Stock Returns and Real Activity: New Evidence from the United States and Japan

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If stock prices reflect the fundamentals of their value, there should be a close relationship between stock returns and expected future real activity. Fama (1990) finds that stock returns are a significant predictor of future real activity for the period from 1953 to 1987 in the United States. This paper confronts these issues with new data, and makes comparisons across two time periods and countries. We examine whether Fama's earlier findings are relevant to the new economy and analyze data from the two largest economies in the world: the United States and Japan. The findings indicate considerable differences in the relationship between stock returns and production growth rates across time and cultures. The results also suggest a breakdown in the explanatory power of stock returns over the past fifteen years, perhaps resulting from speculative bubbles and other persistent economic anomalies.

Introduction

The fundamental value of a firm's stock is the expected present value of future dividends. Future dividends must reflect real economic activity. Past research and conventional wisdom support the notion that asset prices reflect economic news. If all currently available information is taken into account, there should be a close relationship between stock returns and expected future real activity. To the extent that stock prices react quickly to new information about the future, stock prices should be leading indicators of real activity. The absence of any correlation between stock

* The authors would like to thank two anonymous referees for their helpful comments and suggestions.

0747 –5535/02/1400 & 1500/0095/$2.00

returns and future production growth rates would suggest that stock prices do not accurately reflect the underlying fundamentals of value.

There is a considerable literature on the relationships among real, monetary, and financial variables.[1] Fama (1990), among others, finds that stock returns can be significant in explaining future real activity in the United States. Fama finds that monthly, quarterly, and annual stock returns for the period from 1953 to 1987 are highly correlated with future production growth rates. Past stock returns are significant in explaining current production growth rates, and future production growth rates are significant in explaining current stock returns. Moreover, the degree of correlation between stock returns and future production growth rates increases with the length of time over which returns are calculated. Variations in annual returns are explained well by future production growth rates, whereas they only explain a small fraction of monthly returns. Fama (1990, p. 1094) explains that information about a certain production period is spread over many previous periods, and thereby affects the stock returns of each of those periods. In that way, the short-horizon return holds information about the production growth rates of many future periods, but adjacent returns hold additional information about the same production growth rates. As a result, regressions of long-horizon returns on future production growth rates (or regressions of long-horizon production growth rates on past returns) give a better picture of the cumulative information about production embodied in stock returns.

Schwert (1990) analyzes the relation between real stock returns and real economic activity from 1889 to 1988. He replicates Fama's (1990) results using an additional 65 years of data. Fama's findings are robust for this much longer period, with future production growth rates explaining a large fraction of the variation in stock returns. The Fama-Schwert findings establish a relationship between industrial production growth rates and lagged real stock returns in the U.S. Choi, Hauser, and Kopecky (1999) examine the relationship between industrial production growth rates and lagged stock returns for the G-7 countries using cointegration and error-correction models. They use monthly and quarterly data from January 1957 through March 1996 to show that the lag levels of industrial production and stock prices were cointegrated in all of the G-7 countries. Over a short time horizon, the error-correction models indicate that the growth rate of industrial production is correlated with lagged real stock returns at some data frequencies in six of the G-7 countries, with Italy being the only exception.

Binswanger (2000) speaks to the importance of expanding on Fama's work and does so with the same types of testing methods and data used by Fama (1990). Our research extends the investigation into this topic with cross-cultural comparisons and

[1] Examples include Fama (1981, 1990), Geske and Roll (1983), Chen et al. (1986), Schwert (1990), Battlingmayer (1992), Lee (1992), Leachman and Francis (1995), Canova and Nicola (1995), Darrat and Dickens (1999), Choi, Hauser, and Kopecky (1999), Park and Ratti (2000), and Dickinson (2000).

the application of new econometric methods. Park and Ratti (2000) investigate the dynamic interdependencies among economic activity, inflation, stock returns, and monetary policy. Their monthly U.S. data cover the period from January 1955 through March 1998. Using a vector autoregression (VAR) model, they find that shocks from monetary tightening generate statistically significant movements in inflation and expected stock returns and that these movements occur in opposite directions. Sadorsky (2001) uses 1950-1996 U.S. data to test models relating real stock returns and industrial production. He finds that models using difference stationary production could be mis-specified, although treating production as trend stationary instead has little impact on the Granger causal relationships between stock returns and real economic activity.

This paper confronts these issues with new data and makes comparisons across two time periods and two countries. Data from 1970 through 2000 are split into sample periods of equal length, 1970 - 1984 and 1985 - 2000, to determine how the relationship between stock returns and production growth rates changes over time. The study then examines whether Fama's earlier findings are relevant to the more recent period with its speculative bubbles, regulatory changes, and new emphasis on technology. As a further contribution, we analyze data from the two largest economies in the world, the United States and Japan, to allow consideration of similarities and differences in the relationship between stock returns and production growth rates across cultures as well as across time.[2]

Data

The data for this project come from industrial production and stock price indexes for the United States and Japan. The sample period is from January 1970 through June 2000. The Morgan Stanley Capital International Indexes for each country provides measures of stock values. The International Financial Statistics division of the International Monetary Fund Industrial provides country-specific production levels, as well as consumer price index (CPI) values. The nominal stock price index is deflated using the CPI to obtain the real stock price index. The rate of return on stocks and the rate of industrial production growth are calculated as follows: $y_t = (x_t - x_{t-1}) \times 100/x_{t-1}$, where x_t is the real stock index value or the industrial production index value at time t.

The data are divided into three samples:

Sample [A]: January 1970 - June 2000,
Sample [B]: January 1970 - December 1984,
Sample [C]: January 1985 - June 2000.

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[2] In this paper we follow the original methodology used by Fama (1990). Some recent studies have adopted more sophisticated methodologies. Because there has not been a substantial accumulation of research in this area using any of the new methods in particular, we chose to follow Fama's original approach for comparison across countries and periods.

