Aggregate Risk in Japanese Equity Markets

By
R. Anton Braun
University of Tokyo

and

Etsuro Shioji
Yokohama National University

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Abstract

In the past decade Japanese households have been buffeted by some big aggregate shocks. Economic growth has slowed, unemployment risk has risen, and asset prices have fallen to levels not seen since the early 1980's. These shocks have hit both households' financial and human capital. This paper develops a framework for identifying the sources of these shocks and a way to measure how household assessments of these risks vary over time. We consider the perspective of a forward-looking risk-averse household and derive expected returns and time-varying risk premia for each risk factor. We then construct times-series of historical expected risk premia using Japanese data on industry returns. An analysis of this data provides four main findings. First, prior to 1984 expected risk premia on identified goods market shocks, monetary policy and financial market risk are all important determinants of industry level expected returns. Second, starting in 1984 households perceive that the risk from financial shocks is increasing and demand higher risk premia to hold this risk. Third, between 1987 and 1990 risk premia on monetary policy are large and positive. Monetary policy is perceived to be adding to financial risk. Fourth, in 1990 as expected risk premia on financial risk shoot up, expected risk premia on monetary policy shocks turn negative for all industry returns. As stock prices collapse between 1990 and 1995, monetary policy shocks play an important role in hedging risk emanating from the financial sector.

1 Introduction

In the past decade Japanese households have been buffeted by some big shocks. Economic growth has slowed, unemployment risk has risen, and asset prices have fallen to levels not seen since the early 1980's. These shocks have hit both households' financial and human capital. We are interested in identifying the sources of these shocks and understanding how they have affected households' asset demands in the 1980's and 1990's. This paper describes a way to identify the structural shocks behind these events and measure how household assessments of the risks associated with these shocks vary over time. We consider the perspective of a forward-looking risk-averse household and derive a representation for that household's asset demand functions. This representation relates expected excess returns for an asset to a set of time-varying risk premia that measure the contribution of each identified macroeconomic risk factor. To close the model we follow Campbell (1996), and use a vector auto-regression (VAR) to forecast the dynamics of the state of nature. Our work extends Campbell (1996) by identifying a set of structural shocks to aggregate demand, aggregate supply, monetary policy, money-demand and asset prices from the estimated coefficients of the VAR.

Our model provides a way to view the events of the 1980's and 1990's through the lenses of a risk-averse household. Some surprising results emerge. Prior to 1984 all of the macroeconomic shocks are important determinants of expected excess returns for

Japanese industry level data. From the perspective of a risk-averse household, the median risk premium on financial risk is about 2.9%, the risk premium on goods market demand shocks is 0.8 %, the risk premium on technology shocks is -0.6% and the risk premium on monetary policy is -1.8%.

However, starting in 1984 our household begins to demand a relatively large and increasing risk premium to accept financial risks associated with holding Japanese equity. Our household is anticipating the possibility of some big financial shocks and demanding a bigger reward to accept this risk. This risk premium spikes up in 1990 and remains high throughout the 1990's.

It has been argued that the Bank of Japan played an important role in the rise and fall of the stock price boom. Bernanke and Gertler (1999) argue that easy policy in the late 1980's exacerbated the boom, Bayoumi (2000) and Cargill (2002) argue a sudden tightening in 1989-1990 precipitated the collapse of asset prices, and McCallum (2000) finds that monetary policy in the 1990's was too tight, relative to the benchmarks of either a Taylor interest rate rule or a monetary base targeting rule. Hoshi and Kashyap (2001), in contrast, argue that it is difficult to associate the timing of the asset price boom or collapse with the stance of monetary policy.

Our analysis sheds some light on this debate. Between 1987 and 1990 the risk premium on monetary policy varies widely by industry but has a median value of about 3.4%.

During this period shocks to monetary policy are adding to the overall level of expected risk. However, from 1990 to 1995, the expected risk premium on monetary policy turns large and negative for all industry returns. In other words, Bank of Japan policy surprises are perceived by our household to be hedging financial risks.

These results are not conclusive proof that the Bank of Japan caused the either the boom or the collapse. Our results though do suggest that from 1987 to 1990 market participants were indeed anticipating the possibility that the Bank of Japan might take actions that would increase the risk of holding equity. However, from 1990 until about 1995 the perspective of investors was different. During this period they perceived that monetary policy surprises would help them insure against the high risk of holding equity.

Our work is related to a large finance literature that seeks to determine the nature and number of distinct sources of aggregate risk that explain expected asset returns[1]. As in Evans and Marshall (2001) our risk factors are identified innovations to preferences, technology, and government policy. This provides a better way to account for the relative contributions of alternative macroeconomic shocks in pricing assets.[2]

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[1] For some recent examples for this literature see e.g. (Fama and French (1996), Ferson and Harvey (1996), Chan, Karceski and Lakonishok (1998) and Ang and Piazessi (1999). See also Chan, Karceski and Lakonishok (1998), Jaganathan, Kubota and Takehara (1998), and Brown and Otsuki (1993) for analyses using Japanese data.

[2] For instance, one would expect that the response of asset markets to an unexpected rise in inflation would vary depending on whether it is due to an increase in oil prices or an easing in monetary policy. By averaging across these different types of shocks one is likely to understate both the role of monetary policy and the role of oil price shocks.

Our work is also related to the large literature on identified VAR's.[3] Following Uhlig (2001) (see also Faust (1999) and Canova and De Nicolo (2002) for related methodologies) we identify the structural shocks by imposing sign restrictions on impulse response functions.

The remainder of the paper is organized as follows. Section 2 describes the economic model. Section 3 describes how the model is parameterized. Section 4 reports the results and Section 5 contains our concluding remarks.

2 The model

Our economic model has *two* parts. The first part is a description of the consumption-saving problem faced by a risk-averse household. Our goal here is to derive a representation that relates the household's subjective demand for different assets to a set of aggregate risk factors. The second part of our economic model involves imposing restrictions from economic theory so that we can give a structural interpretation to these risk factors.

2.1 The household's decision problem

Our description of the household decision problem closely follows Campbell (1993, 1996) and Campbell, Lo and MacKinlay (1997). The main distinction is that we restrict attention to isoelastic preferences.

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[3] See Christiano, Eichenbaum and Evans (1999) for a recent survey of this literature.

