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In Which Exchange Rate Models Do Forecasters Trust?

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Abstract

Using survey data of market expectations, we ask which popular exchange rate models appear to be consistent with expectation formation of market forecasters. Exchange rate expectations are found to be correlated with inflation differentials and productivity differentials, indicating that the relative PPP and Balassa-Samuelson effect are common inputs into expectation formation of market forecasters.

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[1] We appreciate comments by Menzie Chinn, Gian Maria Milesi-Ferretti, Steve Phillips, and Ken West.

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"It is not a case of choosing those [faces] which, to the best of one's judgment, are really the prettiest, nor even those which average opinion genuinely thinks the prettiest. We have reached the third degree where we devote our intelligences to anticipating what average opinion expects the average opinion to be. And there are some, I believe, who practice the fourth, fifth and higher degrees." (Keynes, General Theory, 1936).

I. INTRODUCTION

What models, if any, do market participants use to forecast exchange rates? It is difficult to anticipate the likely winner among competing models, in light of the well-known difficulty of forecasting exchange rates. If there is anything that resembles a universal consensus in exchange rate economics, it is probably on the difficulty of forecasting exchange rates, especially for short horizons (one year or less). The seminal findings of Meese and Rogoff (1983), that fundamentals-based exchange rate models fail to outperform random-walk models, continue to hang over efforts to develop a forecasting model that applies to a wide set of currencies across a wide span of time and conditions.

These difficulties notwithstanding, exchange rate forecasting continues apace, and provides fertile ground for exploring our question. We compare the extent to which several popular models of exchange rate determination can account for market exchange rate forecasts for more than 50 currencies over the 1989-2006 period as reported in Consensus Forecasts. Our data are monthly or bi-monthly average forecasts for the exchange rates one year later, and encompass both advanced and major emerging-market economies. We believe this to be the first comprehensive investigation of this scope and motivation. Frankel and Froot (1987) examined survey data of five currencies and found that expectation formation is regressive and thus helps to stabilize the foreign exchange market. Our study complements their findings by showing several models that are arguably used in forming expectations, on the basis of an econometric investigation of a much larger number of currencies. In relation to Cheung and Chinn (2009) which surveyed foreign exchange rate traders, we take a ―revealed preference" approach by investigating econometrically what models account for the reported forecasts of exchange rates.

It is also important to clarify what we do not attempt in this paper. Our focus is on what factors appear to enter the formation of forecasts themselves, and not on the performance of those forecasts in predicting subsequent movements in exchange rates. The latter question has been examined in numerous studies and often with less-than-stellar results.[2] In contrast, our somewhat unusual focus on the former question is useful in two aspects.

As regards the capacity to actually predict exchange rates, models used by market participants can be regarded as having obtained the seal of approval by the market itself through an ―evolutionary" criterion different from the statistical criterion of econometricians. When certain models or variables survive the test of time, we might infer that those models or variables have proven their use for the objective of market participants. One possible,

[2] Since Meese and Rogoff (1980), numerous papers confirmed the difficulty of beating random walk as forecasts; see Cheung and others (2005) for a recent re-confirmation of this negative result.

though not exclusive, interpretation is the view that the correct criterion is not the mean squared error (MSE) but the contribution of forecasts to realizing the objective of agents (see West and others, 1993).

This interpretation is backed up by the recent discovery by Engel and West (2005) that the results of Meese and Rogoff (1983) could be the logical outcome of the asset-price nature of exchange rates, even when they are being determined by the very fundamentals that appear to have only a limited value for forecasting exercises. According to Engel and West, when exchange rates are subject to unobservable shocks with large persistence, the actual exchange rates will resemble random walks even when the fundamentals have the expected effect on exchange rates. It is then extremely difficult to discern purely statistically the effect of fundamentals on the realized exchange rates. One way to uncover the importance of fundamentals would be to explore the observed importance in accounting for exchange rate forecasting that withstood the test of time and market demand.

Our investigation also produces a piece of behavioral evidence on a prominent market, that of foreign exchange. We can view the models used widely by forecasters as the observed outcome of a higher-order expectations game among market participants (the opening quote). Market participants have a strong incentive not to be outbid by competitors, while being less averse to running the risk of collective failure. This incentive generates a game of higher-order beliefs, with each forecaster trying to outguess what others are thinking. Widely-used forecasting models can be the observed solution to this higher-order game, even if they could be collectively misguided every so often.

