Understanding Correlations between Stock Returns and Bond Returns based on Income and Substitution Effects: International Evidence

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Abstract

We attempt to better understand varying correlations between stock and bond returns across countries and over sample periods using international data. The observation is that there are two forces that affect the correlation between stock and bond returns. The force that drives a positive correlation is identified as the income effect. The force that drives a negative correlation is identified as the substitution effect. In combination, the two effects help determine the actual correlation between stock and bond returns. We contribute to the literature by proposing an empirical method to identify the two -- income and substitution -- effects and to measure the relative importance of the two effects that determine the actual net relation between the two asset returns. As a result, we show that the income and substitution effects can explain not only diverse correlations across countries but also different correlations over time for countries. We further provide some evidence that the income and substitution effects are related to, among other things, the size of the financial market, the growth of the economy, and the business cycle over time. In addition, the framework of the income and substitution effects helps us better understand the automatic stabilizing effects of the dynamic optimal asset allocation during business cycles.

JEL Classification : G12, G15
Keywords : VAR, Asset allocation, Asset returns correlation
1. Introduction

In this paper, we attempt to understand the correlation between the two most important financial asset returns: stock returns and bond returns. Many economists tend to believe that the prices of bonds and other assets should covary closely with stock prices because the prices of these assets are driven by a common underlying discount factor. However, bond markets may serve as a hedge during periods of stock market declines. In investments class, we regularly teach the capital allocation problem that deals with an optimal allocation between an optimal risky portfolio and risk-free assets and the asset allocation among risky assets such as stocks and bonds. In the asset allocation, the efficient frontier depends on correlations between returns on assets such as stocks and bonds. As such, understanding correlations between stock returns and bond returns is important not only for the potential comovements of various asset returns but also for portfolio construction. While the literature contributes to our understanding of the relation between stock returns and bond returns (e.g., Campbell and Ammer (1993), Bekaert and Grenadier (2001), and Mamaysky (2002)), several issues still remain to be explored. In this paper we address the issue of different correlation across countries and over time.

On a most basic level, one can ask about the correlation between the two types of asset returns. Table 1 provides correlation coefficients for stock and bond returns for Canada, Germany, Japan, the U.K., and the U.S.A. using monthly frequency data (Panel A) and quarterly frequency data (Panel B). [For details, see section 4] A casual look at Table 1 indicates that correlations between stock returns and bond returns are qualitatively as well as quantitatively different across countries and over time. For example, in Panel A, for the sample period of 1986 – 1999, the U.K., the U.S., Canada, and Japan show positive correlations of 0.355, 0.298, 0.131, and 0.019, respectively, whereas Germany exhibits a negative correlation of –0.121. The correlations seem quite stable over time in that they maintain values with the same sign for sub-sample periods. However, it is noted that in Japan and Germany, the correlations for two sub-sample periods are substantially different. For the sub-sample periods of 1986-1992 and 1993-1999, the correlations for Japan are 0.177 and –0.289, while those for Germany are –0.567 and 0.057, respectively.

How do we understand these different correlations across countries and over time? We address this important issue in this paper. We observe that there are two economic/financial forces
that drive the correlation: income (or wealth) effect and substitution effect. The income effect is defined as the economic forces that yield a positive correlation, and the substitution effect as the economic forces that result in a negative correlation. For example, changes in the level of economic activity (e.g., a larger investment fund flow and increased demand for both assets during a boom period) may affect the values of stocks and bonds in the same direction, resulting in a positive relation between stock returns and bond returns. We capture this as an income (or wealth) effect. On the other hand, uncertainty about economic activity may have an opposite effect on the values of stocks and bonds, resulting in a negative relation between stock returns and bond returns. We capture this as a substitution effect.\(^1\)

The actual correlation between the two asset returns is determined by the relative importance of the two effects. If the income effect is relatively more important than the substitution effect, we are likely to observe a positive correlation. Otherwise, we observe a negative correlation. The question remains how to identify the two effects and to measure the relative importance of each effect. We propose and implement an empirical method that addresses these issues.

The rest of the paper is organized as follows. In section 2, we provide a brief review of related literature and discuss various factors that affect the correlation between the two types of asset returns in various asset pricing models. In section 3, we propose a bivariate framework of stock returns and bond returns that identifies income effect and substitution effect. In section 4, we describe the data used in the empirical analyses. In section 5, we discuss the results of the empirical identification and relative importance of the two effects for each country. In section 6, we further discuss empirical evidence on some factors that affect the two effects and potential extension of our empirical model. We conclude in section 7.

2. Related literature and examples of asset pricing models

Regarding the relations between asset returns, some early studies in the 1960s and 1970s have tried to understand the portfolio selection and asset choice problem within the framework of traditional demand theory when the objects of choice are assets. As a result, they derive a variety of Slutsky equations for assets. For example, Bierwag and Grove (1968) separate the effects of

\(^1\) See section 2 for more details, where we provide several asset pricing models to illustrate various factors that drive the correlation between stock returns and bond returns.
changes in mean and variance into wealth and substitution effects. Sandmo (1969) presents Slutsky equations where there is one risky and one safe asset [see also Sandmo (1970)]. Fischer (1972) examines the effects on demands for assets of, for example, changes in the rates of return on assets and the variability of returns and derive equations that can be regarded as Slutsky equations in that wealth and substitution effects can be isolated.²

More recent studies tend to take an intertemporal general equilibrium asset pricing model approach.³ Shiller and Beltratti (1992) examine the relations between changes in stock prices and changes in long-term bond yields. In particular, they are interested in knowing whether the observed relation is correct in the context of rational expectations present value models that base discount factors on market interest rates. They begin their paper by acknowledging that there has long been confusion about the answers to this question. They conclude that there generally should be a slight negative correlation between changes in real stock prices and changes in long-term interest rates.⁴ This is interpreted as suggesting a slight positive correlation between real stock returns and long-term bond returns, which is observed in the U.S., the U.K., and Canada. However, their argument appears to be at odds with a negative correlation between stock returns and bond returns observed in Japan and Germany.

Campbell, Chan, and Viceira (2003) develop an approximate solution method for the optimal consumption and portfolio choice problem of investors who face a set of asset returns described by a vector autoregression in returns and state variables [See also Brennan, Schwartz, and Lagnado (1997)]. Although they do not pursue the income and substitution effects in understanding the correlation between stock and bond returns, they note a positive correlation of bond and stock returns in the quarterly data and interpret this as meaning that positive hedging demand for stocks tends to produce negative hedging demand for bonds in the data.

² According to the mutual-fund separation theorem, a building block of the most basic Capital Asset Pricing Model (CAPM), more risk-averse investors should hold more of their portfolios in the riskless asset. The composition of an optimal risky portfolio, however, should be the same for all investors regardless of their risk preferences. Many advisors recommend that more risk-averse investors should hold a higher ratio of bonds to stocks. This advice contradicts the conclusion that all investors should hold risky assets in the same proportion. Canner, Mankiw, and Weil (1997) question this theorem by pointing out that popular financial advisors appear not to follow the mutual-fund separation theorem. This theorem may have some implications for asset allocation, but it concerns only cross-sectional investors. It is not about the time-series relationship (e.g., correlation over time) between the two assets.
³ See, for example, Campbell (1986), Barsky (1989), Kazemi (1992), Shiller and Beltratti (1992), Bakshi and Chen (1996, 1997), Campbell, Chan, and Viceira (2003), and Campbell, Chacko, Rodriguez and Viceira (2002).
⁴ Kwan (1996) examines the correlation between the returns on stocks and the yield changes of bonds at the firm level, and finds a negative correlation between them.
In the remainder of this section, we present four examples of asset pricing models that illustrate several factors that drive correlation between stock and bond returns. Some factors promote a positive correlation between stock and bond returns, while other factors promote a negative correlation. We draw examples on a Lucas (1978) type exchange economy (Bakshi and Chen (1997), Abel (1988) and Barsky (1989)), and a log-linear approximation asset pricing framework (Campbell and Ammer (1993)), and an affine asset pricing model (Bekaert and Grenadier (2001), Mamaysky (2002) and Li (2002)). These models show how offsetting economic factors interact to determine the correlation of stock and bond returns. While we do not conduct a direct test of the models, these models provide useful intuitions, which broadly support and help understand our empirical framework of the income and substitution effects.

2.1 Multi-period models of Lucas type economy (Bakshi and Chen (1997), and Abel (1988))

The innovative approach in Bakshi and Chen (1997) circumvents the difficulty of dealing with the non-linear Bellman equation in previous models (e.g., Cox et al. (1985)). Bakshi and Chen’s model allows for both power utility and exponential utility functions, and generates a richer set of results (Bakshi and Chen (1996, 2005)). Consider a continuous-time exchange economy of the Lucas type in Bakshi and Chen (1997). In this economy with a single perishable good, there are a market-wide state variable X(t) and an unsystematic state variable Z_n(t) for firm n, each following a mean-reverting square-root process. There are N firms in the economy. Each firm issues one share of stock. The owner of the stock is entitled to receive the dividend. The dividend for firm n, D_n(t), is proportional to an exponential function of X(t) and Z_n(t), where the proportion is linear in both X(t) and Z_n(t). An aggregate output is denoted by q(t), and dq(t)/q(t) follows a square root process. A representative agent with a power utility function maximizes her utility of consumption over infinite horizon. Market clearing requires that aggregate consumption is equal to aggregate output.