Consider the problem of a household who maximizes the following life time utility function:

$$U_t = \sum_{\tau=t}^{\infty} \beta^{\tau-t} C_\tau^{\ 1-\gamma} \ . \tag{2.1}$$

subject to the budget constraint:

$$W_{t+1} = \left(1 + R_{m,t+1}\right) \cdot \left(W_t - C_t\right). \tag{2.2}$$

In the above, C_t is consumption and W_t is wealth in period t, while $R_{m,t+1}$ is the market rate of return between period t and $t+1$. The parameter β is the discount factor and γ is the coefficient of relative risk aversion. Assuming that asset returns and consumption are homoskedastic and jointly lognormal, it can be shown that:

$$E_t\left[\tilde{r}_{it+1}\right] + \frac{V_{ii}}{2} = \gamma \cdot V_{ic} \tag{2.3}$$

where $\tilde{r}_{it+1}$ is the excess return on asset i (that accrues to it between period t and $t+1$), V_{ii} is its variance, and V_{ic} is the covariance with consumption growth. All the expectations, variances, and covariances are conditional on information available in period t. Using the fact that current consumption can be written as a function of current and future (expected) wealth, we can substitute consumption out of equation (2.3) (Campbell (1993, 1996)):

$$E_t\left[\tilde{r}_{it+1}\right] + \frac{V_{ii}}{2} = \gamma \cdot V_{iw} + (\gamma - 1) \cdot V_{iw}^{*} \tag{2.4}$$

where V_{iw} is the conditional covariance with the return on total wealth and V_{iw}^{*} is the conditional covariance with the following variable:

$$r^*_{w,t+1} \equiv E_{t+1}\left[\sum_{j=1}^{\infty}\rho^j r_{w,t+1+j}\right] - E_t\left[\sum_{j=1}^{\infty}\rho^j r_{w,t+1+j}\right] \quad (2.5)$$

where $\rho \equiv 1-\exp(\overline{c-w})$. Here, $\overline{c-w}$ denotes the mean of the log of the consumption- wealth ratio. Thus, this variable is the sum of revisions to expectations about future returns on total wealth, discounted appropriately.

We assume that total wealth consists of financial, human wealth and other types of wealth such as land. Define the return on human capital as $r_{y,t}$, the current return on the market portfolio as $r_{m,t+1}$, and the present value of expectations revisions on future market returns as:

$$r^*_{m,t+1} \equiv E_{t+1}\left[\sum_{j=1}^{\infty}\rho^j r_{m,t+1+j}\right] - E_t\left[\sum_{j=1}^{\infty}\rho^j r_{m,t+1+j}\right]. \quad (2.6)$$

Then by extending the model of Campbell (1996), to incorporate three types of wealth, we get:

$$E_t\left[\tilde{r}_{it+1}\right] + \frac{V_{ii}}{2} = \gamma\cdot\nu\cdot V_{im} + \gamma\cdot\omega\cdot V_{iy} + (1-\nu-\omega)\cdot V_{io} + \left[\gamma(1-\omega)-1\right]\cdot V^*_{im} \ . \quad (2.7)$$

The four V's in this equation are conditional covariances between the return on asset i and:

1. current financial market returns (V_{im});
2. current and future labor income growth discounted in the same way as in (2.5) (V_{iy});

3. current and future returns on assets other than financial and human wealth (V_{i0});
4. the present value of expectation revisions on future market returns (V_{im}^{*}).

The share parameters ν and ω are the average shares of financial and human capital in total wealth. In what follows, due to a lack of adequate data on returns to wealth other than financial and human, we assume that[4]

$$V_{io} = 0. \tag{2.8}$$

Even though this covariance is assumed to be zero, other wealth matters for the calculation of ν and ω.

2.2 Asset demand and risk

We assume that there are K distinct sources of risk, denoted ε_{kt+1} (where k=1, 2, .., K). and that they are linearly related to the three return variables in the following way:

$$r_{m,t+1} - E_t\left[r_{m,t+1}\right] = \sum_{k=1}^{K} \varphi_{mk} \cdot \varepsilon_{k,t+1}\,,\; r_{m,t+1}^{*} = \sum_{k=1}^{K} \varphi_{mk}^{*} \cdot \varepsilon_{k,t+1}\,,\text{ and } r_{y,t+1} = \sum_{k=1}^{K} \varphi_{yk} \cdot \varepsilon_{k,t+1}\,. \tag{2.9}$$

Next combine (2.7)with (2.8) and (2.9), and denote the covariance of the excess return on asset *i* with risk factor *k* by V_{ik}. Then we obtain the following representation for asset demand:

[4] An interesting extension of our analysis would be to model land. However, we chose to omit land from the analysis due to a lack of monthly land price data.

$$E_t\left[\tilde{r}_{it+1}\right] = -\frac{V_{ii}}{2} + \sum_{k=1}^{K} p_k \cdot V_{ik} \tag{2.10}$$

where p_k's are the risk prices defined as

$$p_k = \varphi_{mk} \cdot \gamma \cdot \nu + \varphi_{yk} \cdot \gamma \cdot \omega + \varphi^*_{mk}[\gamma(1-\omega)-1]. \tag{2.11}$$

Equation (2.10) equates expected returns for asset i, adjusted for the Jensen's inequality term, to the sum of the risk premia of the K shocks.

2.3 Dynamics of the risk factors

Following Campbell (1996) we model the dynamics of the risk factors using a VAR:

$$x_{t+1} = C_0 + C(L)x_t + u_{t+1}, \quad u_t \sim IID(0,\Sigma) \tag{2.12}$$

where x_t is a $(K\times 1)$ vector of macroeconomic variables, L is a lag operator, and $C(L)$ is a lag polynomial and u_t is a (Kx1) vector of disturbances. To identify the structural shocks, we posit a linear relationship between the disturbances to the VAR and the structural risk factors $\varepsilon_t = Pu_t$. That is we select a $(K\times K)$ matrix P such that:

$$Px_{t+1} = PC_0 + PC(L)x_t + Pu_{t+1}, \quad E(Pu_t u_t' P') = I \tag{2.13}$$

Using the transformations $\tilde{x}_t = Px_t$ and $\varepsilon_t = Pu_t$ rewrite (2.12) as:

$$\tilde{x}_{t+1} = PC_0 + PC(L)P^{-1}\tilde{x}_t + \varepsilon_{t+1}. \tag{2.14}$$

The second part of our economic model is a set of economic restrictions that serve to pin down P and thereby *identify* the particular rotation of the VAR disturbances that can be interpreted as structural shocks to aggregate goods demand (AD), aggregate goods supply (AS), money demand (MD), monetary policy (MS) and financial markets (MARKET). Our methodology for doing this is empirical and is easier to explain if the list of variables in the VAR is known. For this reason the choice of variables to include in the VAR is described next.