To preview the results, two popular exchange rate models are found to have some power in accounting for market forecasts: relative PPP and the Balassa-Samuelson channel. However, the effect is more qualitative than quantitative—the effects are in the right direction, but do not necessarily go the full distance that is dictated by theories. As for interest rate parity, another popular model of exchange rate determination, we find some consistent evidence at first sight, but also that the supportive evidence appears to be driven primarily by the relative PPP, as nominal interest rate differentials are highly correlated with inflation rate differentials.

The rest of the paper is organized as follows. Section II discusses the data in detail, Section III explores the role of relative PPP, and Section IV explores the role of interest rate parity. Section V estimates an eclectic model to compare the roles of several popular models, and Section VI concludes.

II. Data

The dataset covers all 55 advanced and emerging market economies for which Consensus Economics Inc. (hereafter, ―Consensus") was publishing forecasts at least of exchange rates, GDP growth, and inflation as of end-2006. They are listed in the appendix. The dataset spans the period from January 1990 to December 2006. While coverage greatly varies by series, we have 6,108 observations for our left-hand variable, the forecast on nominal exchange rate.

The variables, whose properties are summarized in Table 1, are defined as follows:

- NER: Percent appreciation against the USD. Where Consensus provides forecasts against EUR, they were converted to USD forecasts with the USD/EUR forecast.

- INT: A short-term interest rate in percent. Consensus provides only one rate per country, typically the 3-month T-bill or money market rate.

- INTM: A short-term interest rate in percent, obtained from IFS.

- INF: annual average inflation rate in percent, with the exception of some emerging market economies for which Consensus provides end-year inflation instead.

- GDP: Real GDP growth in percent.

- CAB: Current account balance in percent of GDP. Consensus provides nominal amounts in local currency or USD, and we have to calculate an implicit forecast of nominal GDP to obtain the ratio to GDP. For the current year, we thus multiply last year's actual nominal GDP (from IMF International Financial Statistics (IFS)) with (1+GDP/100)*(1+INF/100); for the next year, we repeat this procedure starting from the forecasted base.[3] From this forecast of nominal GDP in local currency, we arrive at nominal GDP in USD by multiplying the GDP forecast 12 months ahead (see discussion below on aggregation across the forecast horizons) with (1+NER/100).

- GOV: Budget balance in percent of GDP. This forecast is only available for a small number of countries. In some cases, Consensus provides only nominal amounts; we then divide them by nominal GDP calculated as described above for CAB.

Except for NER and INT, for which forecasts are explicitly for 12 months ahead, Consensus forecasts are available only for the current and the next year, implying a varying forecast horizon. Following Heppke-Falk and Hüfner (2004), in these cases we compute a synthetic forecast for 12 months ahead as $x_i = \left[(12-i)\, x_i^0 + i x_i^1 \right] / 12$, where $i \in [1,12]$ is the publication month of the survey and x_i^0 and x_i^1 are the forecasts for the current and next year, respectively. For example, the vintage of December 2005 consists only of the 2006 annual forecast, whose realization will be certain (ignoring publication lags) 12 months afterwards.

For euro area countries, we use euro area aggregates as far as available, because the euro exchange rate should be influenced by these aggregate developments rather than national ones. For CAB, GDP, and INF, common Euro Area data became available in January 2000; for all other variables in January 2003. Before these dates, the national forecasts for the individual countries are used as available. Given that all exchange rates are expressed relative to the USD, the United States does not form part of the sample. Instead, we most often express the variables above in differentials relative to the respective Consensus forecasts for the U.S.

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[3] This approach introduces an error to the extent that the GDP deflator forecast deviates from the CPI forecast.

We draw on two other data sources to control for the exchange rate regime and the openness of financial accounts. We use Chinn-Ito index of capital account liberalization (Chinn and Ito 2007), which is the first standardized principal component of several variables that reflect the ease of cross-border financial transactions. The Chinn-Ito index is constructed to have a mean of zero, with a higher value corresponding to a more open financial account regime.