Bakshi and Chen (1997) show that rate of return on the τ-period bond that pays one unit of consumption good at the end of time τ and rate of return on a share of stock are given by

\[
\frac{dB(t,\tau)}{B(t,\tau)} = \left[ R(t) - \lambda_x \xi_x(\tau)X(t) \right] dt - \sigma_x \xi_x(\tau) \sqrt{X(t)} d\omega_x(t),
\]  

(1)
\[
\frac{dS(t)}{S(t)} = \mu_s(t)dt + \Gamma_x \sigma_x \sqrt{X(t)} d\omega_x(t) + \Gamma_x \sigma_x \sqrt{Z(t)} d\omega_z(t),
\]

where \( B(t, \tau) \) is the price of a pure-discount bond paying one unit of consumption good in \( \tau \) periods, \( S(t) \) is the price of a share of stock for firm \( n \), \( R(t) \) represents the instantaneous interest rate. \( \lambda_x, \kappa_x, \Gamma_x, \sigma_s, \sigma_z \) are constants, \( \mu_s(t) \) is a drift term defined in Bakshi and Chen (1997) and \( \omega_x(t) \) and \( \omega_z(t) \) are independent Brownian motion processes.

From (1) and (2), the correlation between the bond and stock returns is given by

\[
\text{correl} \left[ \frac{dB(t, \tau)}{B(t, \tau)} \frac{dS(t)}{S(t)} \right] = -\frac{\Gamma_x \sigma_x \sqrt{X(t)}}{\text{std}[dS(t)/S(t)]},
\]

where \( \text{std}[dS(t)/S(t)] \) represents standard deviation of instantaneous stock returns. From (2), it is easy to see that \( \text{std}[dS(t)/S(t)] \) depends on both systematic and unsystematic state variables. This is one of attractive features of Bakshi and Chen approach (1996, 1997 and 2005), which is consistent with considerable empirical evidence (Bates (1996) and Wiggins (1987)) that the volatility of individual stock returns are stochastic and highly correlated with the market-wide volatility. According to equation (3), correlation between stock and bond returns depends on both systematic and unsystematic state variables, and constant coefficients of the processes for state variables and dividend payment. Observe in equation (3) that the sign of the correlation depends on the sign of \( \Gamma_x \), which represents the sensitivity of firm \( n \)’s dividend to market-wide risk.

We now consider a special case that will allow for a comparative static result. First, we consider the price of the market portfolio, whereas the analysis so far is focused on the stock price of an individual firm. The market portfolio is a claim to aggregate output of the economy. The price of the market portfolio should be consistent with the stock price of individual firms. The aggregate output process is given by,

\[
dq(t)/q(t) = [\mu_q + \beta_x X(t)] dt + \sigma_{q,x} \sqrt{X(t)} d\omega_x.
\]

Given equation (4), the price of the market portfolio, \( S^*(t) \), is given by: \( S^*(t) = q(t)/h(X(t)) \), where \( h(X(t)) \), a complex function of \( X(t) \), is the dividend yield for the market portfolio. Since it is hard
to obtain an analytically tractable solution, we consider a special case where $X(t)$ is a constant for each $t$. In this case, $q(t)$ becomes a geometric Brownian motion. The price of the market portfolio also becomes a Brownian motion, i.e.,

$$S^*(t) = q(t)/h(X(t)),$$

(5)

where $h(X(t)) = \rho + (\gamma-1)\mu_q + (\gamma-1)(\beta_x - \gamma\sigma^2_{q,x}/2)$, $\rho$ is the time preference parameter, and $\gamma$ is the constant relative risk aversion parameter.

Secondly, we consider the instantaneous risk-free interest rate, instead of the returns on the $\tau$-period bond. The instantaneous rate, $R(t)$, is given by,

$$R(t) = \rho + \gamma[\mu_q + \beta_x X(t)] - \gamma(1+\gamma)\sigma^2_{q,x}X(t)/2.$$  

(6)

From equations (4)-(6), we have the following result:

$$\frac{\partial R(t)}{\partial \mu_q} > 0; \quad \frac{\partial \left( \frac{dS^*(t)}{S^*(t)} \right)}{\partial \mu_q} > 0,$$

(7a)

$$\frac{\partial R(t)}{\partial \sigma_{q,x}} < 0; \quad \frac{\partial \left( \frac{dS^*(t)}{S^*(t)} \right)}{\partial \sigma_{q,x}} > 0.$$  

(7b)

Observe from equation (7) that a change in mean dividend moves the stock returns and bond returns in the same direction, while a change in mean dividend risk moves the stock returns and bond returns in the opposite direction. Equation (7) provides a theoretical support for the statement in the Introduction that increased demand during a boom period may result in a positive relation between stock returns and bond returns, while uncertainty about economic activity may result in a negative relation.

We obtain a similar result from Abel (1988) who considers a discrete-time model of the Lucas economy. The representative agent has a power utility function. The dividend is assumed to follow a log normal distribution. The mean and standard deviation of the dividend next period are stochastic. After specifying how the mean and standard deviation of the dividend next period
are evolving over time, Abel solves for the equilibrium price function (his equation (15)). In this economy, \( R_{t+1}^F \), the gross rate of return on a one-period risk-free real discount bond is given by

\[
R_{t+1}^F = \beta^{-1} \mu_t^{\gamma} y_t^{-\gamma} (1 + \nu_t^2)^{-\gamma(\gamma+1)/2},
\]

where \( \beta \) is a positive discount rate for the utility of future consumption, \( y_t \) the aggregate output paid during period \( t \), \( \mu_t \) the conditional mean of the aggregate output to be paid during period \( t+1 \), and \( \nu_t^2 \) conditional coefficient of variation, i.e., \( \nu_t^2 \equiv \text{var}(y_{t+1})/\mu_t^2 \). The conditional expected gross rate of return on stocks is given by

\[
E_t (R_t+1) = \left[ \beta^{-1} \mu_t^{\gamma} \theta_t + (1 - \theta_t^2) \mu_t /P_t^* \right] y_t^{-\gamma},
\]

where \( \theta_t \equiv (1 + \nu_t^2)^{(\gamma-1)/2} \) and \( P_t^* \equiv a + b\omega_t\theta_t + d\omega_t + e\theta_t \) with \( a, b, d, e \) being constants defined in Abel (his equations (18a)-(18d)) and \( \omega_t \equiv \mu_t^{1-\gamma} \).

From (8) and (9), it is straightforward to see that

\[
\frac{\partial R_{t+1}^F}{\partial \mu_t} > 0; \quad \frac{\partial E_t R_{t+1}}{\partial \mu_t} > 0, \quad (10a)
\]

\[
\frac{\partial R_{t+1}^F}{\partial \nu_t^2} < 0; \quad \frac{\partial E_t R_{t+1}}{\partial \nu_t^2} > 0, \quad \text{for } \gamma > 1, \text{ and } 2\beta g > 1. \quad (10b)
\]

where \( g \) is the probability that both \( \omega_t \) and \( \theta_t \) do not change from their realized values in previous period. Equation (10) confirms the result from equation (7) that a change in mean dividend moves the stock and bond returns in the same direction, while a change in mean dividend risk moves the stock and bond returns in the opposite direction.

### 2.2 A model of Lucas exchange economy (Barsky, 1989)

Barsky (1989) explores the possible roles of changes in risk and productivity growth for the behavior of bond and stock prices in a simple two-period, two-asset (equity and risk-free bond) model of the general equilibrium asset pricing model. His model is the stochastic version of the
neoclassical theory of an endowment economy of the type studied by Robert Lucas (1978) and Campbell (1986). Barsky (1989) shows that there are two equilibrium forces, the income and substitution effects, which drive the correlation between the returns on stock and bond.

From the first order condition and market clearing condition of his model, Barsky (1989) derives returns on risk-free bond and equity as,

\[ R_f = \frac{1}{P^b} = \frac{U'(Y_1)}{\beta E[U'(\hat{Y}_2)]}, \]  
\[ E[\tilde{R}] = \frac{E[\hat{Y}_2]}{P^q} = \frac{U'(Y_1)E[\hat{Y}_2]}{\beta E[U'(\hat{Y}_2) \hat{Y}_2]} . \]

where \( Y_1 \) is first-period output, \( \hat{Y}_2 \) is the stochastic second-period output, \( P^b \) is the price of a riskless bond, \( P^q \) is the price of an equity, \( \tilde{R} \) is one plus the random rate of return on equity, and \( R_f \) is one plus the real risk-free rate.

Barsky then considers the effect of an increasing risk on \( R_f \) and \( E[\tilde{R}] \) using a mean-preserving spread in \( \hat{Y}_2 \) as a measure of the increasing risk. Specifically, he parameterizes the risk as multiplicative of the form \( (1 + h \eta) \), i.e., \( \hat{Y}_2 = \bar{Y}_2 (1 + h \eta) \) with \( E[\hat{Y}_2] = \bar{Y}_2 \), where \( \eta \) is a zero-mean random variable, \( h \) is a scale parameter, and \( (1 + h \eta) \) is nonnegative.

