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Japan and the United Kingdom: The Inflation Irrelevance Proposition

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Abstract

This paper is about the generalized proposition of inflation irrelevance. The weak form version of inflation irrelevance holds that stock prices are independent of inflation rates. The semi-strong form version is that stock prices are independent of both domestic and foreign inflation rates. The strong, or generalized, version is that stock returns are independent of all three rates, domestic and foreign inflation rates, and changes in foreign exchange rates. Overall, the three forms fail to be rejected separately and jointly under conventional marginal significance levels. The conclusion from this paper is that inflation irrelevance, or nominal neutrality, is a common characteristic in the two countries studied, Japan and the United Kingdom. Therefore, the statistical evidence is mounting manifestly, and is pervasive and applies to diverse economies, among which Japan and UK. This regularity amounts to an international stylized empirical fact that cannot be ignored.

Keywords: Stock returns; Inflation irrelevance; Nominal neutrality; Gordon constant dividend growth model; Multiple regression analysis; Japan; United Kingdom.

1. Introduction

The topic of this paper is under the general rubric of the proposition of inflation irrelevance to stock markets. By this is meant the neutrality of stock markets to the inflation rate. A stock is theoretically perceived to be the present value of cash flows discounted at an appropriate discount rate. These cash flows and this discount rate can be interchangeably either nominal or real, as long as one remains consistent in the analysis. Therefore, stock prices can be considered to be at the same time a nominal and a real aggregate, given the fact that the Net Present Value can be calculated either with real or nominal values. Moreover, it explains why the financial press rarely computes and refers to real stock returns, and that only economists do the subtraction of inflation.

The irrelevance proposition is under the umbrella of the general economic paradigm that nominal variables should not affect real variables, and should only affect nominal magnitudes. It is also akin to the macroeconomic notion of the absence of money illusion. In appearance the insignificant relation implied by the proposition may seem trivial and unimportant. In fact, it is worthy of attention because it links, or rather fails to link, two major indicators of the health of an economy, its purchasing power and its wide-ranging profitability, and both enhance business and consumer confidence and brighten the future economic outlook. When I began researching the proposition in 2010 (Azar, 2010), I thought it was just a stylized empirical fact with limited consequence. However, when I discovered that it applies to more than one sample, to more than one country, to more than one stock index, to more than one individual stock, and by all kinds of econometric specifications and procedures, I came to the conclusion that it has essential and broad ramifications. The resurgence of worldwide inflation has made this conclusion up-to-date. Azar (2022a), is a recent book that develops and summarizes my statistical evidence. In the book are surveys of the literature, to which the reader is referred to. Since I published this book I realized that the proposition which started with domestic inflation, can be generalized to foreign inflation and to foreign exchange rates. (Azar, 2022b) is one of my latest published treatises. Maybe the idea has not caught up yet the spirits of the academia. This might explain why a reviewer to my paper (Azar, 2022b) has commented that since the subject of the said paper is on Canada I may have discovered a transient anomaly which is not convincing and is only applicable to Canada. This paper extends the argument and documents the same hypothesis with two totally disconnected countries which are Japan and the United Kingdom. Azar (2022c) is a recent working paper on the subject that contains international evidence. Support to the irrelevance proposition is building up and accelerating.

2. The Model

The domestic economy is either Japan or the United Kingdom. The foreign economy is the US. The model consists of explaining the log returns of the domestic stock market against domestic and foreign fundamentals, including the domestic and foreign non-fundamental inflation rates. The model relies on the well-known Gordon constant dividend growth model of stock prices (Gordon, 1959), with S the stock price, E the EPS (Earnings per Share), k the cost of equity, g the constant growth rate, κ the payout ratio, and the subscript t the time period

$$(1)\ S_t = \frac{(1+g)*\kappa*E_t}{k-g}$$

If E is decomposed into domestic E_d and foreign earnings in domestic currency E_f. If $E_f = E_f^f * \theta^{\varphi}$, where θ is the domestic foreign exchange rate against the US dollar, E_f^f is foreign earnings in foreign currency, and φ is an elasticity parameter, then

$$(2)\ \Delta logE_f = \Delta logE_f^f + \varphi\Delta log\theta$$

If it is held that, with r the real interest rate, π the inflation rate, α and γ as parameters, and the subscripts are for the US

$$(3)\ k = r + \pi + \alpha r_{us} + \gamma\pi_{us} \Rightarrow \Delta k = \Delta r + \Delta\pi + \alpha\Delta r_{us} + \gamma\Delta\pi_{us}$$