We use the Reinhart-Rogoff measure of exchange rate regime (the coarse classification system from 1 to 6).[4] The exchange rate regime becomes progressively more flexible as the code increases from 1 to 4, with code 4 corresponding to a freely floating regime: Code 1 refers to peg, Code 2 narrow crawling peg (band less than +/- 2 percent), Code 3 wide crawling peg (band larger than +/- 2 percent) or managed floating, and code 4 free floating. However, code 5 corresponds to a ―freely falling" regime and code 6 to a regime with dual currency markets with missing data for the parallel market.

III. PURCHASING POWER PARITY

Under purchasing power parity (PPP), a currency with a higher inflation rate is expected to depreciate vis-à-vis a currency with a lower inflation rate. This is often called *relative PPP*, in contrast to a more stringent *absolute PPP* under which the *level* of exchange rate will be determined to equalize *levels* of prices across countries.

To explore whether relative PPP is a common input into the market expectation of exchange rate changes, we regress expected appreciation of each currency on the differential in expected inflation rate between the currency and the U.S. dollar:

$$NER = c_0 + c_1 \left(INF^{\text{home}} - INF^{US} \right)$$

Relative PPP would imply a negative slope coefficient. The theoretical coefficient would be equal to minus one if the whole consumption basket were composed of traded goods; the presence of non-traded goods in the consumption basket would imply a negative coefficient, but less than one in absolute value. Similarly, the constant term would be zero if the consumption basket is composed only of traded goods, while in the presence of nontraded goods whose cross-country relative price can be changing over time the constant term could be different from zero. Hence the relevant restriction would be a negative value for the slope coefficient.

In the top panel of Table 2, the coefficients for inflation differential are negative, in the range of -0.6 and -0.5, and statistically significant. Considering that our expectation measures are over a one-year horizon, this result is quite surprising. The empirical literature based on observed exchange rate changes has not found strong evidence in favor of relative PPP over a comparable horizon. If any, relative PPP has often been found to work better at a much

[4] We used the indices available on the website (http://terpconnect.umd.edu/~creinhar/Courses.html), an update of Reinhart and Rogoff (2004).

longer horizon than a year (Rogoff, 1996).[5] Nevertheless, our results indicate that relative PPP appears to be incorporated into the formation of exchange rate expectation by market participants.

This support for the relative PPP as an input into market expectations is reinforced by the comparison of different exchange rate regimes, reported in the two lower panels of Table 2. One would expect nominal exchange rates to respond more readily to inflation differential under a more flexible exchange rate regime: under a fixed exchange rate regime— or a regime with tighter controls—nominal exchange rates would be expected to move less in magnitude or frequency than under a floating exchange rate regime. Using the exchange rate regime classification of Reinhart and Rogoff (2004), we find that a more flexible exchange rate regime tends to strengthen the relative-PPP effect. Compared to fixed exchange rate regimes, exchange rate regimes with greater flexibility lead market participants to factor in a greater effect of relative PPP in forming their exchange rate expectations. The difference is statistically highly significant and numerically large—the coefficient roughly doubles when the exchange rate regime has some flexibility. However, the effect does not necessarily appear to be monotone: numerically (but not statistically) the PPP effect is strongest under a crawling peg regime with a narrower band, closely followed by the free-floating regime.

IV. INTEREST RATE PARITY

Under uncovered interest rate parity, a currency with a higher interest rate is expected to depreciate by the amount of interest rate differential, thereby equalizing expected returns from investments in two currencies. Unlike most empirical studies of uncovered interest rate parity which regress ex-post exchange rate changes on interest rate differentials, we have the advantage of relating directly the expected exchange rate change and the interest rate differential.

In the following regression, relating a currency's expected appreciation against the U.S. dollar to the differential between the country's interest rate and the U.S. interest rate, uncovered interest rate parity would imply a slope coefficient of minus one and a constant term equal to zero:

$$\text{NER} = \text{Constant} + \text{Coeff}^*(\text{Domestic INT} - \text{US INT}).$$

The estimates in the top panel of Table 3 seem to suggest that interest rate parity is an often-used input into the formation of exchange rate expectations by market participants. Estimated coefficients on interest rate differentials are negative and statistically significant, though much smaller in magnitude than minus one. The results are similar whether or not the constant term is included, and also when GMM estimation is applied to a specification without the constant term (thus using the parity condition as the base specification).

