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THE THREE FORMS OF INFLATION IRRELEVANCE: INTERNATIONAL EVIDENCE

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ABSTRACT

The weak form of the inflation irrelevance proposition posits that domestic inflation does not impact in a statistically significant way stock returns. The semi-strong form is a hypothesis that, not only domestic inflation, but foreign inflation and foreign exchange rate changes also do not affect stock returns. The strong version is that inflation, foreign inflation and exchange rate changes do not explain stock returns neither in the short run nor in the long run. In other terms these three nominal variables do not affect a real variable like stock prices. Stock prices are designated as a real variable because of the net worth or Net Present Value (NPV) equation: nominal cash flows are discounted by a nominal rate and real cash flows are discounted by a real rate, and each is one side of the same coin, and should be equal. The present paper tests the three forms of the inflation irrelevance proposition on the market stock indexes of a sample of 22 countries, both developed and developing. While the weak form and the semi-strong form are solidly validated and supported empirically, the statistical evidence on the strong version is rather mixed and indeterminate. Overall, the proposition of inflation irrelevance fares well, and deserves to be accepted as a new norm or as an established stylized fact to reckon with.

Key words: stock returns, inflation irrelevance, three forms of general neutrality, Gordon constant dividend growth model, multiple regression analysis, international evidence.

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1. INTRODUCTION

The relation between stock returns and inflation has received a renewed interest and attention recently. See, for example, the comprehensive new book of Azar (2022a), and the references therein. Azar has pioneered the research on the topic since 2010 (Azar, 2010). Before that, the empirical literature has mainly studied the bilateral relation, without resorting to a theoretical background[1]. Azar starts his analysis from the Gordon constant dividend growth model, and solves for the determinants of the stock price. Over the years the determinants have changed, from initially bivariate regressions to multivariate ones. To these determinants the inflation variable is usually appended. The null hypothesis is that the additional variable, which is not part of the fundamentals, does not influence stock returns. Changing the sample period, the stock index, the econometric procedure, the country, the data management procedure, and the number of fundamental determinants do not result in the rejection of the null hypothesis. Moreover, applying the relation on individual stocks, like the Dow stocks, instead of market indexes, produces no statistical significance (Azar, 2020). The evidence is strongly in favor of inflation irrelevance. Azar (2022b) studies Canada's experience and generalizes the irrelevance procedure to include the foreign (US) inflation rate, and finds support to a stronger version of the proposition, which is that both domestic and foreign inflation rates do not impact stock returns. The present paper tests for an even stronger lack of association: domestic inflation, foreign inflation, and, additionally, foreign exchange rate changes do not explain stock returns. Moreover, the paper tests whether the same three variables fail to explain stock returns not only in the short run but also in the long run. A model that incorporates short run and long run effects is developed, based on unconstrained error-correction regression methods which are implied by cointegration. In general, the irrelevance proposition stands solidly, although the support wanes a bit as one expands the null hypothesis.

Theoretically the analysis is in line with monetarist and neoclassical principles. Nominal variables, like inflation and foreign exchange rate changes, should not affect real variables, like stock prices. Stock prices are the present value of future cash flows, and it does not matter whether these cash flows are nominal or real, as long as they are discounted appropriately by either a nominal or a real interest rate. It follows that stock prices are essentially real and nominal variables at the same time.

The paper has the following organization. Section 2 presents the theoretical model. Section 3 provides for the empirical results. These are ventilated depending on the respective explanatory variable. Section 4 gives additional results and a general discussion of findings. The last section, section 5, summarizes.

2. THE THEORETICAL MODEL

The starting point is the well-known Gordon constant dividend growth model of stock prices, 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

$$St = \frac{(1+g)\times\kappa\times E_t}{k-g} \tag{1}$$

By taking a first-order Taylor series expansion of the natural log of S with Δ the first-difference operator one has

$$\Delta\log S_t \cong \frac{\partial\log S}{\partial t}\Delta t + \frac{\partial\log S}{\partial k}\Delta k + \frac{\partial\log S}{\partial E}\Delta E \tag{2}$$

Which converts to, with Δ as an intercept

$$\Delta\log S_t \cong \mu - \frac{1}{(k-g)}\Delta k + \frac{\Delta E}{E} \tag{3}$$

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

$$\Delta\log E_f = \Delta\log E_f^f + \varphi\Delta\log\theta$$

And the relation becomes

$$\Delta\log S_t \cong \mu - \frac{1}{(k-g)}\Delta k + \Delta\log E_d + \Delta\log E_f^f + \varphi\Delta\log\theta \tag{4}$$

Notice that the coefficients on $\Delta\log E_d$ and $\Delta\log E_f^f$ are unitary.

