State Dependency in Japanese Equity Risk Premia

A project exploring the state dependency in Japanese stock returns over a 30 year period.

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Executive Summary

This project analyses the state dependency of equity risk premia in the Japanese stock market. The sample runs from July 1990 to February 2022 and is split based on the unemployment level. To estimate the risk premia of the included factors, a three-pass methodology is employed, which combines the traditional Fama-Macbeth regressions with principal component analysis to establish robust estimates of the risk premia and avoid omitted variable bias. When looking at different popular models of the risk premia, no apparent pattern emerges. Only the strength of the factors have an economic intuitive shape, but still a lot of the results lack economic intuition.

The concluding remark underlines the lack of pattern and statistical significance in the risk premia estimates, which could be challenged by using a different macroeconomic variable as proxy for the sentiment of the investors and the state of the Japanese economy. Additionally, the returns used could be augmented with portfolios consisting of bonds and currencies, as the employed portfolios only consist of equity returns.

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1 Introduction

The classical asset pricing literature has been built on both the factor-mimicking portfolio analysis as of Fama and French 1993 and the two-step cross sectional regression of Fama and MacBeth 1973. This has yielded an abundance of research into different factors and their corresponding risk premia. The evaluation of risk premia across time has however some drawbacks. Researchers have shown time-varying risk premia in the term structure and stock market (Dai and Singleton 2002)(Hodrick 1981). It seems illogical to assume that the risk premia for a certain variable is constant over time and not subject to changes given macroeconomic states. Due to this, this project will examine how the risk premia changes over different states of unemployment in Japan. The focus will be on the Japanese economy and the time period will be the last three decades. Thus the bubble economy of Japan starts out the time period, the increase in unemployment during the entry to the 21st century (Watanabe 2022) will mark the middle of the sample, and the corona crisis concludes the sample. Based on this development we will divide the periods into five different states, and evaluate how the risk premia differentiate across those. Notice that the returns during the war in Ukraine barely are included and wont be touched upon in the analysis.

The problems with using the two-step Fama-Macbeth cross-sectional regression mentioned above is seen in the omitted variable bias prevalent in the estimated risk premia, as the risk premia changes when including more factors in the models, and serves as an uncertainty in the estimation of the risk premia.

The split into different states and evaluation of risk premia within each state builds on the growing trend in the literature. Examples of research within state dependency in the Consumption CAPM framework is seen in Gordon and St-Amour 2004, and in predictability of asset returns in Borup et al. 2021.

The factors of interest in this paper have been chosen based on the extensive research conducted on the American stock market. Therefore, the first three models will be based on a mix of the canonical models of Sharpe 1964, Fama and French 1993, Fama and French 2015, and Carhart 1997. In addition to these models, it will be interesting to see how much correlation there is between trends in the American market and the Japanese stock market, as the Japanese market traditionally has been very open to outside investors. Based on this assumption different American factors will be included in the latter two models, with a focus on macroeconomic variables and the exchange rate of US Dollars against Japanese Yen in one, and news attention of the American market in the other.

We expect the risk premia of the market to be positive across the different states, and the risk premia for the factors in the extended model to be positive as well. This is due to the fact that when analyzing American stock returns and incorporating the estimated factors on the American data, positive risk premia is obtained. As a natural consequence of the sentiment in the financial markets and the openness of the Japanese stock market, the same trends would be expected. Furthermore, we would expect the strength of the factors to be most prominent when looking at commonly acknowledged factors, and less strength in the two last models included.

The project will continue as follows, the methodology will be explained in the following section. Subsequently, the empirical analysis is conducted, and subsections elaborating on the data employed, approach chosen, results obtained, and improvements considered, follow. The conclusion wraps up the project, and any additional information and elaborations are shown in the appendix.

2 Methodology

The three-pass-methodology introduced by Giglio and Xiu 2021 will be used to evaluate the risk premia of the different factors across the states. This approach has been developed based on a need for removing the omitted variable bias and the measurement error bias, as these issues have been proved to be prevalent in the approach proposed by Fama and MacBeth 1973. The three-pass methodology ensures consistent estimates of the risk premia and are less subject to problems arising from errors-in-variables compared to other regression based approaches.