[5] For a recent debate on the PPP hypothesis, see Imbs and others (2005) for reasons of the slow convergence to PPP, and Engel (2005) for counter arguments.

However, the regressions reported in the lower panels of Table 3 cast several doubts on the importance of uncovered interest rate parity in explaining exchange rate forecasts. In the second panel of Table 3, we include EMBI spreads as a control for risk premia. To the extent that the risk premia reflected in EMBI spreads are positively correlated with currency risk premia, an appreciation would be expected and the coefficient on EMBI spreads would be positive.[6] In the event, we obtain negative coefficients, implying that the EMBI spreads are mainly regarded as return differentials to be offset by an expectation of depreciation. This can imply that EMBI spreads are little correlated with currency risk premia, or can cast doubt on the role of interest parity relationship in exchange rate forecasts.

In the third panel of Table 3, we include a term that interacts the interest rate differential with a dummy denoting more open capital account regimes. We expect the interaction term to have a negative coefficient and add to the strength of the interest rate parity relationship, for the interest parity relationship is likely to be stronger for currencies under a more open capital account regime. In the event, the coefficient is positive and statistically significant, raising strong questions on the use of the interest parity relationship in exchange rate forecasts.

The fourth panel provides the most conclusive counter-evidence. Here the inflation differential is included as an additional regressor. The coefficient on the interest rate differential declines to values close to zero, numerically as well as in statistical significance, while the coefficients on inflation differentials are quite similar to those of Table 2 that tested the importance of relative PPP. This result indicates that the prima facie evidence in favor of the interest rate parity has been a spurious outcome which resulted from the Fisher relation and relative PPP. Since the (nominal) interest rate differential is correlated with the inflation differential, relative PPP will generate spurious evidence in favor of uncovered interest rate parity. Beyond our immediate study, these results urge caution against making inferences about the strength of interest parity relationship from regressions that relate nominal exchange rate changes or their expectations to the differentials in nominal interest rates.

V. BEHAVIORAL MODELS

We also estimate an eclectic multivariate model of exchange rate expectations, relating them to inflation differentials, interest rate differentials, GDP growth rate differentials, and current account balances. In a smaller sample comprising only 15 countries, government balances are also included, as differentials between each country and the United States.

The regression results in Table 4 find inflation differentials and GDP growth differentials to be statistically significant in most specifications. The coefficient estimate on the inflation differential is indeed similar to those of Table 2, when the inflation differential was the only regressor, offering strong evidence that the (relative) PPP channel looms large in the conceptual framework used by market participants in forecasting exchange rates. The

[6] Under a high EMBI spread and country risk, the current exchange rate will probably be more depreciated than otherwise, helping to generate an expected appreciation and a higher return compensating for the risk.

coefficient on the growth differential is positive, consistent with theoretical priors. One exception is column III, when country-specific constant terms are included. That specification provides the only case in which the growth differential does not have a statistically significant positive coefficient, while the current account has a statistically positive coefficient.

We already discussed the exchange rate models associated with inflation differentials and interest rate differentials. GDP growth differentials are associated most closely with the Balassa-Samuelson effect, but also with any cyclical exchange rate effects. One example of the latter is that higher GDP growth increases the likelihood of future monetary policy tightening, thereby generating an expectation of future appreciation. Another example would be a rise in capital inflows in booms, which tends to appreciate the nominal exchange rate (e.g. Hau and Rey, 2006). A higher growth rate will then be associated with an exchange rate appreciation, through the Balassa-Samuelson effect, anticipated tightening of monetary policy, orpro-cyclical capital inflows.

All other variables—the interest rate differential, current account balances (except in column III) and government balances—do not have statistically significant coefficient estimates. The ambiguity in the relationship between the government balance and the exchange rate is not too surprising, since the government balance as public saving is just one component of the national saving, which does not have a robust relationship with the current account or exchange rate. If any, the literature has found a relatively weak and unstable relationship between government consumption and the exchange rate (Monacelli and Perrotti, 2010).