2.4 Variable Selection

Our choice of variables for the VAR is motivated by two criteria. First, the list of variables should collectively summarize the principal links between monetary policy and the economy. In particular, the list should include the principal variables considered by the Bank of Japan when conducting its monetary policy. Second, we also want the list of variables to capture other important sources of aggregate non-diversifiable risk in the Japanese economy. Based on these considerations we selected a VAR model with five variables: $x_t=(CPI_t, Y_t, M_t, R_t, MARKET_t)'$. Here, CPI is the price level as measured by the Consumer Price Index net of food expenditures, Y is the level of private economic activities as measured by labor income, M is monetary base, R is the call rate, and MARKET is the value weighted return of stocks on the first tier of the Tokyo Stock Exchange.[5] A notable omission from this list is an exchange rate variable. We

[5] We will drop the time subscripts in our subsequent discussion.

experimented with runs that include the yen/$ exchange rate and found that the exchange rate did not play an important role so we left it out due to concerns about over-parameterization.

2.5 Identification of the Structural Shocks

Given that the VAR includes five variables identification of P (or P^{-1}) amounts to producing a set of economic restrictions that pin down its twenty-five elements. This is accomplished by combining zero restrictions on the elements of P^{-1} with a set of economic restrictions on the impulse response functions.

2.5.1 Zero Restrictions

Assume that the variables in the VAR are partitioned into three groups with *CPI* and *Y* in the first group, *M* and *R* in the second group and *Market* in the third group.

Suppose further that P^{-1} is block triangular:

$$P^{-1} = \begin{pmatrix} P_{11}^{-1} & 0 & 0 \\ P_{21}^{-1} & P_{22}^{-1} & 0 \\ P_{31}^{-1} & P_{32}^{-1} & P_{33}^{-1} \end{pmatrix} \tag{2.15}$$

The four sub-blocks in the upper left corner of P^{-1} are dimensioned (2×2) and P_{31}^{-1} is dimensioned (1×2). The remaining sub-blocks are dimensioned to be conformable. This imposes a contemporaneous block recursive structure between the three blocks. We will identify innovations to the demand and supply for goods from the first block, innovations to money demand and monetary policy from the second block and innovations to financial markets from the third block. One way to interpret these restrictions is that they partition the monetary authority's information set into two parts when setting policy in each period. These restrictions imply that the monetary authority sees the current innovations to demand and supply for goods prior to setting policy, but does not see the current innovation to financial markets.

2.5.2 The macroeconomic effects of structural innovations

The zero restrictions listed above do not completely identify P^{-1}. To complete the identification of the structural shocks we bring in outside information about the economic effects of each structural shock and directly impose this outside information on the set of candidate rotations. One way to isolate the effects of a structural shock is to calculate the impulse response of a model economy to that shock. Dynamic competitive models of the business cycle and monetary policy such as e.g. Rotemberg and Woodford (1997), Ireland (1997), Aiyagari and Braun (1998), and Christiano, Eichenbaum and Evans (2001) have very specific implications for the dynamic response of prices, output, and nominal interest rates to impulses in to preferences, technology or monetary policy. However, the magnitude and duration of these responses can vary substantially depending on the details of the model such as the form of preferences, the assumed type of market structure and the feedback rule for monetary policy. Instead of wedding the identification of the VAR to these types of modeling details, we prefer to look at a weaker set of *sign* restrictions on the impulse response functions that are broadly consistent with a whole class of these models. We hope by doing this we are basing our identification on the implications of these models for which there is broadest agreement within the profession.[6]

Our identifying restrictions for each of the five shocks are:

> **(AD)** Both Y and CPI go up for a majority of months 0 to 5.[7]
>
> **(AS)** Y goes up, while CPI goes down for a majority of months 0 to 5.
>
> **(MD)** M goes up in month 0.
>
> **(MS)** CPI goes up for the majority of months 1 to 6, and M goes up for the majority of months 0 to 5. Y goes up for the majority of months 0 to 6, and R goes up for a majority of months 0 to 5.

The rationale for imposing these sign restrictions on goods demand follows from considering the effects of shocks to government purchases on economic activity. Aiyagari and Braun (1998) report simulations for a costly price adjustment model that produce these same responses when government purchases are a credit good. Similarly, the restrictions on the responses of output and prices to a technology shock is implied by

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[6] Our basic method though is quite general and can easily be adapted to impose other restrictions such as restrictions about persistence as in e.g. Blanchard and Quah (1989) or even a particular set of restrictions implied by a fully-specified dynamic general equilibrium model.

sticky price models such as Altig, Christiano, Eichenbaum and Linde (2003) as well as flexible price models as in e.g. Aiyagari and Braun (1998).

In the literature on fully specified dynamic general equilibrium models, two types of predictions are obtained for the response of R to innovations in monetary policy. In some models, an easing in monetary policy produces a liquidity effect that lowers short-term interest rates (see Christiano, Eichenbaum, and Evans (1999) for a recent survey). Alternatively, sticky price models by Rotemberg (1996), Rotemberg and Woodford (1997), Ireland (2000) and Aiyagari and Braun (1998) have the property that short-term interest rates rise. The analysis of Japanese data by Braun and Shioji (2002) gives overwhelming support to the latter view, and thus this type of restriction is imposed in the analysis that follows.

For money demand there is no consensus in the literature. A surprise increase in money demand may either raise interest rates or leave them unchanged depending on the extent to which they are accommodated by the central bank.[8] For this reason we will not take an ex ante position on money demand shocks and simply define them to be shocks to the money market that are orthogonal to money supply shocks.

Finally, the fifth shock, namely "MARKET" shock, is identified uniquely from the block recursive structure we imposed in the previous section. We do not impose any other

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[7] The period in which the shock arrives is referred to as period 0.

restrictions on this shock.

2.5.3 Imposing sign restrictions to identify P^{-1}

Our method for imposing these sign restrictions is a rejection based quasi-Bayesian monte-carlo procedure that builds on previous work by Uhlig (2001). Given a set of sign restrictions on the impulse response functions, we randomly draw from the posterior distributions of the matrix of reduced form VAR coefficients, the variance covariance matrix of the error term, Σ, and the free elements of P_{11}^{-1} and P_{22}^{-1} to find a set of coefficients that satisfy the sign restrictions. If a particular monte-carlo draw satisfies the sign restrictions we tabulate it, otherwise it is discarded.[9]

3 Parameterization of the model

Parameterizing the model involves:

1. assigning values to preference parameters of the household,
2. parameterizing the dynamics of the conditional covariances in equation (2.10) and choosing their parameters,
3. estimating the VAR that governs the evolution of the aggregate state,
4. and finally identifying, P^{-1}, and thus the structural shocks.