The excess monthly returns of the portfolios is assumed to be linearly dependent on the factors and can be written as:

$$r_t^e = \gamma_0 \iota_N + \beta \left(\gamma + \upsilon_t\right) + u_t \tag{1}$$

where β is a vector of the risk exposures, γ is a vector of the risk premia, and γ_0 can be interpreted as the expected equity risk premium across time. The υ_t is consisting of all the true factors, noting here that not all true factors are observable. In addition to this equation, we assume that the error term, u_t, has an expected value of zero and that there is zero covariance between the error term and the true factors. To estimate this model we can only use the factors which are observable, and Giglio and Xiu 2021 therefore proposed a focus on the relation between the observed factors and the vector of all true factors:

$$g_t = \delta + \eta \cdot \upsilon_t + z_t \tag{2}$$

where g_t is an approximation of the subset of true factors, which are observable and which we want to estimate the risk premia for. η is the relation between the observable factors and the true factors. And as before, we assume that the expected value of the error term, z_t, and the covariance between the error term and the true factors are zero. In the aforementioned article, they argue that the risk premia estimations are invariant to a rotation of the factors, if that rotation is arbitrarily full rank. They employ PCA to find this rotation and use that to estimate consistent risk premia. Giglio and Xiu specify this risk premia to be a product of the risk premia in Equation 1 and the slope coefficient in Equation 2, leading to the following relation: $\gamma_g = \eta \cdot \gamma$. To estimate this risk premia we would need to observe either the product or the two individual values, the approach to find the estimated variables, $\hat{\gamma}_g = \hat{\eta} \cdot \hat{\gamma}$, is elaborated in section 3.2.

State Dependency: The states have been formed based on the forecast error of the unemployment from the model proposed by Hamilton 2018. This model factors out the seasonal movement and the long-run trend of the unemployment. To sort the time periods into the respective states, we use the error term, and sort them into quintiles. Periods with higher unemployment than expected due to either seasonal or trend effects will be categorized in the same state and assumed a constant risk premia. The motivation for using the error term (See the equation in section 5.1.) compared to the observed unemployment rates is the discrete nature of unemployment rates due to rounding, and as such a variable with a higher degree of continuity is better suited.

Forming Portfolios: The Empirical Analysis will be conducted using only equity portfolios. In table III.9 in the online appendix for Giglio and Xiu 2021 it is shown that the risk premia estimates remain the same if they only include equity portfolios compared to using both currencies, bonds and equities. Based on their conclusions, the equity portfolios are chosen as the only test portfolios and it is assumed in line with the conclusion of the aforementioned article that this choice do not have an effect on the risk premia estimates.

3 Empirical Analysis

3.1 Data

For the evaluation the portfolios of Japanese stocks, available at Kenneth French's website, are employed. They are formed based on size, value, operating profitability, investments, and momentum. This leaves us with 171 portfolios spanning from July 1990 to February 2022 (380 months). The portfolios are value-weighted, which reduces the effect of returns obtained by small and illiquid stocks in the portfolios. Following the approach in Giglio and Xiu 2021, these portfolios will be tested using the following five models:

1. *CAPM*: the first model will have the market excess return as the sole factor (along with a constant).
2. *FF3*: the second model incorporates in addition to the market excess, the size and the value factors are included (Fama and French 1993).
3. *FF5 + MOM*: the third model builds on the second by adding both the operating profitability and investment factor (Fama and French 2015), and lastly adding the momentum factor (Carhart 1997).
4. *Macro*: the fourth model will look at the first 6 principle components of the macroeconomic factors from Ludvigson and Ng 2009 and incorporate the US Dollar Japanese Yen exchange rate. This model will only be estimated until December 2021.
5. *News*: the last model is based on the news attention analysis from Bybee et al. 2020 and uses the first 2 principle components from their dataset as factors. This model will only be estimated until 2017.