Sample [A] covers the entire time period under consideration. Samples [B] and [C] cover the first and second halves of the entire period, respectively. The division of the sample at the end of 1984 is meaningful for several reasons. Although there is no definitive starting point for the new economy, several events set the stage for change in the early-to-mid 1980s. The passage of the Depository Institutions Deregulation and Monetary Control Act (DIDMCA) of 1980 and the Garn—St. Germain Depository Institutions Act of 1982 ushered in deregulation of the financial markets. The domain name system (DNS) introduced in 1984 launched the dot-com revolution, and in 1985 the U.S. government created a surge in Internet use by establishing five supercomputers as the backbone for Internet service (Internet Information Services, 2003). Binswanger (2000) also divides his data toward the end of 1984, supported in part by regression diagnostics and Chow breakpoint tests indicating significant subsample instability in 1984. Unbridled advancements in technology and economic expansion during the 1990s prolonged the new economy in the United States, and the associated economic boom inflated prices for technology and venture capital stocks in particular, and invigorated the stock market as a whole.

In Japan, stock price volatility became a particular problem in 1985. After the Nikkei 225 stock index reached a trough in July 1984, growth in the stock index, land prices, and property-based lending all surged ahead of GDP growth as part of Japan's bubble economy of 1985.[3] Since the bubble of 1985 through 1989, Japan has struggled with the after effects, including depressed stock and real estate prices, financial crises stemming largely from non-performing loans, a recession resulting from deflation, and burgeoning national debt. In attempts to rescue financial institutions with substantial cross-stockholdings, the Japanese government and the Bank of Japan tried unsuccessfully to maintain stock prices as part of their economic stimulus policy. For these reasons, it is interesting to consider how the relationship between stock prices and real activity changed over these time periods. Recognition that the stock market does not always adhere to market fundamentals, as highlighted in this research, helps to explain the ineffectiveness of policy measures in Japan and informs U.S. policymakers of potential pitfalls.

Table 1 provides summary statistics for real stock returns and the growth rate of industrial production in Japan and the U.S. for each sample period. For the entire period and the first subsample, Sample [B], the null hypothesis of a normal distribution is rejected for all variables except the production growth rate in Japan. For the second subsample, Sample [C], the null hypothesis of a normal distribution is rejected for the U.S. variables, but not for the Japanese variables. It is notable that the mean of the real rate of return on stocks and the industrial production growth

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[3] See Alexander (1997) for more on what he calls the "transitional phase" in the Japanese economy that began in the mid-1980s.

Table 1—Summary Statistics, Monthly Real Stock Returns and Industrial Production Growth Rates: January 1970 to June 2000

	Mean (%)	Std. Dev.
Sample [A]: January 1970 - June 2000		
U.S.		
Real Stock Return	0.713	4.482
Industrial Production Growth	0.242	0.799
Japan		
Real Stock Return	0.582	5.480
Production Growth	0.247	1.539
Sample [B]: January 1970 - December 1984		
U.S.		
Real Stock Return	0.158	4.545
Industrial Production Growth	0.204	1.022
Japan		
Real Stock Return	0.667	4.769
Industrial Production Growth	0.350	1.328
Sample [B]: January 1985 - June 2000		
U.S.		
Real Stock Return	1.249	4.365
Industrial Production Growth	0.280	0.497
Japan		
Real Stock Return	0.500	6.101
Industrial Production Growth	0.148	1.718

rate decreases between the first and second sub-periods in Japan, whereas the mean of both rates increases over the same period in the U.S.

Empirical Results

Regressions of Monthly Production Growth Rates on Past Monthly Stock Returns

Following Fama (1990), we regress current monthly production growth rates on past monthly stock returns. Because information about a certain production period is likely to be spread over many previous periods, several past returns should have explanatory power. The regression equation is

$$\begin{aligned} IP(t, t+1) = {} & \beta_0 + \beta_1 R(t-1, t) + \beta_2 R(t-2, t-1) + \beta_3 R(t-3, t-2) + \beta_4 R(t-4, t-3) \\ & + \beta_5 R(t-5, t-4) + \beta_6 R(t-6, t-5) + \beta_7 R(t-7, t-6) + \beta_8 R(t-8, \\ & t-7) + \beta_9 R(t-9, t-8) + \beta_{10} R(t-10, t-9) + \beta_{11} R(t-11, t-10) \\ & + \beta_{12} R(t-12, t-11) + e(t, t+1). \end{aligned}$$

$IP(t, t + 1)$ is the monthly production growth rate from t to t + 1, and $R(t - 1 - i, t - i)$ is the monthly real return from $t - 1 - i$ to $t - i$ ($i = 0, 1, \ldots, 11$). The results are displayed in Table 2 for the U.S. and Table 3 for Japan.

Table 2—Regressions of Monthly Production Growth Rates on Past Monthly Returns: U.S.

$$IP(t, t+1) = \beta_0 + \beta_1 R(t-1, t) + \beta_2 R(t-2, t-1) + \beta_3 R(t-3, t-2) + \beta_4 R(t-4, t-3) + \beta_5 R(t-5, t-4) + \beta_6 R(t-6, t-5) + \beta_7 R(t-7, t-6) + \beta_8 R(t-8, t-7) + \beta_9 R(t-9, t-8) + \beta_{10} R(t-10, t-9) + \beta_{11} R(t-11, t-10) + \beta_{12} R(t-12, t-11) + e(t, t+1)$$

	Sample [A] Jan. 1970 – June 2000		Sample [B] Jan. 1970 – Dec. 1984		Sample [C] Jan. 1985 – June 2000	
	β_i	t-value	β_i	t-value	β_i	t-value
Constant	0.103	1.217	0.178	1.817	0.213*	2.257
R(t – 1, t)	-0.001	-0.087	0.004	0.233	-0.005	-0.610
R(t – 2, t – 1)	0.003	0.325	0.002	0.105	0.005	0.546
R(t – 3, t – 2)	0.023*	2.166	0.044**	2.988	0.008	0.733
R(t – 4, t – 3)	0.029*	2.360	0.047*	2.394	0.011	1.101
R(t – 5, t – 4)	0.020	1.793	0.029	1.459	0.005	0.565
R(t – 6, t – 5)	0.021	1.534	0.022	0.957	0.009	0.888
R(t – 7, t – 6)	0.026**	3.095	0.028*	2.103	0.015	1.755
R(t – 8, t – 7)	0.017	1.957	0.029	1.964	-0.003	-0.509
R(t – 9, t – 8)	0.015	1.771	0.036**	2.902	-0.008	-0.884
R(t – 10, t – 9)	0.025**	3.097	0.055**	4.156	-0.002	-0.247
R(t – 11, t – 10)	0.020**	2.601	0.020	1.753	0.017*	2.437
R(t – 12, t – 11)	0.012	1.411	0.022	1.685	0.000	-0.017
$\overline{R}^2$	0.123		0.230		-0.004	
S.E.	0.734		0.887		0.498	
F-value	5.123		5.148		0.943	
P-value	0.000		0.000		0.506	

* Statistically significant at the 5 percent level
** Statistically significant at the 1 percent level
t-values are calculated using the Newey-West HAC standard errors and covariance
S.E. is the standard error of the regression

As is evident from Table 2, up to eleven lags of the one-month return are significant in explaining the current production growth for Sample [A].[4] In terms of the stock market being a leading indicator of real economic activity, this finding is consistent with the empirical results of Binswanger (2000), Fama (1981, 1990), Geske and Roll (1983), Lee (1992), and Sadorsky (2001). The adjusted coefficient of determination is 0.123. Similarly for Sample [B], the results show that up to ten lags of the one-month return are significant in explaining the current production growth, and the adjusted coefficient of determination is 0.230.