It turns out to be convenient to describe these details in a different order. We will start by

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[8] See Clarida, Gertler and Gali (2000) for a nice discussion of this issue.

describing items 3 and 4 and then discuss item 2 and finally describe item 1.

3.1 Estimating the VAR and identifying the macroeconomic shocks

We use monthly Japanese data. The sample runs from January 1973 to December 1998. Details on the data sources are reported in the data appendix. CPI, Y and M are all estimated in log differences.[10,11] The number of lags is chosen to be 6 based on the Akaike information criterion. In the simulations, 200 draws are made from the posterior distribution of the parameters of the VAR and, for each draw from the posterior, 50 draws are made from the free parameters of the matrix P^{-1}. Of the 200 outerloop draws from the posterior distribution 170 draws produced at least one valid innerloop draw of P^{-1}, and the average number of successful innerloop draws per good outerloop draw was 4.5. This makes for 688 valid draws out of a total of 10,000 draws. Impulse responses are reported in Figure 1. For variables other than R, we report *cumulative* responses. The solid lines are generated from the VAR model whose parameter values are set to their means across the valid draws. The lower and upper dashed lines correspond to respectively the 16th and 84th percentiles.

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[9] More details on this methodology can be found in Braun and Shioji (2002).

[10] The augmented Dickey-Fuller test (Dickey and Fuller (1979)) indicates that these three variables are non-stationary. And the two step test of cointegration by Engle and Granger (1987), using the critical values supplied by Engle and Yoo (1987), rejects the presence of cointegration among the three variables.

[11] It should however be kept in mind that the sign restrictions discussed in the previous section are always imposed on their *levels*. For example, an AS shock is supposed to increase levels of CPI and Y for the majority of months 0-5.

Starting with goods market shocks, both shocks to aggregate demand (AD) and shocks to aggregate supply (AS) have persistent effects on prices and labor income. One way to assess the plausibility of our identifying restrictions is to look at the response of the nominal interest rate. AD shocks have a positive effect on nominal interest rate while AS shocks have a negative effect. This is in line with results from textbook AD-AS analysis such as Blanchard (2003). AD shocks also have a persistent and significant negative effect on cumulative market returns, which presumably comes from the increase in R. Moving on to the money market shocks, money demand shocks only have a significant effect only on monetary base. Monetary policy shocks have a large and significant effect on the price level and a small but persistent effect on labor income. Monetary policy shocks also have a persistent effect on the cumulative market return. Finally, the response of the market return to an innovation in MARKET is large and persistent. However, the response of other variables to this shock is small. Overall, the impulse responses reported in Figure 1 are consistent with economists understanding of how these types of structural shocks affect the macro-economy.

3.2 The specification and estimation of the conditional moments

Next we describe how we parameterize the dynamics of the conditional covariances that appear in the right hand side of (2.10).

There is a large econometric literature on estimating conditional covariances (see e.g. Andersen and Bollerslev (1998) for a recent survey). We chose to use a relatively parsimonious model of the conditional covariances and adopt a method similar to the one employed by JP Morgan and Reuter (1996) and described in their "RiskMetrics" handbook. The covariance between the return on the *i*th asset and the *k*th shock in period *t* is estimated by:

$$\hat{COV}_t\left(\tilde{r}_{it+1}, \varepsilon_{kt+1}\right) = \lambda \cdot \hat{COV}_{t-1}\left(\tilde{r}_{it}, \varepsilon_{kt}\right) + (1-\lambda) \cdot \tilde{r}_{it} \cdot \varepsilon_{it}, \tag{3.1}$$

where λ is a constant between 0 and 1. Throughout this paper, we set the value of λ to be equal to 0.97, following JP Morgan and Reuters (1996). The initial values are set to 0. When computing the overall risk premium, we also estimate the Jensen's inequality term in (2.10). We apply a similar approach we used for the covariances. First, the expected return on the *i*th asset is computed by:

$$\hat{E}_t\left(\tilde{r}_{it+1}\right) = \lambda \cdot \hat{E}_{t-1}\left(\tilde{r}_{it}\right) + (1-\lambda) \cdot \tilde{r}_{it}. \tag{3.2}$$

Then the variance of the return on the same asset is computed as

$$\hat{VAR}_t\left(\tilde{r}_{it+1}\right) = \lambda \cdot \hat{VAR}_{t-1}\left(\tilde{r}_{it}\right) + (1-\lambda) \cdot \left(\tilde{r}_{it} - E_{t-1}\left(\tilde{r}_{it}\right)\right)^2. \tag{3.3}$$

3.3 Choice of Preference and other parameters

According to (2.11) and (2.7), four parameter values have to be chosen to compute the risk prices. They are: ρ, which plays the role of a (monthly) discount rate; γ, the coefficient of relative risk aversion; ν, the share of financial wealth; and ω, the share of human wealth.

First, ρ is set to be equal to 0.03/12, which, corresponds to an annual discount rate of 3%. As for the relative shares of wealth, Takayama et. al. (1990) estimate the average financial, real and human wealth for households with two persons or more in Japan. Using micro data (*Zenkoku Shohi Jittai Chosa*) from 1984, they estimate that the average financial wealth per household was 4 million yen, the average real wealth was 24 million yen, and the average human wealth (mainly the present value of wages) was as large as 130 million yen. For our model, this implies ν=0.0253 and ω=0.8228.[12] As for γ, the coefficient of relative risk aversion, the literature on the consumption based CAPM has found that very high values of γ are required if the average household demand for the market portfolio is to be consistent with the measured mean excess return on equity. Campbell (2000) finds that for Japanese data this calls for setting γ to about 134.118.[13] We will use this value of γ in our analysis. The reason for this choice is that we are using

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[12] Even their estimates might understate the importance of human capital. Jorgenson and Fraumeni (1989) estimate not only "market" human capital (which is also defined, basically, as the present value of wage income) but also "non-market" human capital (such as home work) for the US. Their estimates indicate that the total human capital is five to six times larger than market human wealth. We thank Charles Yuji Horioka for bringing this work to our attention.

[13] Campbell (2000) uses the sample period runs from 1970:II-1996:II.

financial data to back out our households attitudes towards risk and we want our household's forecasts to capture some of the main properties of this data. Table 1 reports risk prices using our parameterization of the model. The risk prices are computed using the impulse responses from the VAR model whose parameter values are set to their means across the valid draws. Numbers in the parentheses are the 16th and 84th percentiles. All the risk prices are estimated to be positive. The risk price for MS is by far the largest.