To choose the relevant amount of principle component factors to include in the latter two models, eyeballing statistics will be used. The plots used for the choice is shown in the appendix in Figure 5.2.3.

The unemployment rate is revised data, as the availability of vintage unemployment rates is limited and the focus is on the difference between the expected level of unemployment based on historical trends and the factual level of unemployment. The five different sub-samples are described in section 5.1. Furthermore, the results from the first 3 models are very similar, and as such only the results of the third model will be shown in the following sections, but the general results can be seen in Table 5.1.1.

3.2 Approach

The empirical analysis will build on the following three-step procedure, which follows the description in section 3.3 in Giglio and Xiu 2021 and explanations from slides by Kjær 2022. This section shows how we arrive at $\hat{\gamma}_g = \hat{\eta} \cdot \hat{\gamma}$.

First step: PCA. The primary variation in the returns is found in this step, and the factors which explains the highest amount of variation in the returns are used, that is, the eigenvectors with the largest associated eigenvalues. This corresponds to the dimensions of the rotation that will be implemented. The risk exposures, $\hat{\beta}$, are found as:

$$\hat{\beta} = T^{-1}\bar{R}\hat{V}' \tag{3}$$

where $\bar{R}$ is the demeaned returns of n portfolios across T periods, and $\hat{V}$ is the latent factors found through PCA of the returns, $\hat{V} = T^{1/2}(\zeta_1, \zeta_2, \ldots, \zeta_{\hat{p}})'$. The following estimator for the choice of optimal number of principal components (PC's), $\hat{p}$, is proposed in the article and is employed here:

$$\hat{p} = \arg \min_{1 \leq j \leq p_{max}} \left(n^{-1} T^{-1} \lambda_j \left(\bar{R}^\intercal \bar{R} \right) + j \cdot \phi(n, T) \right) - 1 \tag{4}$$

where p_{max} is the maximum amount of PC's considered and $\phi(n, T)$ is some cost function. The optimal number of PC's to include differs across states of unemployment. Thus four of the five different states have an optimal number of PC's of three, while the remaining state (number 2) has an optimal number of PC's of four. As stated in Giglio and Xiu 2021 we should only conduct robustness tests towards a higher number of PC's, and as such, the estimates will be reported for the optimal amount of included PC's in Table 3.3.2, while the robustness values are reported in the appendix in Tables 5.3.1, 5.3.2, and 5.3.3.

Second step: cross sectional regression. There will be included a constant when regressing the average returns on the factor loadings, $\hat{\beta}$. Thus the following estimation of the intercept and slope coefficients in 1 is:

$$\hat{\gamma}_0 = \left(\iota_N' M_{\hat{\beta}} \iota_N \right)^{-1} \iota_N M_{\hat{\beta}} \bar{r} \tag{5}$$

$$\hat{\gamma}_g = \bar{G} \hat{V}' \left(\hat{V} \hat{V}' \right)^{-1} \left(\hat{\beta}' M_{\iota_N} \hat{\beta} \right)^{-1} \hat{\beta} M_{\iota_N} \bar{r} \tag{6}$$

where $M_{\hat{\beta}} = I_N - \hat{\beta} \left(\hat{\beta}' \hat{\beta} \right)^{-1} \hat{\beta}'$, $M_{\iota_N} = I_N - \iota_N \left(\iota_N' \iota_N \right)^{-1} \iota_N'$, and $\bar{G}$ is the demeaned value of the observable factor. This step then yields the average risk premia of each latent factor, which is used in the risk premia of the observable factors, $hat\gamma$.

Third step: time-series regression. The last step estimate the second part of the product of the risk premia estimates, $\hat{\eta}$. The observable factors are regressed upon the extracted PC's from step one:

$$\hat{\eta} = \bar{G} \hat{V}' \left(\hat{V}' \hat{V} \right)^{-1} \tag{7}$$

which yields the last value needed to form the risk premia estimates of the observable factors within each state. To evaluate the significance of the estimated risk premia, HAC standard errors will be used, as recommended in the article, and OLS turns out to be an efficient estimator in this case. The results will be shown in the following subsection.