Then the first-order Taylor series expansion of $logS$ becomes (Azar, 2022a;2022b), with μ as the intercept

$$(4)\ \Delta logS \cong \mu + \rho\pi + \lambda\pi_{us} + \Delta logE_d + \Delta logE_f^f - \frac{1}{(k-g)}\Delta r - \frac{1}{(k-g)}\Delta\pi - \frac{\alpha}{(k-g)}\Delta r_{us} - \frac{\gamma}{(k-g)}\Delta\pi_{us} + \varphi\Delta log\theta + \beta\Delta logZ$$

The stock log returns ΔlogS are explained by 8 fundamental variables, which are the rate of change of domestic earnings E_d, the rate of change of foreign (US) earnings E_f^f, the change in real domestic interest rates Δr, the change in domestic inflation Δπ, the change in real foreign (US) interest rates Δr_us,the change in foreign (US) inflation Δπ_us, the rate of change of the foreign exchange rate θ, and the log return on the foreign (US) stock market $\Delta logZ$. There are four coefficients corresponding to duration effects, two of them local and two international, specifically on Δr, $\Delta\pi$, Δr_{us}, and $\Delta\pi_{us}$. Notice that the coefficients on $\Delta logE_d$ and $\Delta logE_f^f$ are unitary. Since the proxy variable for both is industrial production, then their coefficients represent domestic and foreign profit margins on sales. The null hypothesis on the non-fundamental inflation variables, is that $\rho = \lambda = 0$. This corresponds to the inflation irrelevance proposition generalized to incorporate the US inflation rate in addition to the domestic (UK or Japanese) inflation rate. An even stronger proposition is the one that considers the joint effect of the UK (or Japanese) and US inflation rates, together with the rate of change of the UK (or Japanese) foreign exchange rate against the US dollar. This stronger proposition will determine the extent of neutrality of these three nominal variables on stock prices. The underlying assumption is that stock prices are at the same time a nominal and a real variable. It is a nominal variable because stock prices are the present value of nominal future cash flows discounted by an appropriate nominal rate. And it is a real variable because they are the present value of real future cash flows discounted by an appropriate real rate. Indeed, this is a position held in leading corporate finance textbooks, like Brealey *et al.* (2017), for example. Consequently, the stronger inflation proposition states that all nominal variables do not impact real variables and are therefore neutral to real variables including stock prices. This neutrality implies an absence of money illusion, and it implies also that investors learn from their own past mistakes.

3. The Empirical Results

All data are retrieved from the web site of the US Federal Reserve Bank of Saint Louis. There are two sample period. Japan's common sample is from February 1971 till March 2022, with 614 monthly observations. The UK common sample is from January 1971 till May 2022, with 617 monthly observations.

Table 1 summarizes the empirical validation of the regression equation (4) for both Japan and UK. The dependent variable is the log return of the domestic stock market index, and the independent variables are ten: domestic inflation, foreign (US) inflation, the percent change in the domestic and foreign (US) industrial productions, the duration, or first-difference, effects of real ex post domestic interest rates and of inflation, the duration, or first-difference, effects of real ex post foreign (US) interest rates and inflation, the percent change in the local foreign exchange rate, and the log return of the US stock market index. The Japan regression includes an AR(1) specification, while the UK regression does not. It is unclear why the Japan regression displays the feature of historical predictability of stock returns, embodied in the AR(1) specification. Both regressions have ARCH effects. The Japan regression is a GARCH(1,1) representation of the conditional variance, while the UK regression is an integrated GARCH, or IGARCH(1,1) representation.

The standardized residuals of the Japan regression exhibit no higher-order serial correlation, and no higher-order ARCH effects. The Ljung-Box Q-statistics on the standardized residuals have high p-values: 0.544 (for lag 6) and 0.442 (for lag 12), which fail to reject the null of no serial correlation. The Ljung-Box Q^2-statistics on the squares of the standardized residuals have also high p-values: 0.751 (for lag 6), and 0.942 (for lag 12), which fail to reject the null of no further ARCH effects. Because the standardized residuals are found to be independently and identically distributed, i.i.d., estimation was carried out without robust standard errors.