The weak relationship between expectations of exchange rate changes and current account may come across as a surprise, in light of popular emphasis on the adjustment in exchange rates and current account.[7] A closer reading of the literature, however, does suggest that the relationship between the current account balance and the exchange rate is indeed quite ambiguous. Since the external budget constraint will impose a natural limit on a country's international borrowing (current account deficit), a large current account deficit is often viewed to portend a reversal accompanied by a depreciating exchange rate. This stylized fact notwithstanding, the correlation between the current account and exchange rate remains ambiguous for two reasons. First, while the current account deficit is continuing before a reversal, a large current account deficit is often associated with a gradual appreciation in the exchange rate which in turn feeds the current account deficit. Second, in general circumstances that do not involve a rapid reversal in current account balances, the relationship between the current account and exchange rate varies with the source of shocks (Chinn and Lee, 2006). These results are consistent with the finding that market forecasters do not appear to place a large emphasis on the short-term relationship between the current account balance and exchange rate.

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[7] See the macroeconomic balance approach of Lee and others (2008) or other current-account based approaches discussed in McDonald (2007).

VI. Conclusions

Amid a plethora of exchange rate models, inflation and growth rates appear to be two robust factors that are considered in the formation of exchange rate expectations by market forecasters. The prominence of inflation points to the broad subscription to a version of purchasing power parity. The prominence of growth rates suggests the broad acceptance of the productivity-driven appreciation, either in terms of the classic Balassa-Samuelson effect or in terms of procyclical capital inflows. Other often-mentioned factors, including the current account balance, do not appear to play a common role in the exchange rate formation.

These findings speak indirectly to the fundamental determinants of exchange rates. To the extent that market forecasters adhere to models or variables which have proven to help forecast exchange rates, inflation and GDP growth rates are time-tested drivers of exchange rate movements. They must have proven to have a robust explanatory power for explaining exchange rates, even though their marginal explanatory power must be highly limited in relation to shocks of all varieties that buffet exchange rates.

APPENDIX

Countries:

Argentina, Australia, Brazil, Bulgaria, Canada, Chile, China, Colombia, Croatia, Czech Republic, Denmark, Dominican Republic, Ecuador, Egypt, Hungary, India, Indonesia, Japan, Korea, Latvia, Lithuania, Malaysia, Mexico, New Zealand, Nigeria, Norway, Pakistan, Panama, Peru, Philippines, Poland, Romania, Russia, Slovak Republic, Slovenia, South Africa, Sweden, Switzerland, Thailand, Turkey, Ukraine, United Kingdom, Uruguay, Venezuela, and 11 of the Euro-area countries (as of end-2006) comprising Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, and Spain.

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Table 1. Descriptive Statistics

	Mean	Median	Maximum	Minimum	Std. Dev.	Obs.
NER	-4.2	-2.6	45.2	-96.5	8.7	6,157
INT	6.6	5.3	74.4	0.1	5.4	4,514
INF	10.0	3.2	4396.7	-1.1	78.2	8,043
GDP	3.3	3.0	10.3	-11.8	2.0	8,043
IND	4.0	3.4	44.8	-11.7	3.3	5,057
WAGE	1.3	1.1	33.0	-24.4	2.7	3,169
MON	11.9	9.0	94.0	4.3	8.9	1,823
CAB	-0.3	-0.5	19.5	-19.1	4.1	6,118
GOV	-1.9	-2.2	7.0	-14.3	2.9	2,648