3.3 Results

It turns out when estimating the first three proposed models, that the risk premia estimates and standard errors do not significantly differ. This supports the conclusion in ibid., as they argue that risk premia estimates obtained using the three-pass procedure should not be affected by omitted variable bias. And it seems that this is the case here, as the coefficients remain stable when adding more explanatory factors. The consistency in the estimation of the risk premia is apparent when comparing with the risk premia estimates of the Fama-Macbeth two-step regressions as shown in Table 5.1.3. The risk premia of the market for example changes across models when looking at the same state. When reporting the coefficients and standard errors, only the third model (and the two remaining models) will be displayed.

Please refer to Table 5.1.1 in the appendix for further interpretation of the coefficients of the first two models.

The analysis of the risk premia estimates in this project will focus on the strength of the factors and on the risk premia estimates, including standard errors and statistical significance. The strength of a factor is determined by how much of the variation in the returns is explained by the factor over time, that is the R^2 of the factor in the time-series regression. The strength of the included factors are shown in Table 3.3.1. The estimated risk premia and the standard errors of the three different models are shown in Table 3.3.2 where statistical significance at 90%, 95%, and 99% levels are indicated with respectively *, **, and ***.

States		1	2	3	4	5
FF5 + MOM	Market	0.9769	0.8869	0.9108	0.9569	0.9786
	Size	0.9897	0.9864	0.9874	0.9838	0.9674
	Value	0.7924	0.9413	0.8470	0.9044	0.7270
	Oper. Profit.	0.2925	0.4060	0.1967	0.4840	0.3682
	Investments	0.1045	0.2581	0.2758	0.6574	0.7144
	Momentum	0.3709	0.4486	0.2586	0.2949	0.5246
Macro	Dollar-Yen Exch. Rate	0.0616	0.2411	0.0256	0.0500	0.0130
	1st Prin. Comp.	0.0549	0.0227	0.0308	0.0202	0.0172
	2nd Prin. Comp.	0.0188	0.2711	0.1000	0.1147	0.0319
	3rd Prin. Comp.	0.2213	0.1931	0.0468	0.1198	0.0410
	4th Prin. Comp.	0.1432	0.1156	0.0089	0.0368	0.0050
	5th Prin. Comp.	0.0974	0.0301	0.1149	0.0355	0.0446
	6th Prin. Comp.	0.0780	0.0775	0.0287	0.0729	0.0820
News	1st Prin. Comp.	0.0342	0.1552	0.0219	0.1467	0.0251
	2nd Prin. Comp.	0.0076	0.2271	0.0551	0.2780	0.0656

Table 3.3.1: Strength of the Factors, evaluated at optimal amount of PC's

Strength We would expect the strength of factors to show a pattern across the states, this is however not the case, as the strength of the factors across states are inconsistent. When looking at the first reported model, the market factor has an increasing strength across the states, with a much higher strength in the state of the highest unemployment compared to the expectation. The expectation would be that the market factor would have the highest strength in periods of high uncertainty, as uncertainty would, intuitively, prompt investors to be more risk-averse. Thus the market risk would explain more of the variation in the data during periods, in which the unemployment rate was higher than the expected level. This does not, however, explain the high strength of the market factor in the first state. The pattern is different when looking at the size factor, which shows a higher strength across all states compared to the strength obtained in Table 2 in Giglio and Xiu 2021. In general it can be stated that the explanatory power of the size factor is surprisingly high. Furthermore, it is noted that the investment factor has an increasing explanatory power given that the unemployment is higher than expected, which means that the higher uncertainty (or worse economic times than expected) leads to the investors looking at the investment factor as a source of risk. It should be noted that the remaining factors of the first reported model show no obvious pattern. Furthermore, the market and the size factors show a very high degree of strength, that is, the variation in the time-series of the returns is highly correlated with the market factor and the size factor, compared to the remaining included factors. This is however not consistent with the results in the aforementioned article, as they find similar values of strength for the included factors.