Table 1

Risk prices implied by the calibration

	AD	AS	MD	MS	Market
Estimate	0.341	0.230	0.193	1.058	0.227
(16th and 84th percentiles)	(0.017, 0.677)	(-0.117, 0.564)	(-0.380, 0.841)	(0.609, 1.748)	(0.035, 0.521)

3.4 Assessing the parameterization

Our objective is to use the model as a device for understanding the ex ante risks households were facing between 1976 and 1998. However, before describing these results it is useful to summarize how well our household does in predicting movements in industry excess returns. If the household does a horrible job of predicting asset returns then there is little reason to take our results seriously. In fact it turns out that our household does reasonably well.

First, we investigate the ability of our estimates to predict the cross-section of returns for the 28 industries in our dataset. Figure 2 displays estimates for overall expected returns and actual excess returns on assets, as suggested by Jagannathan and Wang (1996). The results are averages of *monthly* excess returns for the period of 1976:1-1998:12. Observe that the dots are distributed symmetrically around the 45-degree line with two exceptions. In the lower left hand side of Figure 2 there are two industries that are quite far from the 45 degree line. These two industries are mining and marine transportation. The overall correlation between expected and actual returns is 0.534. Out of 28 industries, actual returns are positive for 27 and expected returns are positive for 26. Overall, our household is doing a reasonable job of predicting the cross sectional distribution of excess industry returns.

A second way to measure the forecasting performance of our household is to look at the contemporaneous correlation between expected excess returns in period $t+1$ and the actual $t+1$ return. Table 2 reports the median correlation, the minimum and maximum correlations across the 28 industries and the number of industries for which the correlation of the predicted and actual return is positive. Results are reported for the entire sample period of 1976:1-1998:12[14], as well as for the following four sub-periods: the "pre-boom" period, 1976:1-1983:12, the "boom" period, 1984:1-1989:12, the "crash" period, 1990:1-1994:12, the "post-crash" period, 1995:1-1998:12. Not surprisingly these

[14] We avoid using data from the first three years (1973-1975) because the estimated covariance (as well as variance) might be influenced by the choice of the initial values for the first few years.

correlations are small. This reflects the well known fact that predictability of returns is modest. Interestingly, the forecasting performance declines in the 1990's. In Section 4 we consider this decline in forecasting performance in more detail.

Table 2

Correlation between expected period t+1 and actual t+1 excess returns

Sample period		Median Correlation	Range	Sign count
Whole sample	1976:1-1998:12	3.9%	(-5.9, 15.5)	20
Pre-boom	1976:1-1983:12	5.9%	(-9.0, 27.2)	18
Boom	1984:1-1989:12	14.0%	(-22.5, 46.7)	22
Crash	1990:1-1994:12	-17.5%	(-31.4, 3.2)	0
Post-Crash	1995:1-1998:12	-8.9%	(-25.5, 1.7)	2

4 Results

Figure 3 reports time-series of expected risk premia for each type of risk and the overall expected excess return. In each panel, the solid line presents the median across all 28 industries at each point in time. The dashed lines are the maximum and the minimum risk premium, also computed at each point in time. These risk premia are based on the average VAR parameterization across valid draws. Some summary statistics from Figure 3 are reported in Table 3, where we again divide the period of 1976-98 into the four sub-periods.

Table 3:
Historical decomposition of median expected returns (annualized, in percentages)

	Actual Returns	Expected risk premia						
		overall	AD	AS	MD	MS	Market	$-V_{ii}/2$
Entire sample	-0.130	3.035	-0.294	-0.620	0.359	-4.565	10.458	2.223
Pre-boom	2.546	-0.026	0.755	-0.562	0.238	-1.770	2.851	-1.110
Boom	16.846	9.907	-1.728	1.138	1.532	3.387	7.424	-2.362
Crash	-15.255	-3.564	-0.954	-1.864	-0.474	-18.906	22.734	-3.817
Post-crash	-8.465	9.583	-0.040	-1.394	0.204	-2.867	16.020	-2.560

Considering first Table 3, observe that the median expected return has the same pattern as the median actual return. Both expected and actual returns are small in the pre-boom period and turn positive and large in the boom period. They are both negative during the crash period, and recover in the post-crash period. This provides further evidence that our household is doing a reasonable job of forecasting the overall risk patterns in Japanese data. Observe next that the two most important risk factors are monetary policy and financial market risk. The only sub-period where we see the other risk factors playing much role in defining overall risk is the pre-boom period.

Next we turn to consider Figure 3 in more detail.

Pre-boom period (1976-1983)

When considering the pre-boom period it is important to understand that Japanese financial markets during much of this period were tightly regulated. For instance as late as 1983 only two Japanese companies (Toyota Auto and Matsushita Electric) were qualified by the government to issue unsecured bonds. By 1985 this number had risen to fifty-seven.[15]

This was also a period in which government expenditures were rapidly rising. Total government expenditures, for instance, increased from 14% of GDP in 1976 to 18% of GDP in 1981 and the government deficit rose from 4.2% of GDP in 1976 to a peak of 6% in 1979 and then declined to 4.72% in 1983. It is interesting that during this same period our household is assigning a positive and relatively large risk premium to aggregate demand shocks.

Boom period (1984-1989)

From the perspective of our household this period is marked by two principal changes in the sources of risk: a gradual but steady rise in the risk premium on financial market risk and a sudden sharp increase in the risk premium on monetary policy that lasts from late 1986 to the end of 1989.

The risk premium on financial market risk starts to rise in about 1984. At about this time many regulations on financial markets were eased. For instance, the number of companies qualified to issue convertible bonds rises from 25 in January of 1983 to 175 by July of 1985. The use of warrant bonds also increased rapidly during this period both domestically and internationally. Figure 3 indicates that by 1986 our household's risk premium on market risk is positive in all 28 industries.

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[15] See Hoshi and Kashyap (2002) for more details.

The second big risk event during the boom period is a sharp rise in the median risk premium on monetary policy. The median risk premium on monetary policy is about zero up until 1986. In 1986 it falls but then becomes positive in November and remains positive through December 1989. Note also that the cross-sectional distribution of risk premia on monetary policy widens in 1986 and then narrows thereafter. It is interesting to consider what events might have produced these changes in the risk premia on monetary policy. Between September 1985 when the Plaza accord was signed and January 1986 the Bank of Japan raised interest rates and the yen appreciated from 237 yen/$ to 192 yen/$. In January 1986 the Bank of Japan began lowering the call rate. The rationale offered for this was that it was an effort to stabilize the yen/$ exchange rate. However, as 1986 progresses the yen continues to appreciate against the dollar. On October 31 1986 Baker and Miyazawa meet and on the following day November 1 1986 the BOJ lowers the discount rate. The timing of these events corresponds to the upward spike in the monetary policy risk premia in Figure 3. Finally in May 1989 the Bank of Japan changes course and starts raising the call rate.