The standardized residuals of the UK regression exhibit higher-order serial correlation, but no higher-order ARCH effects. The Ljung-Box Q-statistics on the standardized residuals have low p-values: 0.005 (for lag 6) and 0.026 (for lag 12), which reject the null of no serial correlation. The Ljung-Box Q^2-statistics on the squares of the standardized residuals have high p-values: 0.911 (for lag 6), and 0.223 (for lag 12), which fail to reject the null of no further ARCH effects. Because the standardized residuals are not found to be i.i.d. estimation was carried out with Bollerslev and Wooldridge (1992) robust standard errors.

The fundamental neutrality of domestic inflation rates is a characteristic of both regressions. For Japan, the coefficient on the Japanese inflation is no different statistically from zero and carries a p-value of 0.3256. The coefficient on the US inflation is also no different statistically from zero and carries a p-value of 0.3311. The joint hypothesis that both coefficients are nil fails to be rejected with a p-value of 0.5601. However, the coefficient on the foreign exchange rate is positive and statistically different from zero and carries a p-value less than 0.0001, which may imply that neutrality of the foreign exchange rate is rejected. Not true. The hypothesis that the sum of the three coefficients is nil fails to be rejected with a p-value of 0.9953. As a conclusion the strong form of inflation irrelevance proposition (Azar, 2022c) is supported by the Japanese statistical evidence.

For the UK, the coefficient on the UK inflation is no different statistically from zero and carries a p-value of 0.1322. The coefficient on the US inflation is also no different statistically from zero and carries a p-value of 0.8252. The joint hypothesis that both coefficients are nil fails to be rejected with a p-value of 0.5044. However, the coefficient on the percent change in the foreign exchange rate, expressed in reverse in terms of UK pounds per one US dollar, is positive and statistically different from zero and carries a p-value less than 0.0001, which may imply that neutrality of the foreign exchange rate is rejected. Not true. The hypothesis that the sum of the three coefficients is nil fails to be rejected with a p-value of 0.0722. As a conclusion the strong form of inflation irrelevance proposition (Azar, 2022c) is supported by the UK statistical evidence.

The two regressions are useful to delineate other empirical facts. In the Japanese regression the coefficients on the domestic and foreign (US) percentage changes in industrial production are respectively 0.1213, with a p-value of 0.0169, and -0.2264, with a p-value of 0.1305. While the first is statistically significantly different from zero, and carries a plausible profit margin on sales of 12.13%, the second is not, and is additionally negative against expectations. In the UK regression the coefficients on the domestic and foreign (US) percentage changes in industrial production are respectively 0.0595, with a p-value of 0.1452, and -0.1154, with a p-value of 0.0730. While the first is statistically insignificantly different from zero, but carries a plausible profit margin on sales of 5.95%, the second has borderline significance, but is anomalously negative against expectations.

The next analysis is about domestic duration effects. In the Japanese regression, the durations on the change in real domestic interest rates and on the change in domestic inflation are negative, as expected, but statistically no different from zero with respective p-values of 0.4431 and 0.4441. In the UK regression, the domestic durations are 54.953 and 54.993 years, are negative as expected, and carry very low p-values that are less than 0.0001. Damodaran (2019) argues that the duration is the inverse of the dividend yield, and that the dividend yield is equal approximately to the equity risk premium. This is true because the term $k - g$ in equation (1) is equal to $k - rf$, and the risk-free rate rf can be considered a close proxy for g. The implied equity premium is hence around the same at 0.0182 or 1.82%. This is noticeably a low figure for a stock premium relative to what is found in the literature. However, it can be interpreted as a *conditional* equity premium that is conditional upon the theorized behavior of stock prices in equation (1). The equity premium that is reported in the literature on the equity premium puzzle is an *unconditional* premium (Mehra and Prescott, 1985;2003;2008). Any way such a low conditional figure is evidence that there are no grounds for an equity premium puzzle.

Presently, foreign (US) duration effects are evaluated. They occur either from changes in US real interest rates or from changes in US inflation rates. In the Japanese regression the durations are estimated to be 24.702 and 26.056 years depending on the variable. These figures imply US dividend yields of 4.048% and 3.84%. They also imply equity premiums of the same magnitudes. These estimates are extremely reasonable for unconditional values, but are rather large for conditional values. Nevertheless, their significance is high with actual p-values less than 0.0001. As for the UK regression the dividend yields and equity premiums are found to be around 2.45%, with high statistical significance falling short of 0.0001. While rather low as estimates of unconditional risk premiums one should remember that they are conditional equity risk premiums.