States		1	2	3	4	5
FF5 + MOM	Intercept	0.0112***	-0.0018	-0.0154***	0.0037**	-0.0025**
	se.	(0.0014)	(0.0025)	(0.0025)	(0.0022)	(0.0015)
	Market	-0.0070**	-0.0020	-0.0003	-0.0137**	0.0072
	se.	(0.0040)	(0.0053)	(0.0093)	(0.0081)	(0.0072)
	Size	-0.0011	0.0033	0.0049	-0.0019	0.0010
	se.	(0.0029)	(0.0039)	(0.0040)	(0.0041)	(0.0042)
	Value	0.0026*	0.0007	0.0012	0.0098**	-0.0039
	se.	(0.0017)	(0.0031)	(0.0034)	(0.0051)	(0.0043)
	Oper. Profit.	-0.0003	0.0004	-0.0008	-0.0013	0.0016
	se.	(0.0008)	(0.0013)	(0.0014)	(0.0028)	(0.0022)
	Investments	0.0008*	0.0004	0.0015	0.0025	-0.0038
	se.	(0.0006)	(0.0009)	(0.0016)	(0.0028)	(0.0040)
	Momentum	-0.0025*	0.0013	-0.0017	-0.0025	0.0038
	se.	(0.0015)	(0.0029)	(0.0039)	(0.0037)	(0.0050)
Macro	Intercept	0.0112***	-0.0018	-0.0154***	0.0036*	-0.0025**
	se.	(0.0014)	(0.0025)	(0.0025)	(0.0023)	(0.0015)
	Dollar-Yen Exc. Rate	0.4210	0.9689	0.1018	-0.2025	-0.0012
	se.	(0.7872)	(1.4274)	(0.3218)	(0.4311)	(0.3289)
	1st Prin. Comp.	0.0072	-0.0033	0.0201	0.0014	-0.0140
	se.	(0.0105)	(0.0078)	(0.0418)	(0.0277)	(0.0179)
	2nd Prin. Comp.	-0.0078	0.0015	0.0118	-0.0332**	0.0059
	se.	(0.0092)	(0.0244)	(0.0194)	(0.0190)	(0.0107)
	3rd Prin. Comp.	-0.0181*	-0.0088	0.0026	-0.0101	-0.0093
	se.	(0.0123)	(0.0153)	(0.0076)	(0.0127)	(0.0112)
	4th Prin. Comp.	0.0114*	-0.0068	-0.0002	-0.0060	0.0028
	se.	(0.0080)	(0.0086)	(0.0041)	(0.0098)	(0.0050)
	5th Prin. Comp.	-0.0092**	-0.0046	-0.0010	0.0089	0.0043
	se.	(0.0053)	(0.0044)	(0.0099)	(0.0081)	(0.0066)
	6th Prin. Comp.	-0.0010	0.0044	-0.0015	-0.0105**	0.0103
	se.	(0.0046)	(0.0050)	(0.0047)	(0.0051)	(0.0094)
News	Intercept	0.0114***	-0.0123***	-0.0126***	-0.0004	-0.0046***
	t-stat	(0.0015)	(0.0028)	(0.0029)	(0.0024)	(0.0015)
	1st Prin. Comp.	-0.0001	0.0001	0.0002	-0.0004	-0.0004
	t-stat	(0.0008)	(0.0013)	(0.0004)	(0.0009)	(0.0006)
	2nd Prin. Comp.	0.0001	0.0002	0.0002	0.0013	-0.0003
	t-stat	(0.0004)	(0.0008)	(0.0005)	(0.0011)	(0.0004)

Table 3.3.2: Coefficients and standard errors for Three-Pass Procedure

For the second and third model the strength of the included variables are significantly lower compared to the strength of the factors in the first model. The Dollar-Yen exchange rate is very weak, as the factor in no state, except state 2, has an explanatory power higher than 7%. In the second state, the exchange rate has a starkly different explanatory power, for which there is no obvious economic intuition, whether it be due to the splitting of the states (see Figure 5.1.1) or the distinction of unemployment levels in that particular state. It was expected that the exchange rate could explain more of the excess returns, given the amount of American investors in the Japanese market, and the perception that the Japanese stock market has been growing steadily compared to the fluctuations seen in other markets.