Differentiating with respect to \( h \) yields:

\[ \frac{dR_f}{dh} = -R_f \bar{Y}_2 \frac{U''(\hat{Y}_2) \eta}{E[U'(\hat{Y}_2)]}, \]  
\[ \frac{dE[\tilde{R}]}{dh} = -\frac{E[\tilde{R}] \bar{Y}_2 E[U'(\hat{Y}_2) \eta]}{E[U'(\hat{Y}_2) \hat{Y}_2]} - \frac{E[\tilde{R}] \bar{Y}_2 E[U''(\hat{Y}_2) \hat{Y}_2 \eta]}{E[U'(\hat{Y}_2) \hat{Y}_2]} . \]

Equation (13) implies that a sufficient condition for increasing aggregate risk to lower the riskless rate is that the sign of \( E[U''(\hat{Y}_2) \eta] \) be positive. Since the sign of \( E[U''(\hat{Y}_2) \eta] \) is that of \( U''(.) \), the condition implies that marginal utility be convex in consumption, which is exactly the condition for the existence of a precautionary demand for saving [Leland (1968)]. That is, in the

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Barsky also considers the effect of a reduction in income (output) on asset prices. The result is that an increase in risk and a reduction in income have strikingly symmetrical effects on asset prices.
presence of the precautionary demand for saving, increasing aggregate risk leads to lowering the riskless rate.

Unlike the case of riskless bonds, the effect of increased equity risk on required stock returns and equity values is ambiguous. The first term in (14) corresponds to the substitution effect in Sandmo (1970) and is positive by risk aversion alone. Increased risk associated with the capital asset exerts pressure toward greater first-period consumption in order to sidestep the risk, and a corresponding fall in the demand for equities. Since the representative consumer must in equilibrium hold his share of the fixed stock of capital, this tends to raise required returns.

The second term is negative under decreasing absolute risk aversion, which reflects a precautionary saving effect [see Sandmo (1970)]. Increased risk raises the prospect of very low consumption in the second period, increasing asset demands and exerting downward pressure on required returns. In general, either effect can dominate, and thus an increase in rate-of-return uncertainty can result in either a rise or fall in the required return to equity. However, if the substitution effect dominates as a result of an increased risk, the analysis implies that equity price and bond price will move in the opposite direction.6

Barsky also considers the effect of an increasing income or output on $R_f$ and $E[\tilde{R}]$. In his framework, an increase in the growth rate in output would be associated with a higher real rate of return on both bonds and stocks. Barsky (1989) extends his simple model where the stock market represents all of the assets in the economy to the case with two risky assets (corporate equities comprise only a fraction of total wealth). Let $\tilde{Y}_2^1$ represent the second-period payoff from stocks, while $\tilde{Y}_2^2$ represents the return from all other assets in the economy. He shows that the ratio $\tilde{Y}_2^1 / (\tilde{Y}_2^1 + \tilde{Y}_2^2)$, which can be thought of as the share of the corporate sector in total wealth, plays an important role in understanding the effects of an increase in risk and in expected future dividends (or output) on stock prices. That is, his argument shows the role of the share of the corporate sector in total wealth in understanding the comovement in the two asset returns.

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6 Barsky (1989) extends the above model to show the differential role of risk aversion and intertemporal substitution. The riskless rate again falls unambiguously as risk increases. The equity premium depends on risk aversion alone because the equity premium is well defined even in a model without intertemporal choice. Whether the required return on equity falls or rises with increasing risk depends only on whether the intertemporal substitution parameter is greater or less than unity. The risk aversion parameter helps determine the magnitude of the effect (in either direction) but has no bearing on the sign.
2.3 Log-linear asset pricing framework (Campbell and Ammer, 1993)

Campbell and Ammer (1993) use a log-linear approximation framework and a vector autoregressive (VAR) approach to break the returns on stock and bond into components associated with news about future cash flows and discount rates. They use their VAR forecasts to examine the ex-post variability and co-movements of stock and bond returns.

Campbell and Ammer express the unexpected excess stock returns in period $t+1$ as a function of changes in rational expectations of future dividend growth, future real interest rates, and future excess stock returns, based on the log-linear approximation framework of Campbell and Shiller (1988) and Campbell (1991). The equation for excess stock return is

$$e_{t+1} - E_t e_{t+1} = (E_{t+1} - E_t) \left\{ \sum_{j=0}^{\infty} \rho^j \Delta d_{t+1+j} - \sum_{j=0}^{\infty} \rho^j r_{t+1+j} - \sum_{j=1}^{\infty} \rho^j e_{t+1+j} \right\}. \quad (15)$$

Here, $e_{t+1}$ denotes the log excess return on a stock held from the end of period $t$ to the end of period $t+1$, relative to the risk-free rate; $d_{t+1}$ the log real dividend paid during period $t+1$; $r_{t+1}$ the log real interest rate from $t$ to $t+1$; $E_t$ an expectation as of the end of period $t$, conditional on an information set; $\Delta$ a one-period backward difference; $\rho$ a number little smaller than one.

Let $x_{n,t+1}$ to be the log excess one-period return on an $n$-period zero-coupon bond held from period $t$ to $t+1$, and $\pi_{t+1}$ to be the log one-period inflation rate from $t$ to $t+1$. Then the equation for excess bond return is

$$x_{n,t+1} - E_t x_{n,t+1} = (E_{t+1} - E_t) \left\{ - \sum_{i=1}^{n-1} \pi_{t+i+1} - \sum_{i=1}^{n-1} r_{t+i+1} - \sum_{i=1}^{n-1} x_{n-i,t+1+i} \right\}. \quad (16)$$

Campbell and Ammer use a VAR approach to estimate the unobservable components, and the expectational revisions in (15) and (16). Based on the VAR estimates, they gauge the relative importance of the components in (15) and (16) in explaining the co-movements between stock and bond returns. They show that several offsetting effects determine the co-movements between stock and bond returns. First, changes in real interest rates promote a positive covariance. The real interest rate is the only common component in (15) and (16), and real interest rate affects the discount rates of both assets. Second, there is a strong positive covariance between news about future excess returns on stocks and bonds. These common movements in future expected returns promote a positive covariance. Third, changes in long-run expected inflation promote a negative covariance since increases in long-run expected inflation tend to drive the stock market up and the
bond market down. In summary, the covariance between excess stock and bond returns are determined by the balance between several effects due to changes in the real interest, the expected excess return and the expected long-run inflation.

### 2.4 An affine model of stock and bond returns

Recently Bekaert and Grenadier (2001) and Mamaysky (2002) propose an affine pricing framework to jointly model stock and bond returns. Both models express bond and stock prices as an affine function of a set of state variables. We present below a simplified version of their model, as adopted in Li (2002).

Assume that the real interest rate $r_{t+1}$, inflation rate $\pi_{t+1}$, and the log dividend yield of stock $\delta_{t+1}$ follow the processes given below:

\[
    r_{t+1} = \bar{r} + \rho_r (r_t - \bar{r}) + \sigma_r \varepsilon_{r,t+1},
\]

\[
    \pi_{t+1} = \bar{\pi} + \rho_\pi (\pi_t - \bar{\pi}) + \sigma_\pi \varepsilon_{\pi,t+1},
\]

\[
    \delta_{t+1} = \bar{\delta} + \rho_\delta (\delta_t - \bar{\delta}) + \sigma_\delta \varepsilon_{\delta,t+1}.
\]

Here, $\bar{r}$, $\bar{\pi}$ and $\bar{\delta}$ represent the long-run equilibrium levels of the real interest rate, inflation rate and dividend yield; $\varepsilon_{r,t+1}$, $\varepsilon_{\pi,t+1}$ and $\varepsilon_{\delta,t+1}$ the shocks to these variables; $\rho_r$, $\rho_\pi$ and $\rho_\delta$ the speed of adjustment. We assume that all shocks follow the standard normal distribution.

The model produces a closed-form solution for stock and bond returns. Specifically, one can write the log return of an $n$-period bond as a sum of the real interest rate, term premium, expected inflation plus inflation shocks and interest rate shocks; the log return of stock as a sum of the real interest rate, risk premium, expected inflation plus inflation shocks, interest shocks and dividend yield shocks. The closed-form solution for stock and bond allows us to consider the conditional covariance of stock and bond returns, given as

\[
    \text{cov}_t (R_{n,t+1}^{m}, R_{n,t+1}^{a}) = \ A_{n-1}^c \ a' \sigma_r^2
\]

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7 As Campbell and Ammer note, this positive association between stock returns and the long-run expected inflation is not inconsistent with results in Fama and Schwert (1977) and others. Inflation news in Campbell and Ammer is not the contemporaneous innovation in inflation, but the revision in long-run expectations. This long-run expectation can have a positive correlation with stock returns even if contemporaneous inflation has a weak negative correlation with stock returns.

8 Given homoskedastic shocks in the model, all moments of stock and bond returns, including the covariance, in this model are constant. However, examining the covariance in (20) is sufficient for our purpose, since we are mainly interested in implications of the model for the driving forces of the covariance between stock and bond returns.
Here $V_{ij}$ denotes an element of the covariance matrix of error terms in (17)-(19);

$$A_{n-1}^\pi \equiv \frac{-(1-\rho_{\pi}^{n-1})}{1-\rho_{\pi}}, \quad A_{n-1}^\pi \equiv \frac{-\rho_{\pi}(1-\rho_{\pi}^{n-1})}{1-\rho_{\pi}}, \quad a^r \equiv \frac{-1}{1-\rho_{\pi}}, \quad \text{and} \quad a^\delta \equiv \frac{\rho_{\delta}}{1-\rho_{\delta}}.$$ Under normal conditions that $|\rho_r|<1$ and $|\rho_{\pi}|<1$, the signs of these variables are $A_{n-1}^\pi < 0$, $A_{n-1}^\pi > 0$, $a^r < 0$, and $a^\delta > 0$.