The spillover effect from foreign (US) equity markets is estimated as an elasticity to be 0.644 for the Japanese regression and 0.873 for the UK regression. Integration between the US stock market and the UK stock market is hence higher than that between the US and Japan. And this is realistic.

4. Robustness

In this section two robustness tests are implemented. The first is on parameter stability and the other on the econometric soundness of a symmetric conditional variance specification, or the absence of a leverage effect. This effect comes about if a negative stock return shock, by reducing the market value of the equity, results in more financial leverage, and hence a higher default risk, as measured by the conditional variance. This test is based on Engle and Ng (1993). Tables 2 and 3 report on the two tests.

Table 2 shows that, for the Japanese regression, stability of the parameters fails to be rejected with the exception of the coefficients on the log return of the US stock market and on the percent change in the Japanese Yen. The joint test supports surprisingly parameter instability. This may be due to the statistical fact that the two intercepts, in the mean and conditional variance regressions, are found to be inherently unstable. As for the UK regression, stability of all parameters, separately and jointly, fails to be rejected, without any exception, including the constants.

Table 3 shows that, for both the Japanese and UK regressions, the null of a standard symmetric GARCH specification against an asymmetric one fails to be rejected, given that all p-values are higher and much higher than 10%. The minimum actual p-value is 0.2034. Therefore, there is no leverage effect. Four leverage tests are undertaken: sign-bias, negative-bias, positive-bias, and joint-bias. The sign-bias test is a test for the significance of a lagged dummy variable (D_t) for negative standardized residuals (z), i.e. $D_{t-1} = 1$ if $z_{t-1} < 0$, on the squares of the standardized residuals (z_t^2). The negative-bias test is a size bias, and tests for the significance of the interaction of the lagged standardized residual with the same lagged indicator variable, i.e. $D_{t-1} * z_{t-1}$, on the squares of the standardized residuals. The positive-bias test is also a size bias, and tests for the significance of the interaction of the lagged standardized residual with one minus the same lagged indicator variable, i.e. (1-D_{t-1}) $* z_{t-1}$, on the squares of the standardized residuals (z_t^2). And the joint-bias test is about the overall significance of the following regression, by applying the Lagrange multiplier test, which follows a Chi-square distribution with three degrees of freedom equal to the number of constraints in $\phi_1 = \phi_2 = \phi_3 = 0$

$$z_t^2 = \phi_0 + \phi_1 D_{t-1} + \phi_2 D_{t-1} z_{t-1} + \phi_3 (1 - D_{t-1}) z_{t-1} + \varepsilon_t$$

In this regression t-tests on the three coefficients $\phi_1, \phi_{2,} \phi_3$ are used to test for sign-bias, negative-bias, and positive-bias respectively. And the Chi-square Lagrange multiplier (LM) test statistic for the significance of the overall regression is equal to TR^2, where T is the sample size, and R^2 the regression R-Square. If the test statistic is large enough then the null of no leverage is rejected. Otherwise, the leverage effect is absent, and this is what actually transpires from the LM test.

In general, the evidence on robustness is favorable despite some limited exceptions.

5. Conclusion

This paper is about an empirical fact that cannot be ignored any more, that of inflation irrelevance, or nominal neutrality. Stock prices are modeled by a theoretical or fundamental equation that includes earnings, domestic and foreign, duration effects, domestic and foreign, and a US stock market spillover. Three nominal variables are added and tested for statistical incremental significance. These variables are inflation rates, domestic and foreign, and changes in foreign exchange rates. The empirical evidence supports the generalized proposition of inflation irrelevance, or what is called the strong form of inflation irrelevance. While the evidence is gathered for two diverse economies, Japan, and the United Kingdom, it augments the general evidence found in the recent study on Canada by Azar (2022b) and supplements significantly the mounting international evidence on the proposition (Azar, 2022c).