The story changes in regard to Sample [C]. Only the eleventh lag of the one-month return is significant at the 5 percent level according to t-statistics. The adjusted coefficient of determination is -0.004, which is much smaller than that for Sample [B]. We also performed F-tests of the hypothesis that all of the slope coefficients (excluding a constant) are zero. The F-value and its associated P-value are

[4] We use Newey-West HAC standard errors and covariances to correct for heteroskedasticity and autocorrelation (Newey and West 1987).

Table 3—Regressions of Monthly Production Growth Rates on Past Monthly Returns: Japan

$$\begin{aligned} IP(t, t+1) = {} & \beta_0 + \beta_1 R(t-1, t) + \beta_2 R(t-2, t-1) + \beta_3 R(t-3, t-2) + \beta_4 R(t-4, t-3) + \beta_5 R(t-5, t-4) \\ & + \beta_6 R(t-6, t-5) + \beta_7 R(t-7, t-6) + \beta_8 R(t-8, t-7) + \beta_9 R(t-9, t-8) \\ & + \beta_{10} R(t-10, t-9) + \beta_{11} R(t-11, t-10) + \beta_{12} R(t-12, t-11) + e(t, t+1) \end{aligned}$$

	Sample [A] Jan. 1970 – June 2000		Sample [B] Jan. 1970 – Dec. 1984		Sample [C] Jan. 1985 – June 2000	
	β_i	t-value	β_i	t-value	β_i	t-value
Constant	0.118	1.496	0.118	1.118	0.096	1.022
R(t – 1, t)	0.014	0.814	0.000	-0.029	0.019	0.765
R(t – 2, t – 1)	0.021	1.392	0.046	1.862	0.009	0.452
R(t – 3, t – 2)	0.008	0.554	0.044*	2.087	-0.014	-0.810
R(t – 4, t – 3)	0.016	1.043	0.013	0.707	0.007	0.337
R(t – 5, t – 4)	0.032	1.839	0.052	1.963	0.015	0.692
R(t – 6, t – 5)	0.006	0.415	0.019	1.010	-0.001	-0.040
R(t – 7, t – 6)	0.032*	2.086	0.042	1.456	0.029	1.482
R(t – 8, t – 7)	0.001	0.054	0.020	0.986	-0.006	-0.248
R(t – 9, t – 8)	0.022	1.354	-0.004	-0.188	0.030	1.329
R(t – 10, t – 9)	0.011	0.698	0.012	0.609	0.006	0.306
R(t – 11, t – 10)	0.004	0.263	0.038	1.797	-0.013	-0.808
R(t – 12, t – 11)	0.019	1.400	0.017	0.969	0.017	0.923
$\overline{R}^2$	0.030		0.134		-0.023	
S.E.	1.532		1.259		1.737	
F-value	1.917		3.146		0.658	
P-value	0.031		0.000		0.789	

* Statistically significant at the 5 percent level
** Statistically significant at the 1 percent level
t-values are calculated using the Newey-West HAC standard errors and covariance
S.E. is the standard error of the regression

5.123 and 0.000, respectively, for Sample [A], 5.148 and 0.000 for Sample [B], but 0.943 and 0.506 for Sample [C]. This suggests that the regression equation is meaningful for Samples [A] and [B], but not for Sample [C]. The finding that stock returns in the new economy do not seem to lead real activity is contrary to the conventional wisdom and most earlier studies and consistent with the results of Binswanger (2000).

As indicated in Table 3, in the results for Sample [A], only the seventh lag of the one-month return is significant at the 5 percent level in explaining current production growth in Japan. The adjusted coefficient of determination is 0.030. For Sample [B], the results show that only the third lag of the one-month return is significant at the 5 percent level in explaining the current production growth according to t-statistics, and the adjusted coefficient of determination is 0.134. For Sample [C], no lags of the one-month return are significant at the 5 percent level. The adjusted coefficient of determination is -0.023 and is much smaller than that for Sample [B]. The F-value and its associated P-value are 3.146 and 0.000 for Sample [B], but 0.658 and 0.789 for Sample [C]. This indicates that the regression equation is meaningful for sample

[B] but not for Sample [C]. These results for Japan are consistent with those for the U.S.

Comparisons between Tables 2 and 3 illustrate differences between the two countries. The performance of the model itself is better for the U.S. than for Japan. The adjusted coefficient of determination for Japan is smaller than that for the U.S. for each sample period. As many as five of the lagged stock return variables are significant at the 5 percent level in explaining movements in current industrial production growth rates for the U.S., whereas at most one lagged variable is significant in each equation for Japan.

Looking at comparisons over time, the performance of the model diminishes for the second subsample for both countries. The adjusted coefficient of determination for Sample [C] is smaller than that for Sample [B] for Japan and the U.S. The number of lagged stock return variables that are significant in explaining growth rate movements drops precipitously between the two sample periods for both countries. Moreover, for both countries, the regression equation is useful in explaining the data in Sample [B], whereas the model does not hold up well in conjunction with the most recent data—that in Sample [C].