The explanatory power of the macro economic principle components are slightly higher in this dataset compared to the ones reported in Giglio and Xiu 2021, it is important, however, to keep in mind that Giglio and Xiu look at the principle components of the first order autocorrelation in these factors, whereas this analysis is build on the original factors. We would expect less explanatory power of American macro economic variables when explaining Japanese stock returns and their variation over time compared to the American stocks, but this turns out to not be the case, as the explanatory power is higher.

With respect to the news factors, it would be difficult a priori to estimate how well they explain the variation in the Japanese stock returns, as they are not included in the aforementioned article. It would be expected, however, that they represent the focus of international media, and thus would affect the Japanese stock returns. It seems that the two principle components of the news have the highest explanatory power in state 2 and 4. The intuitive explanation for this, could be due to the fact that given an unemployment level close to the expected, the sentiment of the international investors would be more prominent, and as such investors would trade based on international news. This would also explain why the explanatory power is lower in the most deviation from the expected level, as a high deviation from the expected level would indicate that the economic conditions within the Japanese market is changing, and as such the local conditions are more important in affecting the international investors sentiment compared to the general news picture. It does not, however, explain the low explanatory power in the middle state.

Risk Premia The estimated risk premia of the models for the five different states show no discernible pattern. The sign of the coefficients changes across states and are not consistent within each state. Furthermore, the market risk premia is not consistent with the economic understanding, as one would expect the market risk premia to be positive across all states.

The expected value for the risk premia would be the same as in the American stock market, which can be found in Table 2 in ibid. When comparing the results, it is immediately clear that the results here are not as statistically significant. In particular the momentum factor is only significant at a 90% level in one state and it is not significant in any of the other states. This is quite different from the results of the article, which shows a momentum factor which is statistically significant at a 99% level.

The size factor has a differing sign across states and is not significant in any state. The value factor has a consistently positive sign across the first four states and is even statistically significant different from zero at a 90% level in state four. The value factor has however a negative risk premia in the fifth state. This is not economically intuitive, as one would expect the value factor to be consistent across unemployment states, or at least show a increase in the risk premia given higher unemployment than expected. A positive risk premia is also seen in Giglio and Xiu, which is found to be 0.21 and significantly different from zero at a 90% level. The fact that very few of the risk premia on size, value and momentum are statistically significant is consistent with the expectations. This is due to the fact that in Giglio and Xiu, they estimate their model on different subsets of the portfolios included, and this results in differing estimates for the risk premia. In addition to this, we can compare the estimated risk premia for the momentum factor in the Japanese market (Fama and French 2012), which found no momentum when sorting the stocks on size and value.

In the macroeconomic model, only very few risk premia are statistically significant across the five states. This results in the sign of the coefficients changing across states and principle components. In addition to this, none of the estimated coefficients of the first three principle components show the same pattern as found in the article for the American stock market. This conclusion should however be interpreted while keeping in mind that the article is looking at the innovations in the macroeconomic variables, whereas this project is looking at the level.

For the news model, only the intercept is statistically significant across most of the states. The remaining factors included are not significant and shows no apparent pattern. This might be because the international investors and their sentiment are not as affected by the international news picture and as such mostly react to other risk factors or the local news for the Japanese market.

Although the states have been split into periods in which there is no common pattern in the risk premia, the systematic variation in the states closely resembles actual cyclical business cycles and can be inspected in Figure 5.1.1. Furthermore, it is seen that the three-pass method does not yield more economically intuitive results than the traditional Fama-Macbeth approach. The corresponding estimated risk premia of the Fama-Macbeth approach is shown in table 5.1.3.