The final model generalizes the duration equation to foreign effects, with α and γ as parameters, and the subscripts are for the US

$$k = r + \pi + ar_{us} + \gamma\pi_{us} \Rightarrow \Delta k = \Delta r + \Delta p + \alpha\Delta r_{us} + \gamma\Delta\pi_{us} \tag{5}$$

The model that includes the domestic and foreign inflation rates then takes the following form with ρ and λ as parameters

$$\Delta\log S \cong \mu + \rho\pi + \lambda\pi_{us} - \frac{1}{(k-g)}\Delta r - \frac{1}{(k-g)}\Delta\pi + \Delta\log E_d + \Delta\log E_f^f + \varphi\Delta\log\theta$$
$$+\frac{\alpha}{(k-g)}\Delta r_{us} + \frac{\gamma}{(k-g)}\Delta\pi_{us} \tag{6}$$

To equation (6), which is the regression in first-differences, is added the first lag of the cointegration residual CR_{t-1}. This variable is equal to the following

$$CR_{t-1} = \log S_{t-1} - \beta_1\log CPI_{t-1} - \beta_2\log CPI_{t-1}^{us} - \beta_3\log E_{d,t-1} - \beta_4\log E_{f,t-1}^f - \beta_5\log\theta_{t-1} \tag{7}$$

Where *CPI* is the Consumer Price Index. Equation (6) becomes the constrained Error-Correction Regression

$$\Delta \log S \cong \mu + \rho\pi + \lambda\pi_{us} - \frac{1}{(k-g)}\Delta r - \frac{1}{(k-g)}\Delta\pi + \Delta \log E_d + \Delta \log E_f^f + \varphi\Delta\log\theta$$

$$+\frac{\alpha}{(k-g)}\Delta r_{us} + \frac{\gamma}{(k-g)}\Delta\pi_{us} + \omega CR_{t-1} \quad (8)$$

The unconstrained Error-Correction Regression is

$$\Delta \log S \cong \mu + \rho\pi + \lambda\pi_{us} - \frac{1}{(k-g)}\Delta r - \frac{1}{(k-g)}\Delta\pi + \Delta \log E_d + \Delta \log E_f^f + \varphi\Delta\log\theta$$

$$+\frac{\alpha}{(k-g)}\Delta r_{us} + \frac{\gamma}{(k-g)}\Delta\pi_{us} + \omega[\log S_{t-1} - \beta_1 \log CPI_{t-1} - \beta_2 \log CPI_{t-1}^{us}$$

$$- \beta_3 \log E_{d,t-1} - \beta_4 \log E_{f,t-1}^{f} - \beta_5 \log \theta_{t-1}] \quad (9)$$

3. THE EMPIRICAL RESULTS

All data are retrieved from the website of the US Federal Reserve Bank of Saint Louis (FRED). The data ranges are: Belgium, France, Germany, Mexico, Sweden, and United Kingdom (1986M01 2021M05), Brazil (1996M11 2021M05), Canada, Italy, Netherlands, and Spain (1986M01 2021M04), Chile (1996M02 2021M05), Colombia (1991M02 2021M05), Greece (1997M07 2021M04), India (1994M05 2018M12), Indonesia (1998M02 2021M05), Japan (1989M02 2021M04), Korea (1986M01 2021M02), Portugal (1988M02 2021M05), South Africa (1990M02 2021M04), Switzerland (1986M01 2021M02), and USA (1986M01 2021M06). The countries include 14 developed and 8 developing.

3.1 The intercepts

The model, equation (9), is estimated for all 22 countries, and the statistical results are given in Table 1 for these 22 countries. The intercepts in Table 1, column 2, measure the conditional mean return for each stock market index for the whole sample of 22 countries. The values, which are expressed in decimals, range between a minimum of –2.019 (Mexico) and a maximum of +2.346 (Brazil). Three of them have *p*-values less than 5%, *i.e.* are statistically significant, and they are for Italy, the Netherlands, and Switzerland. Granted the presence of sampling error, it is safe to infer that the 22 population intercepts, or conditional means, are all zero. This indicates that the average stock returns do not have a constant portion and are entirely variable.