Regressions of Monthly, Quarterly, and Annual Production Growth Rates on Contemporaneous and One-Year Lags of Quarterly Real Stocks Returns

In his second set of regressions of production growth rates on stock returns, Fama (1990) uses quarterly rather than monthly returns and tests for their ability to explain monthly, quarterly, and annual production growth rates. The regression equation is

$$\begin{aligned} IP(t-T, t) = {} & \beta_0 + \beta_1 R(t-3, t) + \beta_2 R(t-6, t-3) + \beta_3 R(t-9, t-6) + \beta_4 R(t-12, \\ & t-9) + \beta_5 R(t-15, t-12) + \beta_6 R(t-18, t-15) + \beta_7 R(t-21, t-18) \\ & + \beta_8 R(t-24, t-21) + e(t-T, t). \end{aligned}$$

The notation $IP(t-T, t)$ represents the growth rate of seasonally adjusted industrial production between $t - T$ and t. That is, the monthly growth rate when $T = 1$, the quarterly rate when $T = 3$, and the annual rate when $T = 12$. The term $R(t - i, t - i + 3)$ represents the real return on stocks for the quarter from $t - i$ to $t - i + 3$ ($i = 3, 6, \ldots, 24$). Following Fama (1990), we use overlapping quarterly observations for the regressions involving annual data. Tables 4 and 5 summarize the results for the U.S. and Japan, respectively.

As illustrated in Table 4, the U.S. results for Sample [A] are close to those for the period from 1953 to 1987 in Fama (1990, p. 1098, Table II). The goodness of fit improves with the time horizon over which production growth is calculated; the adjusted coefficient of determination progresses from 0.124 to 0.286 to 0.336 as we move from monthly to quarterly to annual production growth rates. Regressions

Table 4—Regressions of Monthly, Quarterly, and Annual Production Growth Rates on Contemporaneous and One-Year of Lags of Quarterly Real Stock Returns: U.S.

$IP(t-T, t) = \beta_0 + \beta_1 R(t-3, t) + \beta_2 R(t-6, t-3) + \beta_3 R(t-9, t-6) + \beta_4 R(t-12, t-9) + \beta_5 R(t-15, t-12) + \beta_6 R(t-18, t-15) + \beta_7 R(t-21, t-18) + \beta_8 R(t-24, t-21) + e(t-T, t)$

	Monthly Production Growth Rates IP(t – 1, t)		Quarterly Production Growth Rates IP(t – 3, t)		Annual Production Growth Rates IP(t – 12, t)	
	β_i	t-value	β_i	t-value	β_i	t-value
Sample [A]: January 1970 – June 2000						
Constant	0.132	1.622	0.370	1.466	1.786	1.914
R(t – 3, t)	-0.004	-0.682	-0.042**	-3.089	-0.098**	-3.040
R(t – 6, t – 3)	0.025**	2.656	0.065 *	2.440	-0.020	-0.513
R(t – 9, t – 6)	0.018*	2.245	0.071 **	3.270	0.065	1.510
R(t – 12, t – 9)	0.020**	3.417	0.042 **	2.745	0.135**	2.735
R(t – 15, t – 12)			0.041 **	2.945	0.228**	3.974
R(t – 18, t – 15)					0.160**	3.918
R(t – 21, t – 18)					0.094*	2.562
R(t – 24, t – 21)					0.046	1.218
$\overline{R}^2$	0.124		0.286		0.336	
S.E.	0.739		1.523		3.917	
F-value	13.554		10.363		8.206	
P-value	0.000		0.000		0.000	
Sample [B]: January 1970 – December 1984						
Constant	0.193*	2.033	0.537	1.884	2.426*	2.276
R(t – 3, t)	0.000	-0.003	-0.052	-1.769	-0.107*	-2.206
R(t – 6, t – 3)	0.044**	3.093	0.118**	3.586	0.028	0.573
R(t – 9, t – 6)	0.020	1.763	0.090**	3.538	0.119*	2.410
R(t – 12, t – 9)	0.038**	4.801	0.078**	3.631	0.245**	5.589
R(t – 15, t – 12)			0.059**	3.414	0.363**	7.462
R(t – 18, t – 15)					0.214**	4.612
R(t – 21, t – 18)					0.170**	3.494
R(t – 24, t – 21)					0.084	1.637
$\overline{R}^2$	0.232		0.436		0.574	
S.E.	0.894		1.814		4.306	
F-value	13.684		9.519		9.744	
P-value	0.000		0.000		0.000	
Sample [C]: January 1985 – June 2000						
Constant	0.268**	2.918	0.818*	2.262	2.532*	2.034
R(t – 3, t)	-0.010	-1.726	-0.039**	-2.893	-0.014	-0.355
R(t – 6, t – 3)	0.005	0.701	0.010	0.371	-0.004	-0.066
R(t – 9, t – 6)	0.005	1.101	0.024	1.059	0.023	0.339
R(t – 12, t – 9)	0.002	0.426	-0.006	-0.436	-0.005	-0.084
R(t – 15, t – 12)			0.017	0.919	0.060	1.129
R(t – 18, t – 15)					0.059	1.386
R(t – 21, t – 18)					0.028	0.874
R(t – 24, t – 21)					0.044	1.221
$\overline{R}^2$	0.016		0.093		-0.060	
S.E.	0.493		0.933		2.541	
F-value	1.772		2.258		0.556	
P-value	0.136		0.061		0.801	

IP(t – T, t) is the monthly (T = 1), quarterly (T = 3), or annual (T = 12) growth rate of seasonally adjusted industrial production from t - T to t. R(t – k, t – k + 3) is the real stock return for the quarter from t - k to t – k +3. t-values are calculated using the Newey-West HAC standard errors and covariance. S.E. is the standard error of the regression using Sample [B] yield results similar to those using the whole sample. Whether we regress monthly, quarterly, or annual production growth rates on past stock returns, however, the stock returns do not possess explanatory power over Sample [C]. With Sample [C], the adjusted R^2 is -0.060 for annual production growth rates, and only one of the three equations has a statistically significant lagged returns coefficient at the 5 percent level. For Sample [B], the F-value and its associated P-value are 13.648 and 0.000, respectively, for the monthly production growth rate, 9.519 and 0.000 for the quarterly production growth rate, and 9.744 and 0.000 for the annual production growth rate. For Sample [C], the F-value and P-value are 1.772 and 0.136 for monthly growth, 2.258 and 0.061 for quarterly growth, and 0.566 and 0.801 for annual growth. These results indicate that the regression model is meaningful for explaining the data in Sample [B], but not for Sample [C].