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Table-1. Regression Results on the following model

$$\Delta logS \cong \mu + \rho\pi + \lambda\pi_{us} + \Delta logE_d + \Delta logE_f^f - \frac{1}{(k-g)}\Delta r - \frac{1}{(k-g)}\Delta\pi - \frac{\alpha}{(k-g)}\Delta r_{us} - \frac{\gamma}{(k-g)}\Delta\pi_{us} + \varphi\Delta log\theta + \beta\Delta logZ$$

Dependent Variable: Japanese S Method: ML ARCH - Normal distribution Sample (adjusted): 1971M02 2022M03 Included observations: 614 Convergence achieved after 45 iterations	Dependent Variable: UK S Method: ML ARCH - Normal distribution Sample (adjusted): 1971M01 2022M05 Included observations: 617 Convergence achieved after 46 iterations Coefficient covariance computed using Bollerslev-Wooldridge QML sandwich with expected Hessian

Variable	Coefficient	z-Statistic	Prob.	Coefficient	z-Statistic	Prob.
μ	0.001953	0.805752	0.4204	-0.001904	-1.613522	0.1066
π	0.317116	0.983013	0.3256	0.309828	1.114139	0.2652
π_{us}	-0.559321	-0.971811	0.3311	-0.057598	-0.155258	0.8766
$\Delta logE_d$	0.121340	2.388876	0.0169	0.059536	1.259687	0.2078
$\Delta logE_f^f$	-0.226411	-1.511944	0.1305	-0.115448	-1.151814	0.2494
Δr	-8.891721	-1.809002	0.0705	-54.95261	-11.39467	0.0000
$\Delta\pi$	-8.865473	-1.805395	0.0710	-54.99309	-11.34604	0.0000
Δr_{us}	24.70203	4.942580	0.0000	40.57063	7.713497	0.0000
$\Delta\pi_{us}$	26.05570	5.135742	0.0000	41.06212	7.713897	0.0000
$\Delta log\theta$	0.245991	4.412696	0.0000	-0.389457	-9.978356	0.0000
$\Delta logZ$	0.643763	18.33072	0.0000	0.873485	35.67835	0.0000
$AR(1)$	0.275196	6.701228	0.0000			
Variance Equation						
C	8.17E-05	2.064447	0.0390			
RESID(-1)^2	0.129175	2.992701	0.0028	0.111848	5.933137	0.0000
GARCH(-1)	0.805500	12.35846	0.0000	0.888152	47.11325	0.0000
R-squared	0.385886	0.656741				
Adjusted R-squared	0.374664	0.651076				
S.E. of regression	0.035127	0.026587				
Sum squared residuals	0.742805	0.428348				
Log likelihood	1215.758	1492.522				
Durbin-Watson stat	1.997212	1.811549				
Mean dependent variable	0.004031	0.005303				
S.D. dependent variable	0.044420	0.045009				
Akaike information criterion	-3.911264	-4.799100				
Schwarz criterion	-3.803284	-4.713041				
Hannan-Quinn criterion	-3.869273	-4.765641				

Table-2. Parameter stability test

Variable	Japanese Statistic	UK Statistic	1% Critical	5% Critical	10% Critical
μ	0.4728	0.1447	0.748	0.47	0.353
π	0.0698	0.1169	0.748	0.47	0.353
π_{us}	0.1721	0.0861	0.748	0.47	0.353
$\Delta logE_d$	0.1886	0.04979	0.748	0.47	0.353
$\Delta logE_f^f$	0.0254	0.0623	0.748	0.47	0.353
Δr	0.1878	0.0602	0.748	0.47	0.353
$\Delta\pi$	0.1905	0.0733	0.748	0.47	0.353
Δr_{us}	0.0643	0.0461	0.748	0.47	0.353
$\Delta\pi_{us}$	0.0443	0.0454	0.748	0.47	0.353
$\Delta log\theta$	5.1791	0.0854	0.748	0.47	0.353
$\Delta logZ$	3.2047	0.1708	0.748	0.47	0.353
$AR(1)$	0.1314		0.748	0.47	0.353
Constant	0.4755		0.748	0.47	0.353
RESID(-1)^2	0.2724	0.0356	0.748	0.47	0.353
GARCH(-1)	0.3380		0.748	0.47	0.353

Note: See Table 1 for variable definitions.

Table-3. Engle-Ng Sign-Bias Test. Null Hypothesis: No leverage effects in standardized residuals

	t-Statistic (Japan)	Prob. (Japan)	t-Statistic (UK)	Prob. (UK)
Sign-Bias	-0.2700	0.7873	-1.2732	0.2034
Negative-Bias	-0.4271	0.6695	0.0926	0.9263
Positive-Bias	-0.1986	0.8426	-0.2944	0.7686
Joint-Bias	0.2327	0.9721	2.8754	0.4119