Table 1: Regression results. The model is as follows:

$$\Delta \log S \cong \mu + \rho\pi + \lambda\pi_{us} - \frac{1}{(k-g)}\Delta r - \frac{1}{(k-g)}\Delta\pi + \Delta \log E_d + \Delta \log E_f^f + \varphi\Delta \log \theta$$

$$+ \frac{\alpha}{(k-g)}\Delta r_{us} + \frac{\gamma}{(k-g)}\Delta\pi_{us} + \omega[\log S_{t-1} - \beta_1 \log CPI_{t-1} - \beta_2 \log CPI_{t-1}^{us} - \beta_3 \log E_{d,t-1} - \beta_4 \log E_{f,t-1}^f - \beta_5 \log \theta_{t-1}]$$

Country AR(1)	C	π_d	π_{us}	ΔX_{us}	Δy_{us}	Δy_d	$\Delta(i_{us}-\pi_{us})$	$\Delta\pi_{us}$	$\Delta(i_d-\pi_d)$	$\Delta\pi_d$	$S_d(-)$	$P_d(-)$	$P_{us}(-)$	$X_{us}(-)$	$y_{us}(-)$	$y_d(-)$	
Belgium	–0.513	0.463	–0.291	0.153	0.065	0.068	–67.150	–66.539	–2.337	–1.436	–0.047	0.215	–0.195	0.001	0.140	–0.004	0.250
	–1.746	0.309	–0.243	1.718	0.418	0.796	–5.919	–5.725	–0.150	–0.092	–2.306	0.801	–0.886	0.032	1.889	–0.057	4.966
	0.082	0.757	0.809	0.087	0.676	0.427	0.000	0.000	0.881	0.927	0.022	0.424	0.376	0.974	0.060	0.954	0.000
Brazil	2.346	2.576	–4.687	–0.591	0.182	0.070	14.372	15.508	6.462	5.494	–0.046	0.082	0.032	–0.314	0.087	–0.353	0.288
	1.438	1.724	–1.378	–2.603	0.453	0.342	0.444	0.477	1.627	1.383	–1.308	0.535	0.063	–3.364	0.503	–2.626	3.760
	0.152	0.086	0.169	0.010	0.651	0.732	0.658	0.634	0.105	0.168	0.192	0.593	0.950	0.001	0.615	0.009	0.000
Canada	–0.108	0.936	1.038	0.012	–0.150	0.174	–82.140	–80.660	29.996	29.906	–0.067	–0.328	0.375	–0.022	0.006	0.057	0.171
	–0.453	0.868	0.860	0.143	–0.649	0.822	–8.523	–8.059	3.247	3.254	–3.061	–1.319	1.571	–0.785	0.084	0.630	3.415
	0.651	0.386	0.390	0.886	0.517	0.412	0.000	0.000	0.001	0.001	0.002	0.188	0.117	0.433	0.933	0.529	0.001
Chile	–0.185	–1.003	1.290	0.058	–0.084	–0.031	–35.855	–34.923	–3.442	–3.205	–0.055	0.028	0.088	–0.057	–0.054	0.091	0.200
	–0.261	–0.879	1.140	0.478	–0.509	–0.222	–2.788	–2.648	–3.418	–2.210	–2.419	0.131	0.223	–1.257	–0.595	0.741	2.842
	0.794	0.380	0.255	0.633	0.611	0.825	0.006	0.009	0.001	0.028	0.016	0.896	0.824	0.210	0.552	0.460	0.005
Colombia	0.271	–0.865	0.087	–0.261	–0.016	–0.001	–66.918	–65.318	–21.775	–19.562	–0.050	0.010	0.222	–0.196	–0.031	–0.018	0.376
	0.295	–1.279	0.046	–1.795	–0.049	–0.005	–3.912	–3.787	–4.926	–4.379	–2.734	0.177	1.595	–2.455	–0.226	–0.200	8.449
	0.768	0.202	0.963	0.074	0.961	0.996	0.000	0.000	0.000	0.000	0.007	0.860	0.112	0.015	0.821	0.841	0.000
France	0.427	1.779	0.689	0.116	–0.234	0.375	–40.359	–39.626	–42.317	–43.648	–0.081	–0.577	0.368	0.059	0.255	–0.116	0.223
	0.421	1.008	0.463	1.415	–0.860	3.643	–2.907	–2.828	–3.007	–3.075	–3.283	–0.992	0.941	1.642	2.696	–1.430	4.083
	0.674	0.314	0.644	0.158	0.390	0.000	0.004	0.005	0.003	0.002	0.001	0.322	0.347	0.101	0.007	0.153	0.000
Germany	–0.360	1.040	–1.321	0.199	–0.274	0.358	–78.571	–76.878	87.859	88.089	–0.040	0.130	–0.019	0.018	0.039	–0.050	0.202
	–0.808	0.817	–0.959	2.157	–0.897	2.418	–6.122	–5.897	5.519	5.528	–2.230	0.530	–0.098	0.548	0.797	–0.718	3.582
	0.420	0.415	0.338	0.032	0.370	0.016	0.000	0.000	0.000	0.000	0.026	0.596	0.922	0.584	0.426	0.473	0.000
Greece	1.084	–0.211	1.434	–0.250	0.274	–0.062	–46.674	–43.482	–24.866	–25.221	–0.069	–0.343	0.097	–0.215	0.106	0.182	0.213
	1.247	–0.353	0.667	–1.113	0.923	–0.426	–2.089	–1.901	–8.834	–8.762	–2.978	–1.823	0.514	–2.605	0.645	1.607	3.072
	0.214	0.724	0.505	0.267	0.357	0.671	0.038	0.058	0.000	0.000	0.003	0.069	0.608	0.010	0.520	0.109	0.002