As shown in Table 5, the Sample [A] results for Japan are similar to those for the U.S. The goodness of fit improves with the time horizon for production growth, with the adjusted R^2 increasing from 0.027 to 0.224 to 0.440 as the perspective changes from monthly to quarterly to annual production growth rates. As was the case for the U.S., regressions using Sample [B] are similar to those for the whole sample. And again, when we regress monthly or quarterly production growth rates on past returns, the model's explanatory power over the later (Sample [C]) data is less than that over the earlier (Sample [B]) data. For the 1985-2000 period covered by Sample [C], the adjusted R^2 is -0.016, 0.027, and 0.340 for monthly, quarterly, and annual production growth rates, respectively. None of the coefficients on production growth rates is statistically significant at the 5 percent level in the monthly and quarterly Sample [C] equations. The F and P values for monthly, quarterly, and annual growth rates are, respectively, 7.519 and 0.000, 12.241 and 0.000, and 12.192 and 0.000 for Sample [B], as compared with 0.267 and 0.899, 1.339 and 0.261, and 4.932 and 0.000 for Sample [C]. These results suggest that the regression model is meaningful for explaining the data in Sample [B], but not for Sample [C] with the exception of the annual production growth rate.

With the monthly production growth rate as the dependent variable, the model performs better for the U.S. than for Japan; the adjusted coefficient of determination is 0.124 for the U.S. and 0.027 for Japan. With annual production growth rates as the dependent variable, however, the model performs better for Japan than for the U.S. The adjusted coefficient of determination for Japan is 0.440, as compared with 0.336 for the U.S. The ability of lagged stock returns to explain production growth rates decreases markedly from the first period (1970 - 1984) to the second period (1985 - 2000) for each country and for each dependent variable. For example, with quarterly production growth rates as the dependent variable, the adjusted coefficient of determination falls over time from 0.436 to 0.093 in regressions using U.S. data and from 0.505 to 0.027 in regressions using Japanese data. Moreover, the F and P values indicate that for both countries, the regression model is useful in explaining Sample

Table 5—Regressions of Monthly, Quarterly and Annual Production Growth Rates on Contemporaneous and One-Year of Lags of Quarterly Real Stock Returns: Japan

$IP(t-T, t) = \beta_0 + \beta_1 R(t-3, t) + \beta_2 R(t-6, t-3) + \beta_3 R(t-9, t-6) + \beta_4 R(t-12, t-9) + \beta_5 R(t-15, t-12) + \beta_6 R(t-18, t-15) + \beta_7 R(t-21, t-18) + \beta_8 R(t-24, t-21) + e(t-T, t)$

	Monthly Production Growth Rates IP(t – 1, t)		Quarterly Production Growth Rates IP(t – 3, t)		Annual Production Growth Rates IP(t – 12, t)	
	β_i	t-value	β_i	t-value	β_i	t-value
Sample [A]: January 1970 – June 2000						
Constant	0.139	1.745	0.295	1.234	1.076	1.274
R(t – 3, t)	0.007	1.081	0.013	0.896	0.012	0.388
R(t – 6, t – 3)	0.019**	2.632	0.051*	2.461	0.071	1.782
R(t – 9, t – 6)	0.012	1.630	0.044**	2.672	0.118*	2.409
R(t – 12, t – 9)	0.013*	2.031	0.033*	2.530	0.141**	3.488
R(t – 15, t – 12)			0.058**	2.970	0.181**	4.083
R(t – 18, t – 15)					0.163**	4.812
R(t – 21, t – 18)					0.135**	3.663
R(t – 24, t – 21)					0.103*:	2.837
$\overline{R}^2$	0.027		0.224		0.440	
S.E.	1.536		1.905		4.467	
F-value	3.416		7.737		12.209	
P-value	0.009		0.000		0.000	
Sample [B]: January 1970 – December 1984						
Constant	0.128	1.101	0.319	0.928	1.435	1.112
R(t – 3, t)	0.019*	2.042	0.009	0.451	-0.010	-0.214
R(t – 6, t – 3)	0.038**	3.365	0.110**	5.051	0.144**	3.456
R(t – 9, t – 6)	0.020*	2.207	0.068*	2.462	0.205**	3.507
R(t – 12, t – 9)	0.016	1.782	0.034	1.618	0.223**	4.149
R(t – 15, t – 12)			0.082**	3.043	0.290**	5.184
R(t – 18, t – 15)					0.201**	3.782
R(t – 21, t – 18)					0.119*	2.120
R(t – 24, t – 21)					0.082	1.254
$\overline{R}^2$	0.134		0.505		0.633	
S.E.	1.262		1.638		4.269	
F-value	7.519		12.241		12.192	
P-value	0.000		0.000		0.000	
Sample [C]: January 1985 – June 2000						
Constant	0.120	1.271	0.229	0.844	0.671	0.773
R(t – 3, t)	-0.002	-0.295	0.011	0.571	0.000	0.009
R(t – 6, t – 3)	0.005	0.657	0.007	0.338	0.007	0.145
R(t – 9, t – 6)	0.005	0.507	0.023	1.159	0.049	0.954
R(t – 12, t – 9)	0.009	1.045	0.028	1.752	0.064	1.527
R(t – 15, t – 12)			0.040	1.856	0.095*	2.073
R(t – 18, t – 15)					0.118**	3.744
R(t – 21, t – 18)					0.148**	4.231
R(t – 24, t – 21)					0.136**	3.591
$\overline{R}^2$	-0.016		0.027		0.340	
S.E.	1.731		1.953		3.768	
F-value	0.267		1.339		4.932	
P-value	0.899		0.261		0.000	

IP(t – T, t) is the monthly (T = 1), quarterly (T = 3), or annual (T = 12) growth rate of seasonally adjusted industrial production from t - T to t. R(t – k, t – k + 3) is the real stock return for the quarter from t - k to t – k +3. t-values are calculated using the Newey-West HAC standard errors and covariance. S.E. is the standard error of the regression

[B], but not Sample [C]. It is apparent that the transition into the new economy, with its economic bubbles and price shocks, diminished the predictive value of stock returns that is evident in the results of Fama and others.