Figure 3 shows how these monetary policy surprises affected our household's perspective about holding this type of risk. Initially he treats the easing in monetary policy as hedging market risk. However, by 1987 its perspective has changed and it is now demanding a positive risk premium for assets that are correlated with this risk.

A second way to interpret the positive risk premia on monetary policy between 1987 and 1990 is by comparing the actual time path of the nominal interest rate with that prescribed by a particular interest rate rule such as the Taylor rule. McCallum (2000) provides such a comparison. He finds that Taylor Rules fit to Japanese data imply that the call rate was too high between about 1988 and 1990.

Crash period (1990-1994)

The crash, which we date from 1990:1 to 1994:12 is a period where both actual and expected returns are negative. In early 1990 the household sees a big and sudden increase in financial market risk and demands a bigger premium for holding equity in all industries. In spite of this spike in the risk premia on financial market risk the household expects overall returns to be negative during the first half of this period. This is because the household assigns an even bigger negative risk premium to monetary policy for all industries. Overall, the household is expecting that monetary surprises will more than fully hedge risks emanating from financial markets between 1990 and 1992. Thereafter as the hedging role of monetary policy shocks decline the role of market risk becomes more important in defining overall expected returns.

A widely held view is that the reaction of the Bank of Japan to the crash was slow and too small. McCallum (2000), for instance finds that if one adopts the benchmark of a base targeting rule for monetary policy that monetary policy was too tight between 1990 and 1995. Alternatively, under the benchmark of a Taylor Rule monetary policy is too tight from 1992 through 1997. Our analysis can't say whether monetary policy was too loose or too tight. What we can say though is that households perceived that the nature of risks associated with monetary policy changed in 1990 to one of hedging financial risk.

Finally observe that Figure 3 shows a decline in the cross-sectional dispersion of risk premia. This finding is consistent with results reported in Hamao, Mei and Xu (2003). They use the CAPM to decompose individual stock returns into a market component and idiosyncratic component and find that the market component of individual stock returns goes up during this period. One merit of our approach is that it provides a way to understand what risk factors are driving the increase in the correlations between expected returns of different industries. In order to extract such information from our estimation results, in Figure 4, we report estimated conditional correlations of industry returns with each of the identified macroeconomic shocks. These conditional correlations are based on the conditional covariances, whose derivation was explained in section 3.2. The covariances are converted into the correlations through dividing the former by the conditional standard deviations of industry returns (square roots of the conditional variances whose derivation is described in (3.3)) and those of macroeconomic shocks (derived in the same way as those of industry returns). From Figure 4, we find the following results. First, there is a sudden rise in the median correlation with financial market shocks around 1990. We computed its subsample averages, and they were 0.559 in the boom period and 0.789 in the crash period. Second, the range of the correlations narrows considerably around 1990: during the boom period the range of subsample average correlations across the industries was (0.202, 0.857), and it narrows to (0.681, 0.920) during the crash period. Third, returns of all the industries become negatively correlated with monetary policy shock in the crash period. Fourth, the range of correlations with monetary policy shocks also narrows somewhat between the boom period and the crash period. All of them contribute to increases in correlations in the expected returns between the industries.

Post crash period (1995-1998)

In this period, the overall expected risk premium turns positive for all industries. In fact, it returns to a level comparable to that in the boom period. Two factors are playing roles here. On the one hand, the negative risk premium on monetary policy gradually returns to near-zero levels for all industries (refer to the fourth panel in Figure 3). On the other hand, the risk premium on financial market shocks remains high. We believe that this latter fact reflects a lack of diversification offered by equity. Notice that the expected risk premium on market risk is positive between 1995 and the end of the sample for all industries and that the dispersion is low. The lack of diversification opportunities is also suggested from

Figure 4. The figure shows that the conditional correlations of the expected returns with financial market shocks remained high: the subsample average of the median correlation was 0.822. Also, the range of the correlations remained narrow: the average range was (0.698, 0.914) in this period.

Our household expected to be rewarded for taking on this risk in the form of higher returns. These expectations, however, have not been fully born out by outcomes. Both the results in Table 2 and Table 3 point to a break down in the forecasting ability of households during this period. The correlation of actual with predicted returns reported in Table 2 is -8.9%. And a comparison of the expected overall median return with the actual returns shows that households did not anticipate negative returns of this magnitude.

One possible explanation for this is our assumption that the shares of human capital, financial capital and other capital are fixed throughout the entire sample period. During the 1990's the share of human capital in total wealth has likely increased. To see whether this might offer an explanation for the poor forecasting performance in the 1995:1-1998:12 subsample, we tried increasing the share of human capital in total wealth from the baseline value of 82% to 90%. This change reduces the median overall risk premium for this subsample from 9.6% to 5.1%.

5 Concluding Remarks

In this paper we have developed a methodology for identifying and measuring the source and dynamics of risk associated with holding Japanese equity. We found that the two biggest risk factors since 1976 are monetary policy and financial market risk. Technology shocks don't appear to be important for understanding expected returns. Demand shocks were of some importance in the mid to late seventies before financial markets were deregulated but since then have been overwhelmed by monetary policy and financial market risk. There is an important difference between the properties of these two risks. Risk premia for financial market risk have risen and remained stuck at a high level for much of the 1990's. Monetary policy risk, on the other hand, has added to the risk of holding equity for some periods but hedged market risk in other periods. Our analysis leaves us with a puzzle. Japanese equity markets offered significantly fewer diversification opportunities to households in the 1990's relative to the 1980's. Households expected to be compensated for holding these additional risks but they were not. Understanding why this is the case is a topic of our current research.

Data Appendix

For CPI, we took consumer price index (total) and deseasonalized using the Census X-12 ARIMA method. For Y, labor income, we take the real wage index from the *Monthly*

Labor Survey published by the Ministry of Health, Labor, and Welfare and multiply it by the index of total number of hours published from the same source. Those are indices for all industries, for establishments with more than 30 employees. We also tried indices for establishments with more than 5 employees in manufacturing, and the results turned out to be quite similar. Those indices were also deseasonalized by X-12 ARIMA. M is monetary base, seasonally adjusted and adjusted for reserve requirement ratio changes (from the Bank of Japan). R is the call rate (collateralized, one day, monthly average). Our data on asset returns consists primarily of 28 industrial average stock returns from the Japan Securities Research Institute. The "market" return in the VAR is the weighted average of those 28 industrial returns.