The first term in (20) shows that stock and bond returns tend to move in the same direction as uncertainty about the real interest rate goes up. The positive covariance is due to the fact that the real interest rate affects the discount rate of both stock and bond. The terms in the second line of (20) represent effects of unexpected inflation on nominal bond return, the cash flow of stock, and the discount rate. The first effect is negative, since $A_{n-1}^\pi < 0$, but the effect of the other two terms depends on parameter values of the model. Likewise, the term in the third line has an ambiguous effect. The closed-form solution for bond and stock returns show that expected inflation is a factor common to both bond and stock returns, resulting in a positive covariance. This is the second source of correlation between the stock and bond returns.

Lastly, stock-specific factors promote a negative correlation between stock and bond returns. The stock-specific factors are in the spirit of Mamaysky (2002) who shows that the pricing factors for bond are only a subset of factors for stock. He proposes to consider factors common to stock and bond returns, and a different set of factors unique to stock returns. Specifically, one can write dividend shock as a sum of three shocks: $\varepsilon_{t+1}^\delta = \kappa_{\delta} \varepsilon_{t+1}^{r} + \kappa_{\pi} \varepsilon_{t+1}^\pi + \kappa_{\delta} \varepsilon_{t+1}^u$, where $\varepsilon_{t+1}^u$ is stock-specific shock, independent of the other two shocks. An increase in stock-specific shock will raise the variability of stock returns, and as a result, reduce the correlation between stock and bond returns.

In summary, the model shows that correlation between bond and stocks returns is a result of interaction of several offsetting effects. The uncertainty about the real interest rate and the level of expected inflation generates a positive correlation, and uncertainly about the stock-specific shock generates a negative correlation.
3 Identification based on a bivariate time-series representation

3.1 A bivariate model

In section 2, a brief review of related literature, we find various factors that affect the correlation between the two types of asset returns in various asset pricing models. Here, we discuss how to empirically identify the two forces -- income and substitution effects -- that drive the correlation between stock and bond returns. Consider a 2-by-1 vector $z_t$ consisting of stock returns ($R_t$) and bond returns ($Q_t$): $z_t = [R_t, Q_t]'$. By the Wold theorem, $z_t$ has the following bivariate moving average representation (BMAR):

$$z_t = [R_t, Q_t]' = B(L) \varepsilon_t, \text{ or}$$

$$
\begin{bmatrix}
R_t \\
Q_t
\end{bmatrix} =
\begin{bmatrix}
B_{11}(L) & B_{12}(L) \\
B_{21}(L) & B_{22}(L)
\end{bmatrix}
\begin{bmatrix}
\varepsilon^1_t \\
\varepsilon^2_t
\end{bmatrix},
$$

(21)

(22)

where $R_t =$ stock return; $Q_t =$ bond return; $\varepsilon_t$ is a 2 x 1 vector consisting of $\varepsilon^1_t$ and $\varepsilon^2_t$; $L$ is the lag operator (i.e., $L^nx_t = x_{t-n}$), $B_{ij}(L)$ for $i, j = 1, 2$ is a polynomial in the lag operator $L$ (i.e., $B_{ij}(L) = \sum_{k} b_{ij}^k L^k$ with $\sum_{k} \equiv \sum_{k=0}^{\infty}$), and the innovations are orthonormalized such that $\text{Var}(\varepsilon_t) = I$.

The above representation implies that stock and bond returns are driven by two types of shocks (or disturbances), yet to be identified. Here we want to identify the two shocks as income and substitution shocks, respectively. To achieve this identification, we exploit the relation between the above bivariate moving average representation (BMAR) and its corresponding bivariate vector autoregression (BVAR). This is because the BMAR model (i.e., estimates of $B(L)$) in (22) is derived in practice by inverting a bivariate vector autoregression (BVAR). By estimating the BVAR of $z_t = [R_t, Q_t]'$:

$$z_t = A(L) z_{t-1} + u_t,$$

(23)

where $A(L) = [ A_{ij}(L) ] = [ \sum_{k} a_{ij}^k L^k ]$ for $i, j = 1, 2$, $u_t = [u_{1t}, u_{2t}]' = z_t - E (z_t | z_{t-s}, s > 1)$ with $\text{var}(u_t) = \Omega$, we obtain estimates of $A(L)$ and $\Omega$. Inverting this BVAR of $z_t$ yields a BMAR of $z_t$:

$$z_t = [I - A(L)L]^{-1} u_t,$$

(24)
where \( I \) is the identity matrix of rank 2.

By comparing \( z_t \) in (21) with that in (24), estimates of \( B(L) \) can be obtained by noticing that

\[
B^0 \varepsilon_t = u_t, \tag{25}
\]

and that

\[
z_t = B(L) \varepsilon_t = [I - A(L)L]^{-1} u_t. \tag{26}
\]

Using (25), (26) implies that

\[
B(L) = [I - A(L)L]^{-1} B^0. \tag{27}
\]

To calculate \( B(L) \), we only need an estimate of \( B^0 \) since \( A(L) \) is available from the estimation of BVAR. This can be obtained by taking the variance of each side of (25):

\[
B^0 B^0' = \Omega, \tag{28}
\]

Given an estimate of \( \Omega \), (28) yields three restrictions for the four elements of \( B^0 \): \( b_{11}^0 \), \( b_{12}^0 \), \( b_{21}^0 \), and \( b_{22}^0 \). Therefore, to calculate \( B(L) \) and just-identify the two disturbances as income and substitution disturbances, we need an additional restriction on the coefficients of the BMAR [see Blanchard and Quah (1989)].

### 3.2 An identifying restriction for the substitution effect

As shown in section 3.1, we need an additional restriction to identify the income and substitution disturbances. Here, we identify the substitution effect and its disturbances, which we denote \( \varepsilon_t^S \), by imposing the following restriction: The substitution effect disturbance affects, by definition, stock and bond returns in an opposite manner. In practice, however, we cannot impose a general inequality restriction because it is too broad to be implemented, and the opposite
movement of stock and bond returns need not occur in the same period. As such, we take an alternative, more flexible, approach by assuming that its long-term effect on stock returns is the negative of its long-term effect on bond returns. That is, we identify the substitution disturbance $\varepsilon_t^s$ as having effects on stock returns and bond returns in such a way that the sum of the long-term effects on the two returns over time adds up to zero. As such, the substitution effect here is mainly related to the contemporaneous substitution between competing asset classes. However, given that the substitution effect is measured in a flexible time span (i.e., over time), it is also related to the intertemporal substitution as we discuss in section 2.9 On the other hand, in the absence of such a restriction, the income effect disturbance, $\varepsilon_t^y$, is allowed to affect both returns in the same direction.10

Since MAR coefficients $b_{12}^k$ and $b_{22}^k$ measure the effect of the second shock on stock returns ($R_t$) and bond returns ($Q_t$) after $k$ periods, respectively, the above restriction on the substitution disturbance is represented by the restriction that the coefficients in $B_{12}(L)$ and $B_{22}(L)$ add up to zero:

$$\sum_k b_{12}^k + \sum_k b_{22}^k = B_{12}(L)|L=1 + B_{22}(L)|L=1 = B_{12}(1) + B_{22}(1) = 0, \quad (29)$$

where $B_{ij}(L)|L=1 = B_{ij}(1) = \sum_k b_{ij}^k$ represents the cumulative effect of the $j$-th disturbance on the $i$-th variable over time. With this restriction imposed on the BMAR in (21) (or (22)), we now identify the second shock as the substitution shock, $\varepsilon_t^s$, and the remaining shock as the income shock, $\varepsilon_t^y$.

9 The substitution effect here is related both to the contemporaneous substitution between competing asset classes and to the intertemporal substitution. To see this, consider an increase in the dividend risk in a Lucas type economy (e.g., Bakshi and Chen (1997) and Abel (1988)). This change in dividend risk will have a direct impact on the current consumption and savings decision, which includes the allocation of wealth among competing asset classes. However, the change in dividend risk also affects entire path of future consumption and savings policy, which takes the intertemporal substitution into account.