In addition to this, when looking at the robustness of the risk premia estimates, it seems that they stay at the same level even with 5 additional PC's of the returns added to the method. Thus we can conclude, that results are robust to the choice of PC's. The robustness test can be inspected in Tables 5.3.1, 5.3.2, and 5.3.3.

3.4 Improvements

The variable used for the state dependency might not give a precise picture of the state of the economy. It could be improved by using vintage data, so as to take into account what information the investors had at the time of investment. Furthermore, it could be more accurate to use either an index for the purchasing manager confidence, or a measure of the industrial production, which might catch developments in the macro economy faster than the unemployment rate.

An inclusion of other return portfolios could also be beneficial. This could include portfolios of bonds or currencies, which would help in identifying the risk premia given the sentiment of the investors. In addition to this, equity portfolios sorted on other observable factors could be beneficial to include, or factors related to exposure to market-wide volatility. Furthermore, the portfolios are formed on only a limited amount of factors, and expanding the amount of portfolio sorting variables would perhaps yield more consistent results.

Other considerations could also include to use Ridge regressions instead of PCA to find the direction of variance in the returns, or to compare the three-pass approach utilized here with the two-step selection method based on the double-selection LASSO as in Belloni, Chernozhukov, and Hansen 2014, as this approach also serves to avoid omitted variable bias. Other potential approaches are described in Collot and Hemauer 2021.

4 Conclusion

This project uses the three-pass methodology to estimate , in a more robust way, risk premia for different models across five different macroeconomic states. The returns employed in the analysis consisted of value-weighted equity portfolios from the Japanese stock market, and span a period from July 1990 to February 2022.

We expected the risk premia of the included factors to be significantly different from zero and show a pattern across different macro economic states. This was not the result of the empirical analysis, however, as most of the estimated risk premia are not statistically significant above 90% and the strength of only a few factors show a pattern across the states. The strength of the included factors, however, shows a pattern across the different states, and some of the values is interpreted in an economic intuitive way. Yet other values of strength does not correspond to the prior expectation.

This results in the conclusion that the Japanese economy does not have a significant risk premia for the included factors, and thus the risk premia is not dependent upon the macroeconomic state when splitting the states according to the difference between the expected level of unemployment and the realised. This conclusion could be due to the choice of macroeconomic variable, as a proxy for the production in Japan might catch any shift in the macroeconomic state faster than the unemployment. It could also be due to the included portfolios, as a more diversified portfolio of returns would yield significant results (as the comparison done in Table 4 in Giglio and Xiu 2021.

The three-pass method employed here, yields consistent and robust results, and shows no sign of omitted variable bias. This is in accordance with the conclusion with the original article (ibid.).

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5 Appendix

5.1 Data

In this appendix, all the data sources will be described and choices made regarding the handling of the data will be elaborated.

The portfolios are formed by Kenneth French and available in his library. All the portfolios are sorted on the classical metrics of size, value, operating profitability, investments and momentum. The interest rate is obtained from the Japanese Ministry of Finance[1]. The historical exchange rate is obtained from MacroTrends[2].

The coefficients of the first three models is shown in Table 5.1.1 below.