Table 2: Inflation Differential

	I	II	III
Inflation Rate Differential	-0.56	-0.48	-0.59
	(0.05)	(0.06)	(0.05)
Constants	Pooled	Fixed	No
Rsquared	0.47	0.61	0.46
N of observations	*4650*	*4650*	*4650*
N of currencies	*40*	*40*	*40*
Inflation Rate Differential	-0.30	-0.19	-0.36
	(0.07)	(0.09)	(0.07)
Inflation Rate Differential interacte	-0.33	-0.37	-0.32
with crawling peg or floating reg	(0.08)	(0.09)	(0.09)
Inflation Rate Differential interacte	-0.22	-0.29	-0.19
with freely falling regime	(0.10)	(0.10)	(0.10)
Constants	Pooled	Fixed	No
Rsquared	0.48	0.62	0.47
N of observations	*4493*	*4493*	*4493*
N of currencies	*39*	*39*	*39*
Inflation Rate Differential	-0.31	-0.18	-0.36
	(0.07)	(0.09)	(0.07)
Inflation Rate Differential interacte	-0.43	-0.43	-0.44
with narrow crawling peg	(0.08)	(0.12)	(0.09)
Inflation Rate Differential interacte	-0.24	-0.34	-0.23
with wide crawling peg or	(0.10)	(0.10)	(0.11)
managed floating regime			
Inflation Rate Differential interacte	-0.33	-0.40	-0.32
with free-floating regime	(0.11)	(0.17)	(0.14)
Inflation Rate Differential interacte	-0.22	-0.29	-0.19
with freely falling regime	(0.10)	(0.10)	(0.10)
Constants	Pooled	Fixed	No
Rsquared	0.49	0.62	0.48
N of observations	*4493*	*4493*	*4493*
N of currencies	*39*	*39*	*39*
Standard errors (within parentheses) are robust to serial correlation.			

Table 3: Interest Rate Differential

	I	II	III	IV (GMM)
Interest Rate Differential	-0.28	-0.23	-0.33	-0.32
	(0.06)	(0.07)	(0.06)	(0.06)
Constants	Pooled	Fixed	No	No
Rsquared	0.18	0.51	0.13	0.13
N of observations	*4319*	*4319*	*4319*	*4319*
N of currencies	*40*	*40*	*40*	*40*
Interest Rate Differential	-0.36	-0.32	-0.39	-0.37
	(0.04)	(0.05)	(0.04)	(0.04)
EMBI Spread	-0.21	-0.22	-0.26	-0.26
	(0.10)	(0.06)	(0.13)	(0.13)
Constants	Pooled	Fixed	No	No
Rsquared	0.35	0.64	0.33	0.33
N of observations	*1681*	*1681*	*1681*	*1681*
N of currencies	*24*	*24*	*24*	*24*
Interest Rate Differential	-0.47	-0.40	-0.52	
	(0.05)	(0.03)	(0.06)	
Interest Rate Differential interact	0.31	0.28	0.31	
with more open Capital Accour	(0.10)	(0.08)	(0.09)	
Constants	Pooled	Fixed	No	
Rsquared	0.24	0.53	0.20	
N of observations	*4319*	*4319*	*4319*	
N of currencies	*40*	*40*	*40*	
Interest Rate Differential	0.05	-0.02	0.03	
	(0.05)	(0.05)	(0.05)	
Inflation Rate Differential	-0.59	-0.45	-0.62	
	(0.05)	(0.04)	(0.05)	
Constants	Pooled	Fixed	No	
Rsquared	0.45	0.59	0.44	
N of observations	*4285*	*4285*	*4285*	
N of currencies	*40*	*40*	*40*	
Standard errors (within parentheses) are robust to serial correlation.				

These estimates were obtained from a sample that exclude crisis-level interest rate years (Brazil 1990-94, Russia 1995-96, Uruguay 2000-02, Turkey 2000), and Egypt and Nigeria were excluded owing to the absence of reliable interest rate data.

Table 4: Behavioral Equation

	I	II	III	IV
Interest Rate Differential	0.05	0.03	-0.01	-0.04
	(0.05)	(0.05)	(0.04)	(0.05)
Inflation Rate Differential	-0.59	-0.64	-0.46	-0.49
	(0.05)	(0.06)	(0.03)	(0.04)
GDP Growth Differential	0.30	0.51	0.07	0.68
	(0.17)	(0.15)	(0.28)	(0.21)
Current Account Balance	0.02	-0.07	0.23	0.21
	(0.11)	(0.17)	(0.07)	(0.24)
Government Balance		0.06		-0.27
		(0.14)		(0.26)
Constant	Pooled	Pooled	Fixed	Fixed
Rsquared	0.45	0.68	0.60	0.76
N of observations	*4285*	*1438*	*4285*	*1438*
N of currencies	*40*	*15*	*40*	*15*

Standard errors (within parentheses) are robust to serial correlation.