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Figure 1 Impulse Responses to Structural Shocks

Each panel represents response of a variable listed at the top of the column to a one standard deviation shock of the type listed at the end of the row.

With the exception of R, they are all cumulative responses.

The solid lines are the responses from the VAR model whose parameter values are set to their means across the valid draws. The dashed lines are the 16th and 84th percentiles, respectively.

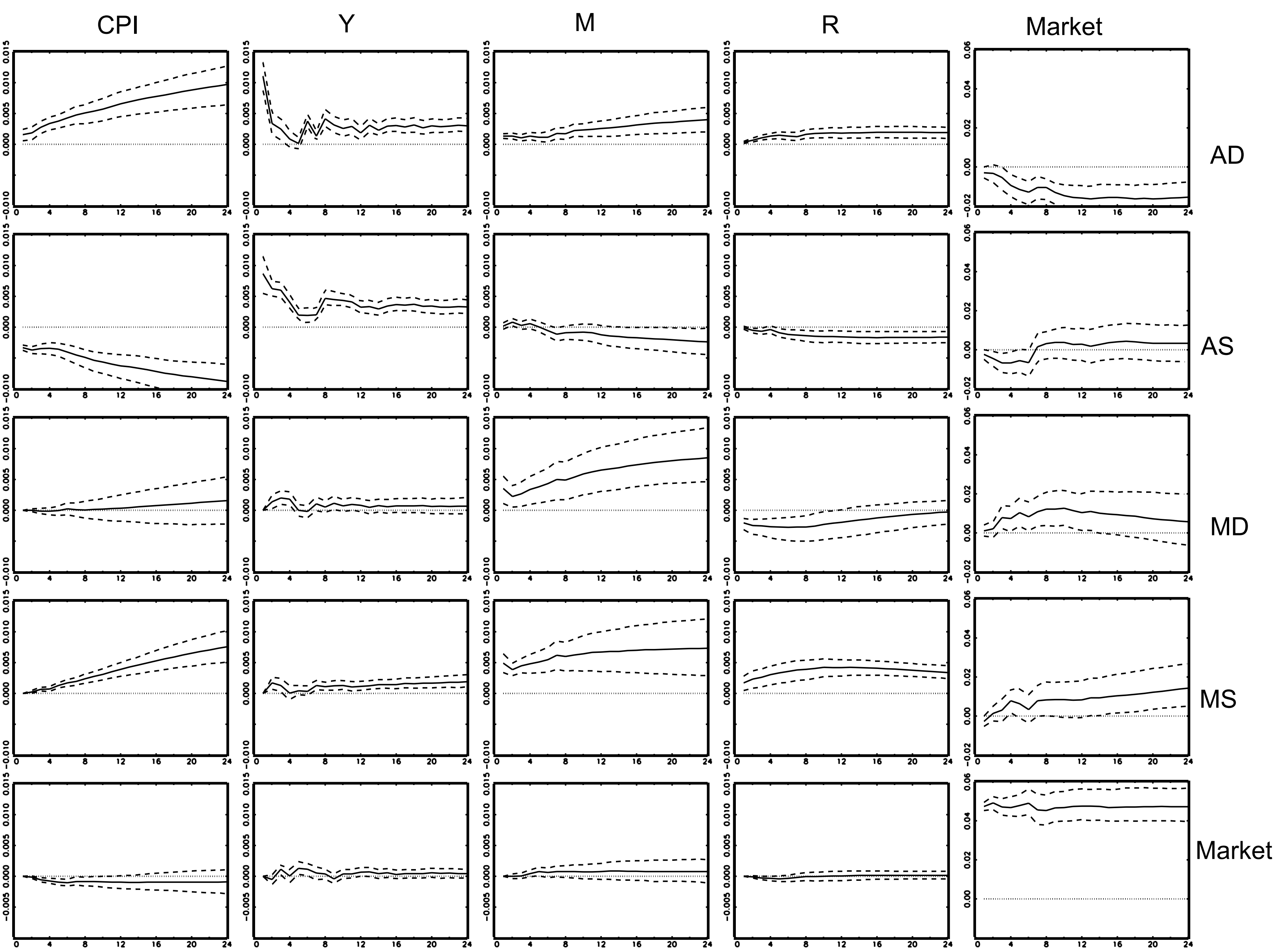

Figure 2

Actual Excess Returns and Expected Excess Returns
for 28 industries (both in percentages)

Sample averages for the period January 1976- December 1998

Each dot represents an industry, and the solid line is the 45
degree line.