Regressions of Monthly, Quarterly, and Annual Real Stock Returns on Contemporaneous and One-Year Leads of Quarterly Production Growth Rates

As in Fama (1990), the third set of regressions tests the explanatory power of quarterly production growth rates over monthly, quarterly, and annual real stock returns. The regression equation takes the form

$$\begin{aligned} R(t, t+T) = {} & \beta_0 + \beta_1 IP(t, t+3) + \beta_2 IP(t+3, t+6) + \beta_3 IP(t+6, t+9) \\ & + \beta_4 IP(t+9, t+12) + \beta_5 IP(t+12, t+15) + \beta_6 IP(t+15, t+21) \\ & + \beta_7 IP(t+18, t+21) + \beta_8 IP(t+21, t+24) + e(t, t+T). \end{aligned}$$

where $R(t, t + T)$ represents the real return on stocks from t to t + T. This term is the monthly return when T = 1, the quarterly return when T = 3, and the annual return when T = 12. The term $IP(t + k, t + k + 3)$ is the growth rate of seasonally adjusted industrial production for the quarter from t = k to t + k + 3 (k = 0, 3, …, 21). Following Fama (1990), we use overlapping quarterly observations for the regressions involving annual data. Tables 6 and 7 present the results for the U.S. and Japan, respectively.

As shown in Table 6, the results for the 1970 to 2000 period in the U.S. resemble those for the 1953 to 1987 period in Fama (1990, p. 1099, Table III). The goodness of fit improves with the time horizon over which stock returns are calculated, with the adjusted R^2 increasing from 0.064 to 0.241 to 0.306 for the monthly, quarterly, and annual stock returns, respectively. The results from the earlier 1970 to 1984 subsample are stronger, with adjusted R^2 values of 0.101, 0.331, and 0.602. For the 1985 to 2000 period, the past production growth rates do not possess reasonably significant explanatory power over any of the categories of stock returns. The adjusted R^2 values are as low as -0.039 for the annual stock return equation, and few coefficients for lagged growth rates are significant at the 5 percent level in any of the Sample [C] equations. For Sample [B], the F and P values are 6.006 and 0.000 for the monthly real rate of return, 6.842 and 0.000 for the quarterly real rate of return, and 11.608 and 0.000 for the annual real rate of return. For Sample [C], the F and P values for monthly, quarterly, and annual returns are 2.104 and 0.082, 2.809 and 0.026, and 0.732 and 0.663, respectively. These results suggest that the regression model is meaningful for explaining the data in Sample [B], but not the data in Sample [C].

The results for the entire 1970-2000 period in Japan are close to those for the U.S., as shown in Table 7. The goodness of fit again improves with the time horizon over which stock returns are calculated, with the adjusted R^2 increasing from 0.033

Table 6—Regressions of Monthly, Quarterly, and Annual Real Stock Returns on Contemporaneous and One-Year Leads of Quarterly Production Growth: U.S.

R(t, t + T) = $\beta_0 + \beta_1$IP(t, t + 3) + β_2IP(t + 3, t+ 6) + β_3IP(t + 6, t+ 9) + β_4IP(t + 9, t+ 12) + β_5IP(t + 12, t+ 15) + β_6IP(t + 15, t+ 21) + β_7IP(t + 18, t+ 21) + β_8IP(t + 21, t+ 24) + e(t, t + T)

	Monthly Real Rate of Return R(t, t + 1)		Quarterly Real Rate of Return (t, t + 3)		Annual Real Rate of Return R(t, t + 12)	
	β_i	t-value	β_i	t-value	β_i	t-value
Sample [A]: January 1970 – June 2000						
Constant	0.152	0.623	0.698	0.878	4.588	1.550
IP(t, t + 3)	-0.280	-1.891	-1.486**	-3.877	-2.009*	-2.557
IP(t + 3, t + 6)	0.538**	2.916	1.490**	2.936	-0.426	-0.694
IP(t + 6, t + 9)	0.104	0.787	1.078**	3.585	1.276*	2.117
IP(t + 9, t + 12)	0.358**	2.963	0.479	1.553	1.553*	2.466
IP(t + 12, t + 15)			0.407	1.232	3.355**	4.430
IP(t + 15, t + 18)					1.311*	2.205
IP(t + 18, t + 21)					0.822	1.558
IP(t + 21, t + 24)					0.216	0.255
$\overline{R}^2$	0.064		0.241		0.306	
S.E.	4.328		7.312		14.744	
F-value	7.090		8.444		7.275	
P-value	0.000		0.000		0.000	
Sample [B]: January 1970 – December 1984						
Constant	-0.430	-1.460	-1.058	-1.264	-1.751	-0.646
IP(t, t + 3)	-0.178	-1.100	-1.262*	-2.632	-2.589**	-3.152
IP(t + 3, t + 6)	0.506**	2.639	1.533**	2.983	0.024	0.037
IP(t + 6, t + 9)	0.100	0.722	0.915*	2.671	0.787	1.380
IP(t + 9, t + 12)	0.386**	2.707	0.738*	2.211	2.284**	4.915
IP(t + 12, t + 15)			0.267	0.776	3.361**	4.976
IP(t + 15, t + 18)					1.036	1.789
IP(t + 18, t + 21)					1.304*	2.107
IP(t + 21, t + 24)					-0.482	-0.601
$\overline{R}^2$	0.101		0.331		0.602	
S.E.	4.311		7.283		11.702	
F-value	6.006		6.842		11.608	
P-value	0.000		0.000		0.000	
Sample [C]: January 1985 – June 2000						
Constant	1.251*	2.487	3.965*	2.665	12.863*	2.653
IP(t, t + 3)	-0.965*	-2.141	-3.053**	-2.869	-0.025	-0.014
IP(t + 3, t + 6)	0.652	1.254	1.043	0.818	-1.426	-0.997
IP(t + 6, t + 9)	0.079	0.277	1.469*	2.083	1.695	0.783
IP(t + 9, t + 12)	0.253	0.686	-0.516	-0.614	-2.314	-0.980
IP(t + 12, t + 15)			1.000	1.236	2.424	1.124
IP(t + 15, t + 18)					1.434	1.200
IP(t + 18, t + 21)					-0.813	-0.487
IP(t + 21, t + 24)					2.728	1.081
$\overline{R}^2$	0.025		0.137		-0.039	
S.E.	4.285		6.987		14.384	
F-value	2.104		2.809		0.732	
P-value	0.082		0.026		0.663	