10 The restriction on the substitution disturbance, $\varepsilon_t^s$, may help assure its opposite impact on the two types of returns. The question remains how to guarantee that the income effect disturbance will affect the two types of returns in the same direction. Here, we simply take the position that, in the absence of such a restriction, the income effect disturbance, $\varepsilon_t^y$, is allowed to affect both market returns in the same direction. As such, it seems that there is no stringent restriction that guarantees the effects of the income disturbance. As discussed in the text, the bivariate VAR model is under-identified, requiring only one additional restriction. If we impose an additional restriction on the income effect disturbance, we have an over-identifying restriction, which needs to be tested for its empirical validity. Given this problem, we take the position in this paper that we impose a just-identifying restriction (on the substitution effect disturbance) and see whether the outcome will show that the income effect disturbances affect both returns in the same direction. This can be an informal test of the validity of our restriction. In fact, we confirm that the income...
Given the relation between the MAR coefficients and VAR coefficients in (27), $B(L) = [I - A(L)L]^{-1} B^0$, the restriction on the MAR coefficients in (29) is implemented by imposing the following restriction on the VAR coefficients:

$$[1 - A_{22}(1) + A_{21}(1)] b_{12}^0 + [1 - A_{11}(1) + A_{12}(1)] b_{22}^0 = 0. \quad (30)$$

This provides an additional restriction on the relationship between the BMAR coefficients $b_{12}^0$ and $b_{22}^0$ given estimates of the BVAR, $A_{11}(1), A_{12}(1), A_{21}(1), \text{ and } A_{22}(1)$.

With this additional restriction, we can achieve the just-identification of the bivariate model of $[R_t, Q_t]'$. As a result of imposing this restriction on BMAR in (21) (or (22)), we now obtain the following just-identified BMAR representation:

$$z_t = [R_t, Q_t] = B(L) \epsilon_t, \quad \text{or}$$

$$\begin{bmatrix} R_t \\ Q_t \end{bmatrix} = \begin{bmatrix} B_{11}(L) & B_{12}(L) \\ B_{21}(L) & B_{22}(L) \end{bmatrix} \begin{bmatrix} \epsilon_t^y \\ \epsilon_t^s \end{bmatrix}, \quad (32)$$

where $R_t = \text{stock return}; Q_t = \text{bond return}; \epsilon_t^y = \text{income effect shock}; \epsilon_t^s = \text{substitution effect shock};$ and the innovations are orthonormalized such that $\text{Var}(\epsilon_t) = I$ with $\epsilon_t$ being a 2 x 1 vector consisting of $\epsilon_t^y$ and $\epsilon_t^s$. Now, we can interpret that stock and bond returns are driven by two types of shocks (or disturbances): income and substitution shocks. The time paths of the dynamic effects of income and substitution effects on stock returns and bond returns are implied by the coefficients of the polynomials $B_{ij}(L)$, i.e., $b_{ij}^k$.

### 3.3 A measure of the relative importance of each effect

Since we argue that income effect yields a positive correlation between stock returns and bond returns while substitution effect generates a negative correlation and that the sign of the correlation depends on the relative importance of each effect, we need to establish a measure of effect indeed affects the two returns in the same direction, confirming our conjecture [see Section 5.1]. In addition, the income effect in usual price theory is not necessarily positive (e.g., inferior goods).

\[11\] As an alternative identifying restriction, we may consider a more restrictive one. For example, we may identify the substitution disturbance $\epsilon_t^s$ by assuming that its effect on stock returns is the negative of its effect on bond returns in each period: $b_{12}^0 = - b_{22}^0$. 

Effect indeed affects the two returns in the same direction, confirming our conjecture [see Section 5.1]. In addition, the income effect in usual price theory is not necessarily positive (e.g., inferior goods).
the relative importance of each effect. Such a measure would be based on the fraction of (forecast error) variance in each return explained by each type of disturbance. For example,

\[
Q^r_k = \frac{\sum_k (b_{11}^k)^2}{\sum_k [(b_{11}^k)^2 + (b_{12}^k)^2]} \tag{33}
\]

measures the fraction of the forecast error variance in stock returns explained by income effect disturbance because the MAR coefficient \(b_{1j}^k\) measures the effect of \(\varepsilon^y_t\) (for \(j = 1\)) or \(\varepsilon^s_t\) (for \(j = 2\)) on stock returns in \(k\) periods. Therefore,

\[
Q^r = \frac{\sum_k (b_{11}^k)^2}{\sum_k [(b_{11}^k)^2 + (b_{12}^k)^2]} + \frac{\sum_k (b_{21}^k)^2}{\sum_k [(b_{21}^k)^2 + (b_{22}^k)^2]} \tag{34}
\]

will measure the relative importance of the income effect disturbance that explains variances in stock returns and bond returns. Similarly,

\[
Q^s = \frac{\sum_k (b_{12}^k)^2}{\sum_k [(b_{11}^k)^2 + (b_{12}^k)^2]} + \frac{\sum_k (b_{22}^k)^2}{\sum_k [(b_{21}^k)^2 + (b_{22}^k)^2]} \tag{35}
\]

will measure the relative importance of substitution effect disturbance that explains variances in stock returns and bond returns.\(^{12}\)

As observed in Table 1, correlations between stock returns and bond returns are qualitatively as well as quantitatively different across countries and over time. To explain the diverse correlations, our main observation is that there are two economic/financial forces that drive the correlation: income effect and substitution effect, where the income effect yields a positive correlation, and the substitution effect generates a negative correlation. Using the

We find this restriction too restrictive because under this assumption there is a one-to-one substitution in the two returns in each period without allowing for possible (temporary) parking of investment funds in other assets.\(^{12}\)

As an alternative measure, one may consider

\[
Q^* = \frac{\left[ \sum_k (b_{11}^k)^2 + (b_{21}^k)^2 \right]}{\sum_k [(b_{11}^k)^2 + (b_{12}^k)^2 + (b_{21}^k)^2 + (b_{22}^k)^2]} \]

to measure the relative importance of the income effect disturbance that explains variances in stock returns and bond returns. The problem with such a measure is that it ignores the different size of variance of stock returns and bond returns by mixing the two. For example, although the income effect disturbance explains 40% of variance in stock returns...
measure of relative importance proposed in this section, if the income effect is relatively more important than the substitution effect (i.e., \( Q^y > Q^s \)), we anticipate observing a positive correlation. Otherwise (i.e., \( Q^y < Q^s \)), we expect to observe a negative correlation. We also provide factors (e.g., rates of the growth of the economy and business cycle) affecting the income and substitution effects and thus the correlation between the two asset returns.\(^{13}\)

4 The data

Our data consist of national stock and bond returns for five major developed countries -- the U.S., Japan, the U.K., Germany, and Canada -- and cover the period from December 1985 through December 1999. As a proxy for bond returns for each country, we use the J.P. Morgan Government bond return index, which is one of the most widely-used benchmarks for measuring performance and quantifying risk across international fixed income bond markets.\(^{14}\) The J.P. Morgan Government bond return index is measured in the foreign currency, and it includes both principal returns and interest returns, which are based on price appreciation of the bond and based on the coupon accrual, respectively.\(^{15}\) As a proxy for stock return for each country, we use the Morgan Stanley Capital International (MSCI) national stock total return (capital gains plus dividends) denominated in the foreign currency. Each index is obtained from Datastream. Consumer price indices and quarterly gross domestic products are obtained from the IMF’s

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13 Given that our focus is on empirical identification of the income and substitution effects that may be compatible with various factors in asset pricing models as discussed in section 2, our framework of bivariate structural VAR model seems more flexible and appropriate than the vector GARCH models that specifically focus on mean return and conditional volatility. Should our focus be on the modeling of persistent volatility and on the direct relation between return and volatility without empirical identification of general income and substitution effects, the vector GARCH model would be very useful too.

14 Bonds within a given country’s J.P. Morgan Government Bond Index are divided into three liquidity classifications. Benchmark issues are the most liquid issues, recognized as market indicators. They are usually sizable new issues or recently reopened issues. Active is the next level of liquidity, including all benchmark issues plus other issues with significant daily turnover usually including previous benchmark issues. Traded is the broadest level of liquidity and includes all benchmark and active issues plus any other issues which meet the liquidity criteria set by J.P. Morgan. From communications with staff at Datastream, we find that the J.P. Morgan Government Bond Index data provided by Datastream (and used in this study) are based on the active issues.

15 For consistency, it is important to use bond returns of a similar risk, which is usually measured by the duration of bonds. The average duration of the bonds included in the J.P. Morgan Government Bond Index for each country, which was compiled from the data available from Datastream for the sample period of 1986-1999, is as follows: 5.25
International Financial Statistics. The consumer price index (CPI) inflation rate is subtracted from nominal returns to calculate real returns. As a proxy for stock market capitalization for each country, we use the market capitalization of the Datastream market index.

Table 1 presents correlations between annual stock and bond returns for each country for the sample period of 1986-1999 and two subperiods, 1986-1992 and 1993-1999, using monthly frequency data (Panel A) and quarterly frequency data (Panel B). In computing correlations, we use one year rolling period returns. These returns are obtained by moving a view window of fixed length along time series for two asset classes and computing the cross-correlation between the two asset classes for each window. These view windows are useful for examining how asset class returns vary together for holding periods similar to those actually experienced by investors [see, for example, Ibbotson (1997, p.120)].

We employ a BVAR of stock returns and bond returns with three lags. The lag length is chosen considering both the Akaike (1974) and Schwarz (1978) criteria. Our preliminary findings show that logged stock price and bond price series are not cointegrated, which justifies our use of a bivariate model of their returns.

5. Empirical results and implications
5.1 Dynamic effects of income and substitution effect disturbances

The time paths of the dynamic effects of the two types of disturbances on stock returns and bond returns are implied by the coefficients of the polynomials \( B_{ij}(L) \), i.e., \( b_{ij}^k \) (i.e., the orthonormalized moving average coefficients). The coefficients \( b_{11}^k \) and \( b_{21}^k \) measure the effect of \( \varepsilon_{ty} \) on stock returns (\( R \)) and bond returns (\( Q \)) after \( k \) periods, respectively, and \( b_{12}^k \) and \( b_{22}^k \) measure the effect of \( \varepsilon_{ts} \) on stock returns (\( R \)) and bond returns (\( Q \)) after \( k \) periods, respectively.