Country *AR(1)*	C	π_d	π_{us}	ΔX_{us}	Δy_{us}	Δy_d	$\Delta(i_{us} - \pi_{us})$	$\Delta\pi_{us}$	$\Delta(i_d - \pi_d)$	$\Delta\pi_d$	$S_d(-)$	$P_d(-)$	$P_{us}(-)$	$X_{us}(-)$	$y_{us}(-)$	$y_d(-)$	
India	0.379	–1.287	0.495	–0.304	0.425	0.320	–51.361	–50.115	–0.071	1.122	–0.051	0.064	–0.039	–0.108	0.016	0.036	0.208
	0.380	–2.240	0.283	–2.035	0.748	1.706	–2.988	–2.902	–0.126	2.606	–2.559	1.046	–0.109	–1.627	0.190	0.247	3.341
	0.705	0.026	0.777	0.043	0.455	0.089	0.003	0.004	0.900	0.010	0.011	0.297	0.913	0.105	0.850	0.805	0.001
Indonesia	–1.623	0.192	–0.302	–0.109	0.005	2.996	–76.750	–74.950	–3.749	–2.714	–0.066	–0.017	0.460	–0.120	–0.079	0.171	0.424
	–1.088	0.436	–0.149	–0.716	0.012	1.324	–4.305	–4.149	–0.970	–0.683	–2.029	–0.140	1.003	–1.800	–0.418	0.468	5.694
	0.278	0.663	0.882	0.475	0.990	0.187	0.000	0.000	0.333	0.495	0.044	0.889	0.317	0.073	0.676	0.641	0.000
Italy	–1.174	2.014	–0.759	0.056	–0.370	0.365	–1.909	1.018	–78.300	–78.637	–0.091	–0.199	0.059	0.089	0.354	0.045	0.279
	–2.694	0.809	–0.515	0.593	–1.557	5.552	–0.147	0.076	–5.898	–5.819	–4.074	–1.490	0.408	2.330	3.141	0.660	5.377
	0.007	0.419	0.607	0.554	0.120	0.000	0.883	0.940	0.000	0.000	0.000	0.137	0.683	0.020	0.002	0.510	0.000
Japan	0.437	1.710	–0.884	0.127	–0.191	0.288	–46.806	–44.786	45.363	44.583	–0.018	0.004	–0.014	–0.008	0.030	–0.088	0.227
	0.589	1.601	–0.611	1.149	–1.038	2.284	–4.065	–3.835	2.907	2.868	–1.152	0.027	–0.266	–0.191	0.419	–1.027	4.311
	0.556	0.110	0.541	0.251	0.300	0.023	0.000	0.000	0.004	0.004	0.250	0.979	0.790	0.849	0.675	0.305	0.000
Korea	0.367	1.023	–1.701	–0.042	–0.131	11.703	–32.318	–27.974	–18.336	–19.456	–0.081	–0.408	0.711	–0.098	0.020	–0.227	0.294
	0.262	1.470	–0.883	–0.355	–0.535	7.807	–2.112	–1.797	–2.618	–2.753	–3.846	–2.887	3.614	–1.999	0.257	–0.708	5.686
	0.793	0.142	0.378	0.723	0.593	0.000	0.035	0.073	0.009	0.006	0.000	0.004	0.000	0.046	0.797	0.479	0.000
Mexico	–2.019	1.373	0.265	0.271	0.236	15.243	–27.174	–23.932	–0.097	–1.597	–0.124	0.099	1.111	–0.046	–0.001	–0.612	0.452
	–1.880	3.340	0.093	1.669	0.511	0.799	–1.336	–1.148	–0.367	–3.578	–4.352	2.008	1.807	–0.423	–0.005	–1.059	11.964
	0.061	0.001	0.926	0.096	0.610	0.425	0.182	0.252	0.714	0.000	0.000	0.045	0.072	0.673	0.996	0.290	0.000
Netherlands	0.665	–0.005	–1.441	0.246	0.233	–0.127	–97.464	–94.930	95.153	95.457	–0.031	–0.164	0.195	–0.011	0.218	–0.349	0.189
	2.071	–0.007	–1.395	2.816	1.466	–1.372	–8.769	–8.342	5.777	5.775	–1.554	–1.009	1.394	–0.260	2.444	–4.010	3.615
	0.039	0.994	0.164	0.005	0.144	0.171	0.000	0.000	0.000	0.000	0.121	0.314	0.164	0.795	0.015	0.000	0.000
Portugal	–0.528	1.034	–0.535	0.034	0.239	–0.005	–40.060	–37.887	–5.443	–6.448	–0.056	0.080	–0.066	0.029	0.145	–0.016	0.338
	–1.231	1.387	–0.400	0.330	1.154	–0.050	–3.837	–3.589	–0.703	–0.834	–2.756	1.118	–0.593	0.727	1.370	–0.223	7.425
	0.219	0.166	0.689	0.742	0.249	0.960	0.000	0.000	0.483	0.405	0.006	0.264	0.554	0.468	0.172	0.823	0.000
S. Africa	–1.271	–0.635	0.297	0.028	0.307	–0.184	–5.531	–2.267	–35.758	–35.810	–0.043	–0.095	0.462	0.005	–0.014	–0.040	0.276
	–1.650	–0.916	0.223	0.287	1.388	–2.594	–0.469	–0.192	–6.272	–6.160	–1.626	–1.257	1.906	0.132	–0.191	–0.427	4.815
	0.100	0.361	0.823	0.774	0.166	0.010	0.639	0.848	0.000	0.000	0.105	0.210	0.058	0.895	0.849	0.670	0.000
Spain	–0.691	1.218	–2.140	0.175	0.301	0.038	–42.802	–40.040	–35.021	–35.060	–0.071	–0.078	0.009	–0.024	0.277	0.034	0.289
	–1.877	1.470	–1.454	1.738	1.064	0.310	–3.217	–2.956	–3.496	–3.443	–3.241	–0.509	0.052	–0.547	2.430	0.504	5.477
	0.061	0.142	0.147	0.083	0.288	0.757	0.001	0.003	0.001	0.001	0.001	0.611	0.959	0.585	0.016	0.614	0.000