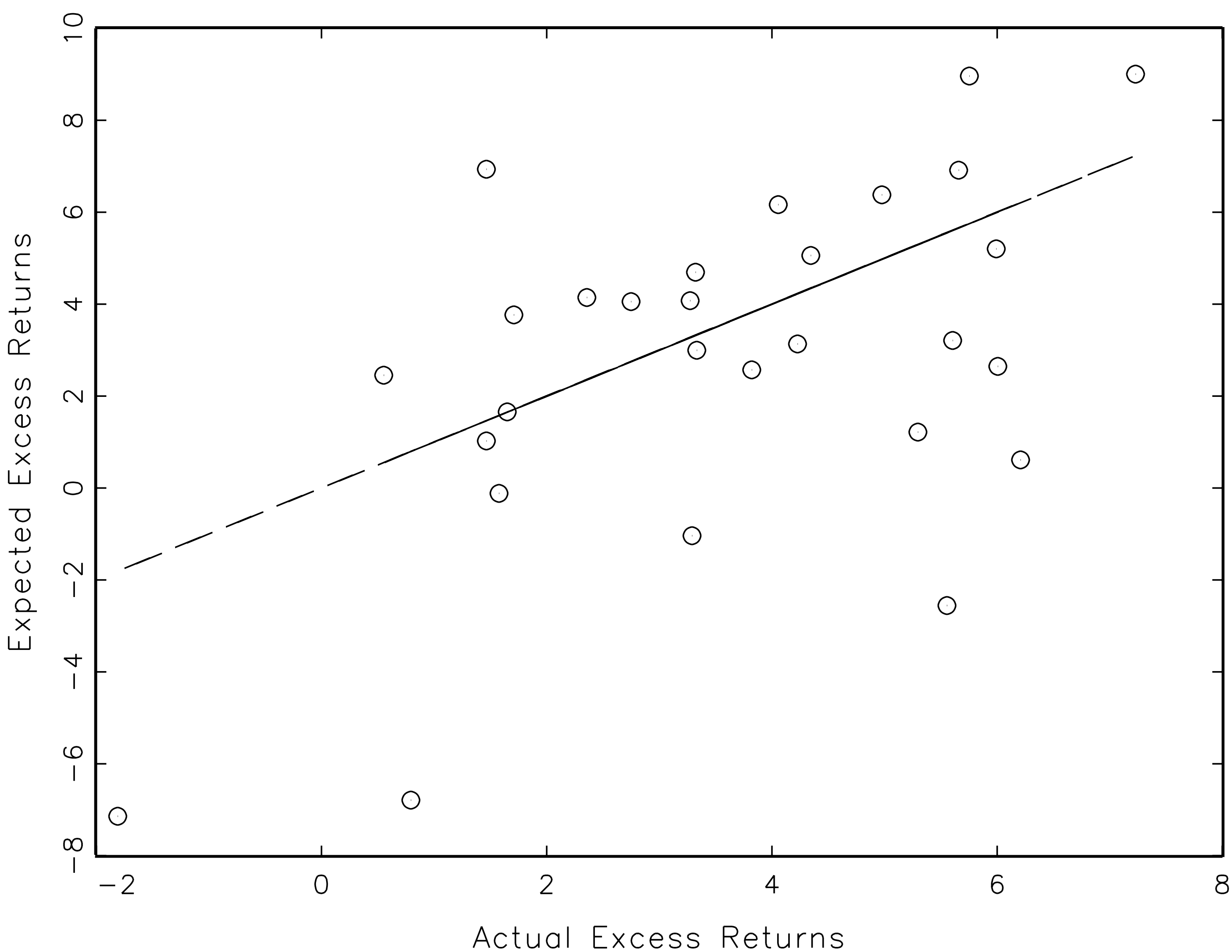

Figure 3

Expected risk premia associated with shocks to aggregate goods demand (AD), aggregate goods supply (AS), money demand (MD), monetary policy (MS), and financial markets (Market), and overall expected risk premia. All are in annualized rates, in percentages.

Solid lines are median risk premia across the 28 industries at each point in time, and dashed lines are the maximum and the minimum across the 28 industries, also computed at each point in time.

Note that the first three panels use different scaling from the last three panels.

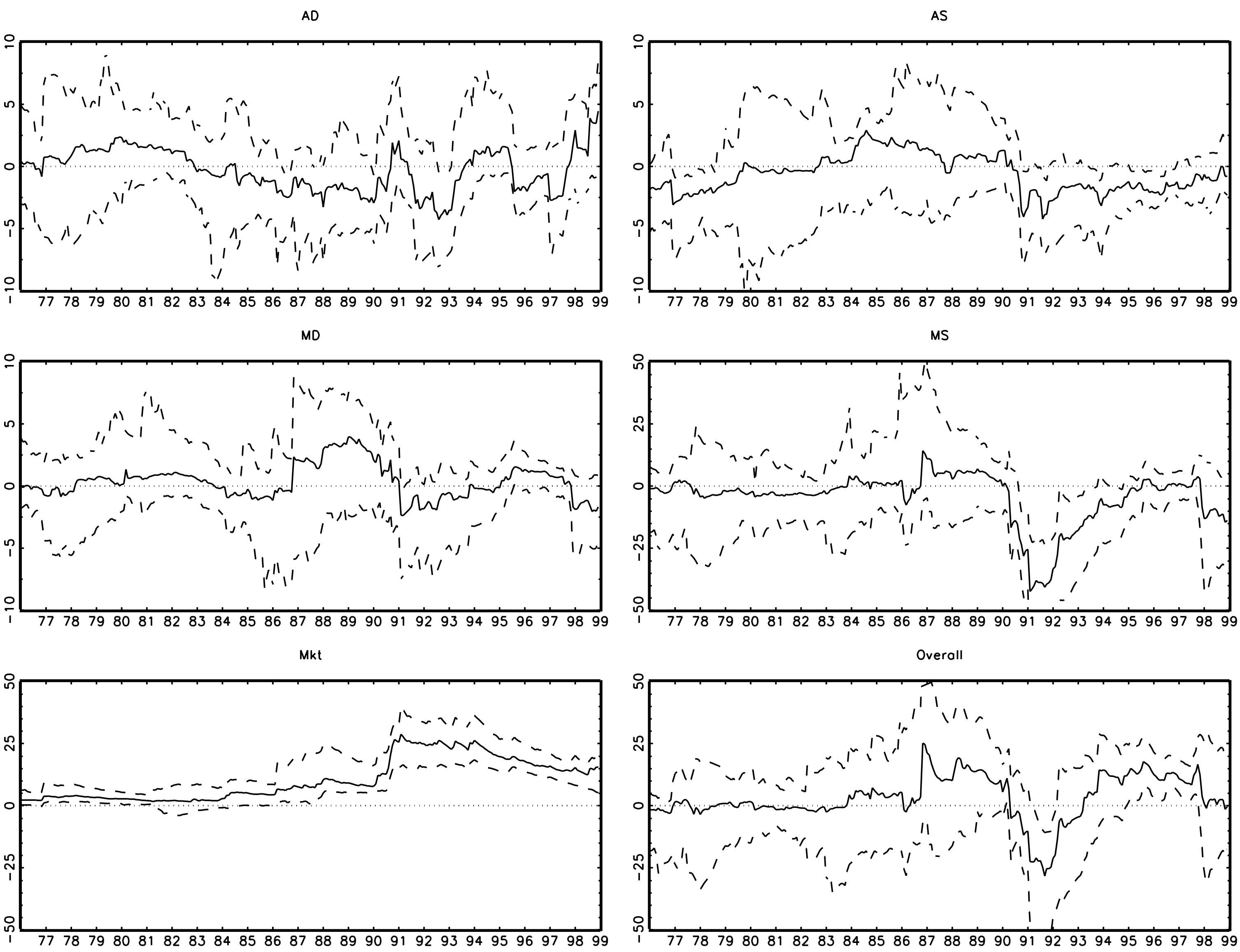

Figure 4

Estimated conditional correlations between identified structural shocks and industry returns.

Each panel represents conditional correlations of each macroeconomic shock, listed at the top of the panel, with the 28 industry returns. Solid lines are the median of the conditional correlations across the 28 industries, computed at each point in time. Dashed lines are the maximum and the minimum across the 28 industries, also computed at each point in time.