Figure 1 depicts the response of U.S. stock returns [Panel A] and bond returns [Panel B] to a one-standard deviation in either income or substitution shocks. The standard errors are computed years for Canada, 5.02 years for Germany, 5.56 years for Japan, 5.88 years for the U.K., and 4.69 years for the U.S.A., respectively.

The Akaike (1974) and Schwarz (1978) criteria provide different lag lengths for each country’s stock and bond return equations. Specifically, for stock return equations, the Akaike criterion chooses lag lengths of 11, 4, 2, 3, and 2, whereas the Schwarz criterion chooses lag lengths of 1, 1, 2, and 2, for Canada, Germany, Japan, the U.K. and the U.S.A., respectively. Similarly, for bond return equations, the Akaike criterion chooses lag lengths of 9, 4, 2, 11, and 9, whereas the Schwarz criterion chooses lag lengths of 1, 2, 1, 1, and 2, for Canada, Germany, Japan, the U.K.
by using a Monte Carlo integration due to Kloek and Van Dijk (1978). The Monte Carlo results are based on 1000 simulations and take into account the identifying restrictions.

Income shocks (——— ) initially have a strong positive effect on both stock returns and bond returns, and the effect increases for a few months; however, the effect begins to decline after one quarter. Substitution shocks (---------) have a strong initial positive effect on stock returns, and the effect declines over time. However, the substitution shocks have strong initial negative effects on bond returns, and the negative effect declines over time. As such, it is observed that the income effect shock has a positive effect on both stock returns and bond returns so that it generates a positive correlation between the two returns. However, the substitution effect shock has a positive effect on stock returns but a negative effect on bond returns so that it drives a negative correlation between the two rates.

Figure 2 illustrates the response of Japanese stock returns [Panel A] and bond returns [Panel B] to a one-standard deviation in either income or substitution shocks. The pattern of dynamic responses of Japanese stock returns and bond returns to the two types of shocks is very similar to that of the U.S.: The income effect shock has a positive effect on both stock returns and bond returns so that it generates a positive correlation between the two returns. However, the substitution effect shock has a positive effect on stock returns but a negative effect on bond returns so that it drives a negative correlation between the two rates.

It is noticed, however, that the initial effects of the income and substitution shocks on U.S. stock returns are 3.9 versus 5.3, whereas those on Japanese stock returns are 4.6 versus 6.9. This shows that the substitution effect is relatively stronger for the Japanese stock market than for the U.S. market, which helps explain why the correlation is close to zero for Japan and positive for the U.S. For Japan, the economy and stock market remained stagnant during most of the 1990s. With lower economic growth and a higher uncertainty about the future of the economy, the substitution effect tends to dominate the income effect, generating a lower correlation between the two asset returns.17

**5.2 The relative importance of income and substitution effect disturbances**

and the U.S.A., respectively. Given differing lag lengths, we choose three lag lengths, considering that it takes into account a quarter period serial correlations.

17 For a more detailed discussion of the Japanese market and factors affecting the two effects, see sections 5.3 and 6.1.
Once we identify income and substitution effect disturbances by imposing the restriction in (29) on the BMAR [or (30) on the BVAR], we can examine the relative importance of each type of disturbance in explaining stock and bond returns. Table 2 summarizes the results for each country. The numbers in parentheses are standard errors, which are computed by using a Monte Carlo integration due to Kloek and Van Dijk (1978). The Monte Carlo results are based on 1000 simulations and take into account the identifying restrictions.

For different correlations between stock and bond returns across countries, we look at the relative importance of the income and substitution effects across countries. In Table 1, for the sample of 1986 – 1999, the U.K., the U.S., Canada, Japan, and Germany show contemporaneous correlations of 0.355, 0.298, 0.131, 0.019, and –0.121, respectively. The relative importance of the income effect \(Q_y\) is 124.5% for the U.K., 120.4% for the U.S., 101.7% for Canada, 94.6% for Japan, and 87.4% for Germany, at the 24-month horizon, respectively. Notice that the ordering of the contemporaneous correlation between stock and bond returns is the same as the ordering of the relative importance of the income effect \(Q_y\). This confirms our claim that the relative importance of the income and substitution effect captures the two forces that drive the correlations between stock and bond returns in each country.

For the U.K., the U.S., and Canada, the income effect is relatively more important than the substitution effect (i.e., \(Q_y > Q_s\)), and thus the correlation is positive. For Japan, whose correlation is close to zero (0.019), the relative importance of the income effect \(Q_y\) is close to 100% (i.e., 94.6% with a standard error of 3.89%). For Germany, whose correlation is negative (–0.121), the relative importance of the income effect \(Q_y\) is lower than 100% (i.e., 87.4%). This is strongly consistent with our observation that the income effect generates a positive correlation and the substitution effect drives a negative correlation, and that the actual correlation is determined by the relative importance of each type of effect.

### 5.3 Structural changes

In Japan, although the correlation for the sample period of 1986-1999 is close to zero (0.019), sub-sample period correlations are substantially different: For the 1986-1992 period, the correlation is positive (0.177), whereas for the 1993-1999 period, the correlation is negative (–0.289). To understand the different correlations between the sub-sample periods, we again
examine the relative importance of the two types of shocks. Panels F and G of Table 2 demonstrate that the income effect was more important than the substitution effect in the first sub-period: the relative importance of the income effect ($Q^y$) is 106.9% while that of the substitution effect ($Q^s$) is 93.1%. However, the income effect was less important than the substitution effect in the second sub-period: the relative importance of the income effect ($Q^y$) is 89.5% while that of the substitution effect ($Q^s$) is 110.5%. Again, this is consistent with our hypothesis. In Japan, the income effect that drives a positive correlation between stock and bond returns was more important in the 1980s so that the correlation was positive, whereas in the 1990s the substitution effect that drives a negative correlation was more important so that the correlation is negative.

6. Further discussions

6.1 Factors affecting the correlations

Economic theory suggests that the relative size of the income effect depends on the size of income and the growth of income. For example, Barsky (1989) shows that the effects of an increase in both risk and output on stock prices may depend on the share of the corporate sector in total wealth, which implies an important role of the share of the corporate sector in total wealth in understanding the comovement in the two asset returns [see section 2.2]. In our context, this can be interpreted as implying that the larger the relative size of the financial market (relative to the size of the economy), the larger the income effect. That is, other things being equal, the larger the relative size of financial market capitalization relative to the size of the economy, the larger the correlation between the two returns. Similarly, the greater the growth of the economy, the larger will be the income effect.

The return spread between stocks and bonds is expected to be lower during the period of recession. Similarly, as Haugen (1997) points out, if the economy is booming or emerging from a recession, efficient portfolios may be more heavily invested in stocks rather than bonds, resulting in a larger premium for stocks. However, if the economy is in recession or is recession-bound, the efficient portfolios are weighted heavily in high-quality bonds, resulting in a lower premium for stocks.

For each country and each period, Table 3 presents the ratio of the market value to GDP in panel A, real GDP growth rate in panel B, and the spread between stock return and bond return in

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18 By definition, $Q^y$ greater than 100% indicates that the income effect is more important than the substitution effect.
Panel C. Panel A of Table 3 presents the relative size of the equity market relative to GDP for each country. It is confirmed that for each country, the subperiod with a larger equity market value has a larger correlation between stock and bond returns. More specifically, all the countries except Japan have a larger equity market value for the 1993-1999 subperiod, when the correlation is larger. For Japan, the 1993-1999 subperiod has a smaller equity market value and a smaller correlation.19

Panel B of Table 3 illustrates the growth rates of real GDP for each country. For Canada, the U.K. and the U.S., the period of 1993-1999 has greater economic growth with a larger correlation. For Japan, the economy and stock market used to grow fast in the 1980s, but they remained stagnant during much of 1990s. As such, the 1993-1999 period has lower economic growth with a lower correlation. It is also noted that Japan, which has the lowest correlation between stock and bond returns, shows the lowest GDP growth rate among the five countries. For Germany, it is hard to compare the GDP growth rates in the two sub-periods due to the German unification process in the sample periods.

Panel C of Table 3 reports the spreads between stock and bond returns for each subsample period. When the Canadian economy grew faster during the 1993-1999 period, the spread is drastically larger than the 1986-1992 period. When the Japanese economy grew faster in the 1986-1992 period, the spread was relatively larger than the 1993-1999 period. When the Japanese economy was mostly in recession during the 1993-1999 period (average GDP growth rate is 0.19%) with a relatively large risk in the economy,20 the spread is even negative, which confirms our conjecture. A similar observation is made for the U.K. and the U.S. in that their economies grew faster and the spread was larger in the 1993-1999 period than in the 1986-1992 period. Our finding suggests that investors tend to demand a larger premium when the economy grows faster.21 Overall, evidence in Table 3 is consistent with our conjecture based on factors affecting income and substitution effects. This finding provides additional empirical evidence in

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19 The Datastream market index of each country does not include all the stocks traded in each national market but consists of a representative sample of stocks for each market. The number of stock components included in each index is as follows: the U.K. 545 firms; Japan, 1000 firms; Germany, 201 firms; Canada, 250 firms; the U.S.A., 989 firms. The lists of component stocks are available from the authors upon request.