Country	*C*	π_d	π_{us}	ΔX_{us}	Δy_{us}	Δy_d	$\Delta(i_{us} - \pi_{us})$	$\Delta\pi_{us}$	$\Delta(i_d - \pi_d)$	$\Delta\pi_d$	$S_d(-)$	$P_d(-)$	$P_{us}(-)$	$X_{us}(-)$	$y_{us}(-)$	$y_d(-)$	*AR(1)*
Sweden	–0.755	–0.905	–0.607	0.104	–0.031	0.122	–30.637	–29.197	–11.683	–10.921	–0.055	–0.079	0.185	0.060	0.112	–0.056	0.337
	–1.913	–1.387	–0.376	1.036	–0.171	0.890	–2.849	–2.701	–1.140	–1.068	–2.468	–0.953	2.014	1.548	0.841	–0.570	6.141
	0.057	0.166	0.707	0.301	0.864	0.374	0.005	0.007	0.255	0.286	0.014	0.341	0.045	0.122	0.401	0.569	0.000
Switzerland	–0.182	0.007	0.403	–0.004	0.005	–0.021	1.387	1.253	1.410	1.407	0.001	–0.002	0.002	0.000	0.000	0.039	
	–2.471	1.373	5.076	–0.636	0.258	–0.365	1.293	1.155	1.144	1.141	0.142	–1.554	0.795	0.119	–0.012	2.586	
	0.014	0.171	0.000	0.525	0.797	0.716	0.197	0.249	0.253	0.255	0.887	0.121	0.427	0.905	0.991	0.010	
UK	–0.173	–0.119	–0.579	0.107	–0.053	0.201	–51.242	–49.920	2.657	3.266	–0.072	0.261	–0.263	–0.009	0.152	–0.031	0.178
	–0.451	–0.116	–0.526	1.422	–0.232	1.237	–5.380	–5.056	0.264	0.327	–2.633	2.121	–1.801	–0.361	1.497	–0.306	3.254
	0.653	0.908	0.599	0.156	0.817	0.217	0.000	0.000	0.792	0.744	0.009	0.035	0.072	0.718	0.135	0.760	0.001
USA	0.086		–0.358	–0.040	–0.136		–3.657	–1.978			–0.004		0.042	–0.003	–0.050		0.230
	0.410		–0.352	–0.492	–1.273		–0.290	–0.157			–0.267		1.080	–0.116	–1.229		4.170
	0.682		0.725	0.623	0.204		0.772	0.875			0.790		0.281	0.908	0.220		0.000

Table 2: Actual *p*–values of hypothesis tests. A *p*-value lower than 5% is a rejection of the null hypothesis of inflation irrelevance.