Note: R(t, t + T) is the monthly (T = 1), quarterly (T = 3), or annual (T = 12) real stock return from t to t + T. IP(t + k, t + k +3) is the growth rate of seasonally adjusted industrial production for the quarter from t + k to t + k + 3. t-values are calculated using the Newey-West HAC standard errors and covariance. S.E. is the standard error of the regression to 0.129 to 0.356 for the monthly, quarterly, and annual stock returns, respectively. As in the U.S., relative to the results for the whole period, the explanatory value of production growth rates is considerably stronger in the earlier period and weaker in the later period. For the period from 1985 to 2000, none of the eight lagged production growth variables is significant at the 5 percent level in the monthly or quarterly stock returns regressions. In the annual stock returns regression for 1985-2000, two of the lagged variables are significant at the 5 percent level, relative to five for the same regression using data from 1970-2000. The F-value and its associated P-value for monthly, quarterly, and annual real rates of return are 6.031 and 0.000, 6.796 and 0.000, and 7.946 and 0.000, respectively, for Sample [B]. For Sample [C] the corresponding F and P values are 0.549 and 0.700, 1.067 and 0.389, and 4.012 and 0.001 for monthly, quarterly, and annual real rates of return, respectively. The findings from Japan again lead to the conclusion that the regression model is more meaningful when applied to Sample [B] than to Sample [C].

Comparing the model's performance between the two countries on the basis of monthly and quarterly stock returns, the model provides a better fit for the U.S. than for Japan. The performance of the model is better for Japan than for the U.S., however, in explaining annual stock returns. For both countries, the adjusted coefficient of determination falls over time, and more multiple lags of stock returns are significant in explaining movements in current industrial production growth rates for the earlier Sample [B] than for the later Sample [C]. Moreover, the F-value and its associated P-value suggest that the regression model may be meaningful for Sample [B], but not for Sample [C]. These findings suggest that the relationships identified by Fama and others break down for more recent data.

Testing for Granger Causality

This section explains the application of a Granger causality test involving monthly real stock returns and monthly industrial production growth rates. Because the Granger test measures precedence and information content, it is an appropriate follow-up to the regression analysis. We run the following bivariate model:

$$\begin{aligned}IP(t, t+1) = {} & \alpha_0 + \alpha_1 IP(t-1, t) + \alpha_2 IP(t-2, t-1) + \ldots + \alpha_{12} IP(t-12, t-11) \\ & + \beta_1 R(t-1, t) + \beta_2 R(t-2, t-1) + \ldots + \beta_{12} R(t-12, t-11) + e_{IP}(t, t+1)\end{aligned}$$

$$\begin{aligned}R(t, t+1) = {} & \alpha_0 + \alpha_1 R(t-1, t) + \alpha_2 R(t-2, t-1) + \ldots + \alpha_{12} R(t-12, t-11) \\ & + \beta_1 IP(t-1, t) + \beta_2 IP(t-2, t-1) + \ldots + \beta_{12} IP(t-12, t-11) + e_R(t, t+1)\end{aligned}$$

where $IP(t-i, t-i+1)$ is the monthly production growth rate from $t-i$ to $t-i+1$ ($i = 0, 1, \ldots, 12$), and $R(t-i, t-i+1)$ is the monthly real return from $t-i$ to $t-i+1$ ($i = 0, 1, \ldots, 12$). The null hypothesis is that the monthly real stock return

Table 7—Regressions of Monthly, Quarterly, and Annual Real Stock Returns on Contemporaneous and One-Year Leads of Quarterly Production Growth: Japan

R(t, t + T) = $\beta_0 + \beta_1$ IP R(t, t + 3) + β_2 IP R(t + 3, t + 6) + β_3 IP R(t + 6, t + 9) + β_4 IP R(t + 9, t + 12) + β_5 IP R(t + 12, t + 15) + β_6 IP R(t + 15, t + 18) + β_7 IP R(t + 18, t + 21) + β_8 IP R(t + 21, t + 24) + e(t, t + T)

	Monthly Real Rate of Return R(t, t + 1)		Quarterly Real Rate of Return R(t, t + 3)		Annual Real Rate of Return R(t, t + 12)	
	β_i	t-value	β_i	t-value	β_i	t-value
Sample [A]: January 1970 – June 2000						
Constant	0.111	0.364	-0.091	-0.116	-1.583	-0.557
IP R(t, t + 3)	0.018	0.125	-0.089	-0.261	0.470	0.511
IP R(t + 3, t + 6)	0.341*	2.324	1.047	1.957	1.443	1.839
IP R(t + 6, t + 9)	0.124	0.814	0.444	1.153	1.744*	2.034
IP R(t + 9, t + 12)	0.204	1.372	0.197	0.393	1.451	1.301
IP R(t + 12, t + 15)			1.218**	2.675	2.670*	2.585
IP R(t + 15, t + 18)					1.938*	2.591
IP R(t + 18, t + 21)					1.826*	2.062
IP R(t + 21, t + 24)					2.128**	2.699
$\bar{R}^2$	0.033		0.129		0.356	
S.E.	5.434		10.061		19.680	
F-Value	3.982		4.473		8.873	
P-Value	0.004		0.001		0.000	
Sample [B]: January 1970 – December 1984						
Constant	-0.189	-0.512	-0.600	-0.562	-2.757	-0.694
IP R(t, t + 3)	0.043	0.207	-0.668	-1.288	-0.033	-0.022
IP R(t + 3, t + 6)	0.573**	3.094	2.267**	4.591	1.529	1.348
IP R(t + 6, t + 9)	0.050	0.304	0.415	0.762	2.130	1.625
IP R(t + 9, t + 12)	0.193	1.381	-0.301	-0.530	2.145	1.181
IP R(t + 12, t + 15)			1.139	1.750	3.638*	2.460
IP R(t + 15, t + 18)					1.767	1.759
IP R(t + 18, t + 21)					0.298	0.225
IP R(t + 21, t + 24)					1.369	1.270
$\bar{R}^2$	0.101		0.329		0.498	
S.E.	4.522		8.094		17.295	
F-Value	6.031		6.796		7.946	
P-Value	0.000		0.000		0.000	
Sample [C]: January 1985 – June 2000						
Constant	0.332	0.688	0.472	0.346	-0.395	-0.101
IP R(t, t + 3)	-0.084	-0.372	0.090	0.151	1.123	0.871
IP R(t + 3, t + 6)	0.081	0.367	-0.100	-0.135	1.278	0.891
IP R(t + 6, t + 9)	0.150	0.646	0.299	0.501	0.311	0.233
IP R(t + 9, t + 12)	0.257	0.959	0.931	1.282	-0.366	-0.336
IP R(t + 12, t + 15)			1.366	1.863	1.182	0.789
IP R(t + 15, t + 18)					2.747	1.837
IP R(t + 18, t + 21)					4.705**	2.816
IP R(t + 21, t + 24)					4.050*	2.531
$\bar{R}^2$	-0.010		0.006		0.297	
S.E.	6.251		11.682		20.678	
F-Value	0.549		1.067		4.012	
P-Value	0.700		0.389		0.001	