20 Although the GDP growth rate in Japan is lower in the second period, its standard deviation is larger in the second period. Specifically, the standard deviation of GDP growth rate is 4.33% and 5.20 % in the first period (1986-1992) and second period (1993-1999), respectively.

21 This is consistent with Kim and Lee (2007), who find strong evidence that the risk premium is substantially larger in the period of boom than in recession.
favor of explaining the correlations between the two returns based on the income and substitution effects.

Understanding the correlations based on the income and substitution effects may have implications on the dynamic optimal asset allocation. When the substitution effect gets stronger, for example in a recession period, with the correlation between stock and bond returns decreasing, the efficient frontier curve that connects the two assets will be more convex. As a result, the capital allocation line will become steeper, and investors can achieve a higher level of utility assuming that expected returns and risk of stocks and bonds remain not significantly changed. Similarly, when the income effect gets stronger during a booming period, the capital allocation line will become flatter, and investors may achieve a lower level of utility. Presumably, asset returns and risks will change during business cycles. That is, the framework of the income/substitution effects helps us understand the offsetting (i.e., automatic stabilizing) effects of the dynamic optimal asset allocation during business cycles.

6.2 The role of inflation: Real versus nominal returns

The relation between asset (e.g., stocks and bonds) returns and inflation has been debated for a long time. In particular, Bakshi and Chen (1996) and Hess and Lee (1999) show that inflation, which can be partially non-monetary, can have varying effect on asset returns. In section 2.3, we have observed, based on a model of Campbell and Ammer (1993), that changes in long-run expected inflation promote a negative covariance since increases in long-run expected inflation tend to drive the stock market up and the bond market down.

In our analyses, we have used real returns for stocks and bonds. However, it is quite possible that inflation may incur some wedge for the correlations between real and nominal returns as pointed out by Bakshi and Chen (1996) and Hess and Lee (1999). As such, we recalculate the correlations between stock and bond returns using nominal returns. The results are presented in Panels C and D of Table 1. In Panel C, for the sample period of 1986 – 1999, correlations of nominal bond and stock returns for the U.K., the U.S., Canada, Japan, and Germany are 0.257, 0.196, 0.071, -0.088, and -0.092, whereas those of real returns are 0.355, 0.298, 0.131, 0.019, and -0.121, respectively. Again, the correlations seem quite stable over time.
in that they maintain values with the same sign for sub-sample periods. However, it is noted that in Japan and Germany, the correlations using nominal returns for two sub-sample periods are substantially different. For the sub-sample periods of 1986-1992 and 1993-1999, the correlations using nominal returns for Japan are 0.028 and –0.303, while those for Germany are –0.374 and 0.018, whereas the correlations using real returns for Japan are 0.177 and –0.289, while those for Germany are –0.567 and 0.057, respectively. Overall, we find a pattern of correlations for nominal stock and bond returns, which is very similar to that for real stock and bond returns so that our analyses based on the relative importance of the income and substitution effects should hold for nominal return correlations as well.

6.3 Extension to integrated international markets

Several studies have shown that international capital markets become more integrated, resulting in an increase in international stock market correlations and a decrease in the potential gains from international diversification [e.g., Finnerty and Schneeweis (1979), Cochran and Mansur (1991), Kasa (1992), Longin and Solnik (1995), Eun, Janakiramanan, and Senbet (2002), Goetzmann, Li, and Rouwenhorst (2005), and Eun, Huang, and Lai (2007)]. These studies are mainly concerned with the potential comovements among international capital markets, either stock markets or bond markets. In this paper, our focus is on the correlation between stock and bond market returns in each country. Further, since we find that the two market indices are not cointegrated, we do not introduce a cointegration term in our bivariate model.

However, the cointegrated markets may have some implications for our analyses. When we look into contemporaneous correlations between stock returns of each pair of countries, we find that they are positive and are relatively large although their magnitudes vary across countries. And, we find a similar pattern for bond returns. This indicates that stock returns of the five countries tend to move together over time and so do bond returns of the five countries. Further, we find that there is at least one cointegrating vector for the five stock market indices. Similarly, we find at least one cointegrating vector for the five bond market indices. This implies that these is

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22 One implication of this observation is that investors need to do more diversification during a booming period to achieve a lower correlation between assets.

23 Note that Eun, Janakiramanan, and Senbet (2002) analyze the equilibrium pricing of closed-end country funds from emerging markets under the condition of segmented capital markets and emphasize the effect of market segmentation on the pricing of country funds.
some evidence of comovements among stock market indices and among bond market indices, but the comovement relation is rather weak as indicated by one cointegrating vector.

Now, the issue is, as a result of this finding, whether we have to take into account integrated markets rather than segmented markets. If our focus is on the interaction among the five stock markets, it should help to take into account potential cointegration among the five markets. However, our main focus is on the correlation between stock market and bond market returns in each country and on identification of the income and substitution effects. Given our main focus in this paper, there appears to be less compelling need to incorporate the international market integration into our analysis. Also, it is not clear how to incorporate the effect of a potential comovement among the five countries on the correlation between stock and bond returns in a particular country. One possibility is to introduce a cointegrated term into the model of stock and bond returns for each country, which leads to a quite different identification of three -- income, substitution, and international cointegrating effects -- potential effects driving the correlation, which can be an important extension of our paper. As such, we leave this issue as a future research topic to be further explored.

7. Concluding remarks

This paper is an attempt to better understand varying correlations between stock and bond returns across countries and over sample periods using international data. The observation is that there are two forces that affect the correlation between stock and bond returns. The force that drives a positive relation between stock returns and bond returns is identified as the income effect. The force that drives a negative relation between stock and bond returns is identified as the substitution effect. In combination, the two effects help determine the actual correlation between stock and bond returns. We show the presence of the two forces in various asset pricing models. Some factors such as the level of economic activity may affect the values of stocks and bonds in the same direction, whereas uncertainty about the economic activity may have opposite effects on the values of stocks and bonds.

We contribute to the literature by proposing a way to identify the two -- income and substitution -- effects and to measure the relative importance of the two effects that determine the actual net relation between the two asset returns. As a result, we show that the income and
substitution effects can explain not only diverse correlations across countries but also different correlations over time for countries. We provide some evidence that the income and substitution effects are related to, among other things, the size of the financial market, the growth of the economy, and the business cycle over time. In addition, the framework of the income and substitution effects helps us better understand the automatic stabilizing effects of the dynamic optimal asset allocation during business cycles.

There may be other ways to identify the two forces that drive stock and bond correlations. There may be other approaches to explain diverse correlations between stock and bond returns. Given the importance of the relationship, we may need to continue to search for a better approach. While we focus our attention on the income and substitution effects in each country’s capital market, it would be interesting to incorporate international cointegrating effects into our empirical framework because international stock markets and bond markets are linked. We leave investigation of such possibilities to further work.
References

Abel, Andrew, 1988, Asset prices under time-varying risk and expected return: Solution in an infinite horizon model, *Journal of Monetary Economics* 22, 375-93


Li, Lingfeng, 2002, Macroeconomic factors and the correlation of stock and bond returns, working paper, Yale University


Mamaysky Harry, 2002, A model for pricing stocks and bonds, working paper, Yale University


Table 1.
Correlation Coefficients between Stock and Bond Returns

Panel A. Based on Monthly Frequency (real returns)

<table>
<thead>
<tr>
<th>Period</th>
<th>Canada</th>
<th>Germany</th>
<th>Japan</th>
<th>U.K.</th>
<th>U.S.</th>
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<td>86-92</td>
<td>0.012</td>
<td>-0.567 ***</td>
<td>0.177</td>
<td>0.165</td>
<td>0.263 *</td>
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<tr>
<td></td>
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<td>(0.109)</td>
<td>(0.144)</td>
<td>(0.103)</td>
<td>(0.158)</td>
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<tr>
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<td>0.057</td>
<td>-0.289 ***</td>
<td>0.570 ***</td>
<td>0.386 ***</td>
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<tr>
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<td>(0.116)</td>
<td>(0.119)</td>
<td>(0.111)</td>
<td>(0.136)</td>
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<tr>
<td>86-99</td>
<td>0.131</td>
<td>-0.121</td>
<td>0.019</td>
<td>0.355 ***</td>
<td>0.298 ***</td>
</tr>
<tr>
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<td>(0.104)</td>
<td>(0.090)</td>
<td>(0.112)</td>
<td>(0.078)</td>
<td>(0.098)</td>
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</table>

Panel B. Based on Quarterly Frequency (real returns)

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<th>Japan</th>
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<th>U.S.</th>
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<td>(0.226)</td>
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<tr>
<td>93-99</td>
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<td>(0.175)</td>
<td>(0.183)</td>
<td>(0.134)</td>
<td>(0.186)</td>
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<tr>
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<td>-0.004</td>
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<td>(0.146)</td>
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<td>(0.123)</td>
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Panel C. Based on Monthly Frequency (nominal returns)