Country	*Domestic inflation beta* $\rho = 0$	*Foreign inflation beta* $\lambda = 0$	*Beta of foreign exchange rate changes* $\varphi = 0$	*Short and long domestic inflation betas* $\rho = \omega\beta_1 = 0$	*All 3 Short betas* $\rho = \lambda = \varphi = 0$	*All short and long slopes # 1* $\rho = \lambda = \varphi = 0$ and $\omega\beta_1 = \omega\beta_2$ $\omega\beta_5 = 0$	*All short and long slopes # 2* $\rho = \lambda = \varphi = 0$ and $\beta_1 = \beta_2 = \beta_5 = 0$
Belgium	0.7579	0.8085	0.0866	0.7589	0.3387	0.7118	0.7171
Brazil	0.0858	0.1694	0.0097	0.2159	0.0195	0.0035	0.0055
Canada	0.3859	0.3904	0.8860	0.2255	0.2795	0.1275	0.0076
Chile	0.3799	0.2553	0.6330	0.6727	0.6542	0.4640	0.2882
Colombia	0.2018	0.9634	0.0735	0.4334	0.1622	0.0140	0.0011
France	0.3140	0.6439	0.1579	0.3138	0.2800	0.1355	0.0861
Germany	0.4146	0.3380	0.0316	0.5110	0.1109	0.1126	0.1560
Greece	0.7242	0.5050	0.2667	0.3259	0.6107	0.0955	0.1598
India	0.0259	0.7774	0.0428	0.0399	0.0388	0.1166	0.0998
Indonesia	0.6633	0.8815	0.4747	0.8182	0.8095	0.4095	0.0000
Italy	0.4192	0.6069	0.5535	0.1847	0.7792	0.2282	0.0033
Japan	0.1102	0.5413	0.2512	0.2776	0.2836	0.6861	0.6839
Korea	0.1424	0.3778	0.3778	0.0103	0.4269	0.0037	0.0000
Mexico	0.0009	0.9262	0.6336	0.2718	0.0056	0.0044	0.0000
Netherlands	0.9944	0.1637	0.0051	0.4872	0.1630	0.0083	0.0336
Portugal	0.1663	0.6894	0.7415	0.2973	0.5447	0.7068	0.8016
South Africa	0.3605	0.8234	0.7743	0.4509	0.8118	0.3413	0.0000
Spain	0.1423	0.1468	0.0830	0.3112	0.0587	0.1982	0.2129
Sweden	0.1661	0.7071	0.3009	0.2486	0.4052	0.2306	0.1157
Switzerland	0.1705	0.0000	0.5249	0.3905	0.0000	0.0000	0.0001
UK	0.9080	0.5993	0.1559	0.0229	0.4429	0.1503	0.0644
USA	0.7247		0.6232	0.3555	0.8486	0.5460	0.9733
Statistical significance (*p*-value < 0.05)	2/22	1/21	4/22	3/22	4/22	6/22	10/22

3.2 Domestic inflation

The short run estimated coefficients on domestic inflation are reproduced in column 3 of Table 1. Two of them are statistically significant, with *p*-values less than 5%, and they are for India and Mexico. Remarkably the coefficient signs differ. India has a negative, and

Mexico a positive coefficient. More details are exhibited in Table 2, column 2. Granted the presence of sampling error, it is safe to infer that the 22 population domestic inflation betas all zero. This indicates a strong support for the weak form version of the inflation irrelevance proposition.

3.3 Foreign (US) Inflation

The short run estimated coefficients on foreign (US) inflation are reproduced in column 4 of Table 1. Only one of them is statistically significant, with a p-value less than 5%, and it is for Switzerland. More details are exhibited in Table 2, column 3. Granted the presence of sampling error, it is safe to infer that the 22 population foreign inflation betas are all zero. This indicates a strong support for the weak form version of the inflation irrelevance proposition.

3.4 Foreign Exchange Rate

The short run estimated coefficients on changes in the foreign (US) exchange rate are reproduced in column 5 of Table 1. Four of them are statistically significant, with p-values less than 5%, and they are for Brazil, Germany, India and the Netherlands. Remarkably the coefficient signs differ. Two have positive and two have negative signs. More details are exhibited in Table 2, column 4. Granted the presence of sampling error, it is safe to infer that the 22 population foreign exchange betas are all zero. This indicates a strong support for the weak form version of the inflation irrelevance proposition.

3.5 Foreign Output

The short run estimated coefficients on foreign (US) output are reproduced in column 6 of Table 1. None is statistically significant at the same conventional marginal significance level of 5%. The result is that foreign output does not explain stock returns. But, more specifically, US output does not explain counterparty stock returns. It may be arguable that other foreign outputs may explain stock returns depending on the particular major foreign trading partners of each country.