Note: R(t, t + T) is the monthly (T = 1), quarterly (T = 3), or annual (T = 12) real stock return from t to t + T. IP(t + k, t + k + 3) is the growth rate of seasonally adjusted industrial production for the quarter from t + k to t + k + 3. t-values are calculated using the Newey-West HAC standard errors and covariance. S.E. is the standard error of the regression does not Granger cause the monthly industrial production growth rate in the first regression and that the monthly industrial production growth rate does not Granger cause the monthly real stock return in the second regression. That is,

$$H_0: \beta_1 = \beta_2 = \ldots = \beta_{12} = 0.$$

Tables 8a and 8b provide the test results for the U.S. and Japan, respectively. For the U.S., we reject the null hypothesis that real stock returns do not Granger cause industrial production growth rates for samples [A] and [B], but not for sample [C]. This is consistent with the results in Table 2. Furthermore, we reject the null hypothesis that industrial production growth rates do not Granger cause real stock returns for samples [A] and [B], but not for sample [C]. These results indicate that the relationship between U.S. stock returns and production growth rates became less significant in the more recent sample.

For Japan, we reject the null hypothesis that real stock returns do not Granger cause industrial production growth rates for sample [B], but not for sample [C]. The P-value for the combined dataset, sample [A], is 0.087. This is consistent with the results in Table 3. We cannot reject the null hypothesis that industrial production growth rates do not Granger cause real stock returns for any of the samples. These results may indicate that the relationship between stock return and production growth is less significant in Japan.

Table 8—Granger Causality Test

Null Hypothesis	Test Statistic	P-Value
Panel A: U.S.		
Sample [A]: January 1970 – June 2000		
R does not Granger cause IP	2.632	0.002
IP does not Granger cause R	1.838	0.041
Sample [B]: January 1970 – December 1984		
R does not Granger cause IP	2.585	0.003
IP does not Granger cause R	2.335	0.009
Sample [C]: January 1985 – June 2000		
R does not Granger cause IP	1.156	0.319
IP does not Granger cause R	0.375	0.971
Panel B: Japan		
Sample [A]: January 1970 – June 2000		
R does not Granger cause IP	1.609	0.087
IP does not Granger cause R	1.046	0.406
Sample [B]: January 1970 – December 1984		
R does not Granger cause IP	2.151	0.017
IP does not Granger cause R	1.346	0.199
Sample [C]: January 1985 – June 2000		
R does not Granger cause IP	0.772	0.678
IP does not Granger cause R	0.775	0.675

Note: R is the monthly real stock return. IP is the monthly industrial production growth rate

Conclusions

Stock markets are seen as the pulse of worldwide economies and the purse for large volumes of wealth. As equity values increase in their importance to the average citizen's financial state, their predictive power over real variables such as capital accumulation and productivity growth may be waning. Regressions of U.S. stock returns on measures of real activity from 1970 to 2000 seem to confirm the findings of Fama (1990), which are based on data from 1953 to 1987. The implications of Fama's model, however, appear not to hold across time or cultures.

Regressions of current monthly production growth rates on past monthly stock returns exhibit inferior explanatory power for Japan relative to the U.S. for each of the sample periods. Regressions of monthly, quarterly, and annual production growth rates on contemporaneous and one-year lags of quarterly real stocks returns suggest a better fit for the U.S. when monthly production growth rates are the explained variable and a better fit for Japan when annual production growth rates are the explained variable. Regressions of monthly, quarterly, and annual real stock returns on contemporaneous and one-year leads of quarterly production growth yield similarly mixed results in cross-country comparisons. In general, we find that stock return variation can explain real activity better in the medium and long term than in the short term, and that this tendency is much stronger in Japan than in the United States.

The article presents evidence of a breakdown in the relationship between stock returns and future real activity in the period since 1985 in both the United States and Japan. The adjusted coefficient of determination falls considerably for each set of regressions and each country when the 1970-1984 dataset is replaced with the 1985-2000 dataset. Furthermore, the results of F-tests suggest that the regression model performs well with data from the earlier period, but not with data from the later period. These findings, supported by a Granger causality test, suggest that stock returns do not always contain significant information about future real activity. In a related study, Choi, Huser, and Kopecky (1999) conclude that the Fama-Schwert relationship holds true for the G-7 countries. Our results, however, suggest that the Fama-Schwert findings do not hold true for recent data from either the United States or Japan.[5]

The significant correlation between stock returns and the real economy in both the U.S. and Japan that appears in 1970-1984 data but not in 1985-2000 numbers may signify the development of stock market bubbles, fads, and related persistent phenomena influencing the stock markets during the latter period. Stock prices fell sharply in 2001 as the economic slowdown became apparent, and consensus grew

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[5] These results do not depend on the outlying influence of the 1987 stock market crash. Binswanger (2000) finds that regressions using a post-crash 1989-1997 sample also fail to suggest a significant relationship between stock returns and real activity.

that the U.S. had experienced a bubble. If such an economic slowdown is cyclical, conventional fiscal and monetary policy instruments may provide sufficient remedies. If a structural recession occurs in the U.S. or elsewhere, it will be important to deal swiftly with the after effects of an antecedent bubble by implementing flexible policy instruments in the early stages after the bubble bursts and by reorganizing industrial sectors damaged by the collapse. One lesson from Japan is that policy responses must take into account the prospective independence of asset prices and expected future real activity as identified here. The specifics of optimal policies are left to further research.

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Appendix

Industrial Production Index:

Industrial production index is obtained from the International Financial Statistics of International Monetary Fund.

Japan: 15866..IZF.

the USA: 11166..IZF...

Stock Returns:

Nominal stock return is obtained from the Morgan Stanley Capital International Index.

Consumer Price Index:

Consumer price index is obtained from the International Financial Statistics of International Monetary Fund.

Japan: 15864..ZF

the USA: 11164..ZF