in U.S. monetary policy being responsible for U.S. real interest rates, then our results imply that the policy the Fed adopts for the U.S., it also adopts, at least in part, for a portion of the rest of the world.

11 For an excellent example analogous to this problem, see Roberds (1988).

Estimation Results

Dependent Variable: The Change in the Taiwan Real Interest Rate

Estimated Coefficients

Sample Period	85:12-91:03	85:12-87:12	88:01-91:03
Constant	0.043	−0.102	0.296
$DMDOT_t$	0.402	−0.019	0.028
$DMDOT_{t-1}$	0.012	0.017	0.027
$DIPDOT_t$	0.027*	−0.073*	0.088
$DIPDOT_{t-1}$	0.040	−0.016	0.061
$DUSRRCPI_t$	−0.543	0.718	−1.896*
$DUSRRCPI_{t-1}$	−0.025	−0.270	−0.505
RECESSION	−0.756	—	−1.465

Block Significance Levels
χ^2 Statistics

DUSRRCPI	1.64	3.53	7.27*
DMDOT & DIPDOT	1.36	9.96*	2.96

Chow Test: $\chi^2(6) = 15.30$*

Note: * indicates significance at 5%.

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