3.6 Domestic Output

The short run estimated coefficients on domestic output are reproduced in column 7 of Table 1. Out of 22, six are statistically significant at the same conventional marginal significance level of 5%. The result is that domestic output may explain stock returns. This depends on whether the coefficients, that should measure profitability ratios, and specifically the profit margins on domestic sales, have the expected desirable and reasonable values. These are 37.5% (France), 35.8% (Germany), 36.5% (Italy), and 28.8% (Japan), figures that are too high to be acceptable. The coefficients on the Korea and South Africa outputs are aberrant. The first is too high at 11.703, and the second is negative. Remarkably, domestic US output does not impact in a significant way and contemporaneously US stock returns, despite all expectations that US stock markets are leading indicators of business activity. Moreover, and since the variable can represent unanticipated output developments, because log output is a random walk, US stock markets do not react to output unexpected news. This is for the least surprising. And the lack of association for the remaining countries is also surprising.

3.7 Changes in Real Foreign Interest Rates

The estimated coefficients on the change in the real foreign (US) interest rate are reproduced in column 8 of Table 1, and their units is in years. These coefficients measure duration effects. They are all negative except for two countries Brazil and Switzerland. Out of the 20 others, 4 are statistically insignificant. They have low estimates, in absolute terms, for the duration effect, ranging from 1.909 (Italy) to 27.174 (Mexico). The remaining 16 have more plausible duration effects, ranging in absolute terms from 32.318 (Korea) to 97.464 (Netherlands). Therefore, the changes in US real interest rates are found in general to explain stock returns.

3.8 Changes in the Foreign (US) Inflation Rate

The estimated coefficients on the change in the foreign (US) inflation rate are reproduced in column 9 of Table 1, and their units is in years. These coefficients measure also duration effects, and should have values of the same magnitude as in the previous subsection. They are all negative except for three countries Brazil (again), Italy, and Switzerland (again). Out of the 19 others, 5 are statistically insignificant. They have low estimates, in absolute terms, for the duration effect, ranging from 1.978 (US) to 43.482 (Greece). The remaining 14 have more plausible duration effects, ranging in absolute terms from 34.923 (Chile) to 94.930 (Netherlands, again). The respective duration effects for changes in real foreign interest rates and foreign inflation rates move closely in tandem, and they seem to denote a general presence of significant duration effects.

3.9 Changes in Real Domestic Interest Rates

The estimated coefficients on the changes in the real domestic interest rate are reproduced in column 10 of Table 1, and their units is in years. These coefficients measure also duration effects. A count of 14 are negative, and 7 of them are statistically insignificant, and a count of 7 are positive, and 6 out of them are statistically insignificant. Granted the presence of sampling error there is still weak evidence for a duration effect from this variable.

3.10 Changes in Real Domestic Inflation Rates

The estimated coefficients on the change in the real domestic inflation rates are reproduced in column 11 of Table 1, and their units is in years. These coefficients measure also duration effects. A count of 7 are statistically insignificant, and take both positive and negative values. And a count of 14 are statistically significant, 6 of them are positive, and 8 out of them are negative. Granted the presence of sampling error there is still weak evidence for a duration effect.

3.11 The Lag of the Cointegration Residual

The estimated coefficients on the error-correction variable, or the first lag of the cointegration residual, appear in column 12 of Table 1. They are expected to be negative. Only one country regression violates this principle (Switzerland). The minimum is 0.004 (US), which is statistically non-significant, and the maximum is 0.124. An additional 4 regressions have statistically non-significant coefficients. The inverse of this coefficient is the speed of adjustment to the long run. The maximum speed is around 8 months (=1/0.124), which is less than a year, and is very fast. The average of the 17 statistically significant coefficients is 0.059, which translates to an average speed of 17 months (=1/0.059), or 1.4 years, which is quite fast.

3.12 The Domestic Price Level

The estimated coefficients on the first lag of the log of the domestic price level, which represent the long run effect of the domestic price levels, are listed in column 13 of Table 1. Eleven coefficients are negative, one out of them is statistically significant (Korea), and ten coefficients are positive, two of them are statistically significant (Mexico and UK). Granted the presence of sampling error, it can safely be inferred that the domestic price level does not explain stock returns. Therefore there is no long run relation between the domestic price level and stocks. This is in support of long run inflation irrelevance.

3.13 The Foreign Price Level

The estimated coefficients on the first lag of the log of the foreign price level, which represent the long run effects of the foreign price levels, are listed in column 14 of Table 1. Five coefficients are negative, none is statistically significant, and 17 coefficients are positive, two of them are statistically significant (Korea, again, and Sweden). Granted the presence of sampling error, it can safely be inferred that the foreign price level does not explain stock returns. Therefore there is no long run relation between the foreign price level and stocks. This is in support of long run inflation irrelevance.