<table>
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<th>U.S.</th>
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<td>0.120</td>
<td>0.119</td>
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<td>93-99</td>
<td>0.227 **</td>
<td>0.018</td>
<td>-0.303 ***</td>
<td>0.577 ***</td>
<td>0.348 ***</td>
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<tr>
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<td>0.110</td>
<td>0.105</td>
<td>0.090</td>
<td>0.104</td>
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<tr>
<td>86-99</td>
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<td>0.196 **</td>
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<td>0.080</td>
<td>0.080</td>
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Panel D. Based on Quarterly Frequency (nominal returns)

<table>
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<th>Japan</th>
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<th>U.S.</th>
</tr>
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<td>0.213</td>
<td>0.213</td>
<td>0.212</td>
</tr>
<tr>
<td>93-99</td>
<td>0.253</td>
<td>0.018</td>
<td>-0.369 *</td>
<td>0.639 ***</td>
<td>0.457 **</td>
</tr>
<tr>
<td></td>
<td>0.190</td>
<td>0.196</td>
<td>0.182</td>
<td>0.151</td>
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<tr>
<td>86-99</td>
<td>0.070</td>
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<td>-0.108</td>
<td>0.273 **</td>
<td>0.228 *</td>
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<tr>
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<td>0.141</td>
<td>0.141</td>
<td>0.141</td>
<td>0.136</td>
<td>0.138</td>
</tr>
</tbody>
</table>
Panels A and B (Panels C and D) present correlations between real (nominal) stock and bond returns for each country for the sample period of 1986-1999, and two subperiods (1986-1992 and 1993-1999), based on monthly and quarterly frequency, respectively. These returns are obtained by moving a view window of fixed length (e.g., a year) along time series for two asset classes and computing the cross-correlation between the two asset classes. The Morgan Stanley Capital International (MSCI) total stock return index and J.P. Morgan Government bond return index for each country, measured in local currency, are used as proxies for the stock and bond returns. Each index is obtained from the Datastream.

Standard errors are shown in the parentheses. They are computed using a GMM procedure with Newey-West procedure for serial correlations due to the rolling correlations.

***, ** and * indicate the statistical significance at the 1%, 5%, and 10% levels, respectively.
Table 2.
Relative Importance of Income and Substitution Effect
- Forecast Error Decomposition of Stock Returns and Bond Returns

Panel A. The United States

<table>
<thead>
<tr>
<th>Step (months)</th>
<th>Stock Returns</th>
<th>Bond Returns</th>
<th>Q'</th>
</tr>
</thead>
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<tr>
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<td>35.40</td>
<td>64.60</td>
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</tr>
<tr>
<td></td>
<td>(0.48)</td>
<td>(0.87)</td>
<td>(3.88)</td>
</tr>
<tr>
<td>2</td>
<td>45.96</td>
<td>54.04</td>
<td>47.29</td>
</tr>
<tr>
<td></td>
<td>(0.65)</td>
<td>(0.90)</td>
<td>(3.87)</td>
</tr>
<tr>
<td>3</td>
<td>53.49</td>
<td>46.51</td>
<td>48.37</td>
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<td>(0.83)</td>
<td>(1.15)</td>
<td>(3.89)</td>
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<tr>
<td>4</td>
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<td>41.02</td>
<td>48.79</td>
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<td>(1.00)</td>
<td>(1.35)</td>
<td>(3.90)</td>
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<td>5</td>
<td>62.92</td>
<td>37.08</td>
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<td>(1.14)</td>
<td>(1.52)</td>
<td>(3.90)</td>
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<tr>
<td>6</td>
<td>65.74</td>
<td>34.26</td>
<td>48.84</td>
</tr>
<tr>
<td></td>
<td>(1.26)</td>
<td>(1.68)</td>
<td>(3.90)</td>
</tr>
<tr>
<td>9</td>
<td>70.17</td>
<td>29.83</td>
<td>48.40</td>
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<tr>
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<td>(1.48)</td>
<td>(1.98)</td>
<td>(3.89)</td>
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<tr>
<td>12</td>
<td>71.74</td>
<td>28.26</td>
<td>48.06</td>
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<tr>
<td></td>
<td>(1.58)</td>
<td>(2.13)</td>
<td>(3.89)</td>
</tr>
<tr>
<td>15</td>
<td>72.29</td>
<td>27.71</td>
<td>47.91</td>
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<td>72.47</td>
<td>27.53</td>
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<td>24</td>
<td>72.54</td>
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<tr>
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<td>(1.65)</td>
<td>(2.23)</td>
<td>(3.88)</td>
</tr>
</tbody>
</table>

Notes:
1. The numbers in this table indicate the percentage of the k-step ahead forecast error variance in stock returns (or bond returns) explained by either income effect shock or substitution effect shock.
2. $Q' = \left\{ \left[ \sum_k b_{1h} k \right] ^2 / \sum_k \left[ (b_{1h} k)^2 + (b_{1h} k)^2 \right] \right\} + \left\{ \left[ \sum_k b_{2h} k \right] ^2 / \sum_k \left[ (b_{2h} k)^2 + (b_{2h} k)^2 \right] \right\} =$ the relative importance of the income effect disturbance that explains variances in stock returns and bond returns. If the number exceeds 100, it indicates that the income effect is more important than the substitution effect.
3. The numbers in parentheses are standard errors, which are computed by using a Monte Carlo integration due to Kloek and Van Dijk (1978). The Monte Carlo results are based on 1000 simulations and take into account the identifying restrictions.
<table>
<thead>
<tr>
<th>Step (months)</th>
<th>Stock Returns</th>
<th>Bond Returns</th>
<th>Q'</th>
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<td>$\epsilon^b$</td>
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<td><strong>Panel C. The U.K.</strong></td>
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<td>(5.62)</td>
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<td><strong>Panel E. Canada</strong></td>
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<td>(1.61)</td>
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<td><strong>Panel F. Japan : 1986 – 1992</strong></td>
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<td><strong>Panel G. Japan : 1993 – 1999</strong></td>
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Table 3.

Panel A. Quarterly Average of Market Value/GDP

<table>
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<tr>
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<th>Germany</th>
<th>Japan</th>
<th>U.K.</th>
<th>U.S.A.</th>
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</thead>
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<td>1986-1992</td>
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<td>0.09</td>
<td>0.88</td>
<td>0.60</td>
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<td>1993-1999</td>
<td>0.54</td>
<td>0.13</td>
<td>0.66</td>
<td>1.13</td>
<td>0.76</td>
</tr>
<tr>
<td>1986-1999</td>
<td>0.40</td>
<td>0.11</td>
<td>0.77</td>
<td>0.86</td>
<td>0.56</td>
</tr>
</tbody>
</table>

Panel B. Quarterly Average of Real GDP Growth Rate (Unit = Per Annum, %)
- Real GDP Growth Rate = Nominal GDP Growth Rate - Changes in CPI

<table>
<thead>
<tr>
<th>Period</th>
<th>Canada</th>
<th>Germany</th>
<th>Japan</th>
<th>U.K.</th>
<th>U.S.A.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1986-1992</td>
<td>0.95</td>
<td>6.06</td>
<td>3.58</td>
<td>1.88</td>
<td>1.94</td>
</tr>
<tr>
<td>1993-1999</td>
<td>3.06</td>
<td>1.05</td>
<td>0.19</td>
<td>2.99</td>
<td>2.93</td>
</tr>
<tr>
<td>1986-1999</td>
<td>1.99</td>
<td>3.75</td>
<td>1.95</td>
<td>2.43</td>
<td>2.43</td>
</tr>
</tbody>
</table>

Panel C. Spreads Between Stock and Bond Returns (% One Year Rolling Return)

<table>
<thead>
<tr>
<th>Period</th>
<th>Canada</th>
<th>Germany</th>
<th>Japan</th>
<th>U.K.</th>
<th>U.S.A.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1986-1992</td>
<td>-3.71</td>
<td>-0.93</td>
<td>0.71</td>
<td>2.06</td>
<td>5.24</td>
</tr>
<tr>
<td>1993-1999</td>
<td>5.57</td>
<td>10.52</td>
<td>-3.88</td>
<td>5.91</td>
<td>14.43</td>
</tr>
<tr>
<td>1986-1999</td>
<td>1.26</td>
<td>5.20</td>
<td>-1.74</td>
<td>4.12</td>
<td>10.16</td>
</tr>
</tbody>
</table>

Panel A shows the quarterly average ratio of the stock market capitalization (MV) to Gross Domestic Product (GDP) for each country. As a proxy for stock market capitalization for each country, we use the market capitalization of the Datastream market index. Panel B contains quarterly average real GDP growth rate, which can be defined as the nominal GDP growth rate minus the changes in consumer price index (CPI) for each country. CPI and quarterly GDP are obtained from the IMF’s International Financial Statistics. Panel C represents the mean of differences in returns between stock and bond for the period from 1986 to 1999, based on the 12-month rolling period real returns measured in local currency.
Figure 1.A The response of U.S. stock returns to income (series 1) and substitution (series 2) shocks with a standard error band

Figure 1.B The response of U.S. bond returns to income (series 1) and substitution (series 2) shocks with a standard error band
Figure 2.A The response of Japanese stock returns to income (series 1) and substitution (series 2) shocks with a standard error band

Figure 2.B The response of Japanese bond returns to income (series 1) and substitution (series 2) shocks with a standard error band