3.14 The Foreign Exchange Rate

The estimated coefficients on the first lag of the log of the foreign exchange rate of the US dollar, which represent the long run effect of the US foreign exchange rate, are listed in column 15 of Table 1. Fifteen coefficients are negative, two are statistically significant (Colombia and Greece), and 7 coefficients are positive, one of them is statistically significant (Italy). Granted the presence of sampling error, it can safely be inferred that the level of the US foreign exchange rate does not explain stock returns. Therefore there is no long run relation between the level of the US foreign exchange rate and stocks. This is in support of long run inflation irrelevance.

3.15 Foreign Output

The estimated coefficients on the first lag of the log of foreign (US) output, which represent the long run effect of foreign (US) output, are listed in column 16 of Table 1. Seven coefficients are negative, none is statistically significant, and 15 are positive, out of which 3 are statistically significant (France, Italy, and Spain). Granted the presence of sampling error, it can safely be inferred that foreign (US) output does not explain stock returns. Therefore there is no long run relation between foreign (US) output and stocks.

3.16 Domestic Output

The estimated coefficients on the first lag of the log of domestic output, which represent the long run effects of domestic output, are listed in column 17 of Table 1. Twelve coefficients are negative, two of them are statistically significant (Brazil, and Netherlands), and 9 are positive, out of which 2 are statistically significant (Spain and Switzerland). Granted the presence of sampling error, it can safely be inferred that domestic output does not explain stock returns. Therefore there is no long run relation between domestic output and stocks.

3.17 Coefficient on AR(1)

The estimated coefficients on the autoregressive error term AR(1) are listed in column 18 of Table 1. Only Switzerland lacks an autoregressive variable. The coefficients range between 0.171 (Canada) and 0.452 (Mexico). The highest p-value is 0.005, which is highly significant statistically. The presence of this variable may denote weak form financial inefficiency, but this is not certain depending on factors like risk adjustment and transaction and other liquidity costs.

4. DISCUSSION

Table 2 summarizes the empirical results, and provides for additional results. The discussion will dwell upon the number of significant relations, which equals the number of rejections of the null hypothesis. Recall that the null hypothesis is that of inflation irrelevance. This hypothesis transcends domestic inflation per se and includes other neutrality aspects like neutrality of foreign inflation and foreign exchange rates. The rejection rates are negligible. Neutrality of domestic inflation is rejected in two counts out of 22 (column 2). Neutrality of foreign inflation is rejected in one count out of 21 (excluding the US). See column 3. Neutrality of the foreign exchange rate is rejected in 4 counts out of 22 (column 4). Neutrality of the three variables, domestic and foreign inflation and the foreign exchange rate is rejected in 4 counts out of 22 (column 6). Neutrality of both short term and long term domestic inflation rates is rejected in 3 counts out of 21 (column 5). These outcomes are strong evidence of weak, semi-strong and strong form versions of the inflation irrelevance proposition. The rejection rates for the two joint hypothesis that all short run and long run impacts of the three nominal variables, domestic and foreign inflation rates and foreign exchange rate, fare less well by scoring 6 and 10 out of 22 respectively (Table 2, last two columns). However, these last two joint hypotheses have a sizable level of sampling error, since they test 6 variables at the same time, and are subject to complex coefficient interrelationships.

5. CONCLUSION

The purpose of the present paper is to test for inflation irrelevance. Strictly speaking, irrelevance means that inflation has no effect upon stock returns. Less strictly, it means that the three nominal variables, domestic and foreign inflation rates and foreign exchange rates do not impact stock returns. The hypothesis can be generalized to cover both the short run and the long run. All in all, the evidence is in total agreement with the null hypothesis of no association and widespread neutrality. Theoretically this result is in line with the monetarist doctrine and the rational expectations movement which state that nominal variables do not affect real variables, and the only effect is from unanticipated news. Moreover, if one assumes that the level variables are random walks, nominal news, i.e. the change or first-difference of the level variables, are also neutral. While this runs against rational expectations per se, the econometric results are nevertheless still solid. The issue is that the market participants are found to be highly sophisticated and can disentangle developments in the real sector from those in the nominal sector. Money illusion is not an underlying feature, and is utterly rejected. Imperfect financial markets, like in the presence of distortionary taxes, are inconsequential and trivial. The three forms of inflation irrelevance, *i.e.* the weak, semi-strong, and even strong forms, powerfully apply. The same working hypothesis can be also useful to the study of other financial instruments, like bond prices. This is an avenue for future research.

Note

1. See Bodie (1976), Nelson (1976), and Jaffe and Mandelker (1976), followed closely by Fama and Schwert (1977). This initiated a plethora of research, and a huge attempt to explain this negative relation theoretically. Other early empirical studies are Gultekin (1983) and Solnik (1983).

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