States		1	2	3	4	5
CAPM	Intercept	0.0112***	-0.0018	-0.0154***	0.0037**	-0.0025**
	se.	(0.0014)	(0.0025)	(0.0025)	(0.0022)	(0.0015)
	Market	-0.0070**	-0.0020	-0.0003	-0.0136**	0.0072
	se.	(0.0040)	(0.0053)	(0.0093)	(0.0081)	(0.0072)
FF3	Intercept	0.0112***	-0.0018	-0.0154***	0.0037**	-0.0025**
	se.	(0.0014)	(0.0025)	(0.0025)	(0.0022)	(0.0015)
	Market	-0.0070**	-0.0020	-0.0003	-0.0136**	0.0072
	se.	(0.0040)	(0.0053)	(0.0093)	(0.0081)	(0.0072)
	Size	-0.0011	0.0033	0.0049	-0.0019	0.0010
	se.	(0.0029)	(0.0039)	(0.0040)	(0.0041)	(0.0042)
	Value	0.0026*	0.0007	0.0012	0.0098**	-0.0039
	se.	(0.0017)	(0.0031)	(0.0034)	(0.0051)	(0.0043)
FF5 + MOM	Intercept	0.0112***	-0.0018	-0.0154***	0.0037**	-0.0025**
	se.	(0.0014)	(0.0025)	(0.0025)	(0.0022)	(0.0015)
	Market	-0.0070**	-0.0020	-0.0003	-0.0137**	0.0072
	se.	(0.0040)	(0.0053)	(0.0093)	(0.0081)	(0.0072)
	Size	-0.0011	0.0033	0.0049	-0.0019	0.0010
	se.	(0.0029)	(0.0039)	(0.0040)	(0.0041)	(0.0042)
	Value	0.0026*	0.0007	0.0012	0.0098**	-0.0039
	se.	(0.0017)	(0.0031)	(0.0034)	(0.0051)	(0.0043)
	Oper. Profit.	-0.0003	0.0004	-0.0008	-0.0013	0.0016
	se.	(0.0008)	(0.0013)	(0.0014)	(0.0028)	(0.0022)
	Investments	0.0008*	0.0004	0.0015	0.0025	-0.0038
	se.	(0.0006)	(0.0009)	(0.0016)	(0.0028)	(0.0040)
	Momentum	-0.0025*	0.0013	-0.0017	-0.0025	0.0038
	se.	(0.0015)	(0.0029)	(0.0039)	(0.0037)	(0.0050)

Table 5.1.1: The Three First Models, Similarity in Coefficients

The time periods included in this project are split into the different states according to the method mentioned in section 2, and the split is shown in Figure 5.1.1. Furthermore, the estimated risk premia of the Fama-Machbeth

[1] https://www.mof.go.jp/english/policy/jgbs/reference/interest_rate/index.htm
[2] https://www.macrotrends.net/2550/dollar-yen-exchange-rate-historical-chart

States		1	2	3	4	5
Returns	Mean	0.00323	-0.00418	-0.01324	-0.00931	0.00437
	Min.	-0.19	-0.24	-0.16	-0.19	-0.13
	25th perc.	-0.02	-0.04	-0.06	-0.06	-0.03
	Median	0.01	0	-0.01	-0.01	0
	75th perc.	0.03	0.03	0.03	0.03	0.04
	Max.	0.08	0.19	0.18	0.16	0.15
	Variance	0.0015	0.004	0.0062	0.0043	0.0031

Table 5.1.2: Descriptive Statistics, Returns across States

regressions are shown in Table 5.1.3. The data set is split into 5 different subsamples, which is described in Table 5.1.2.

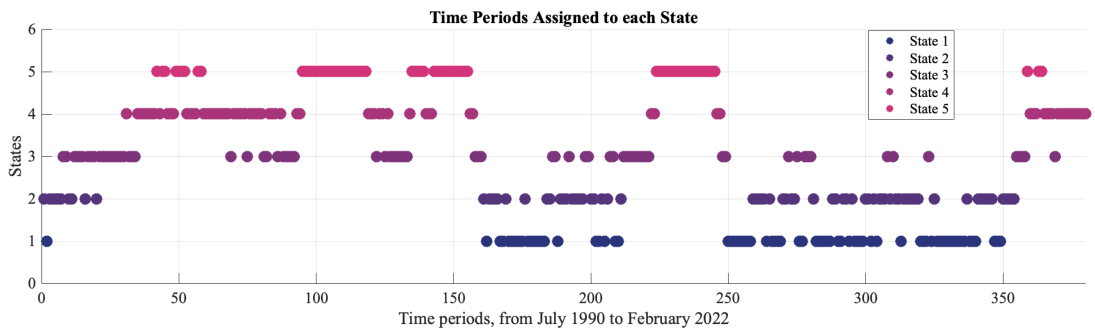


Figure 5.1.1: Time Periods Assigned to each State

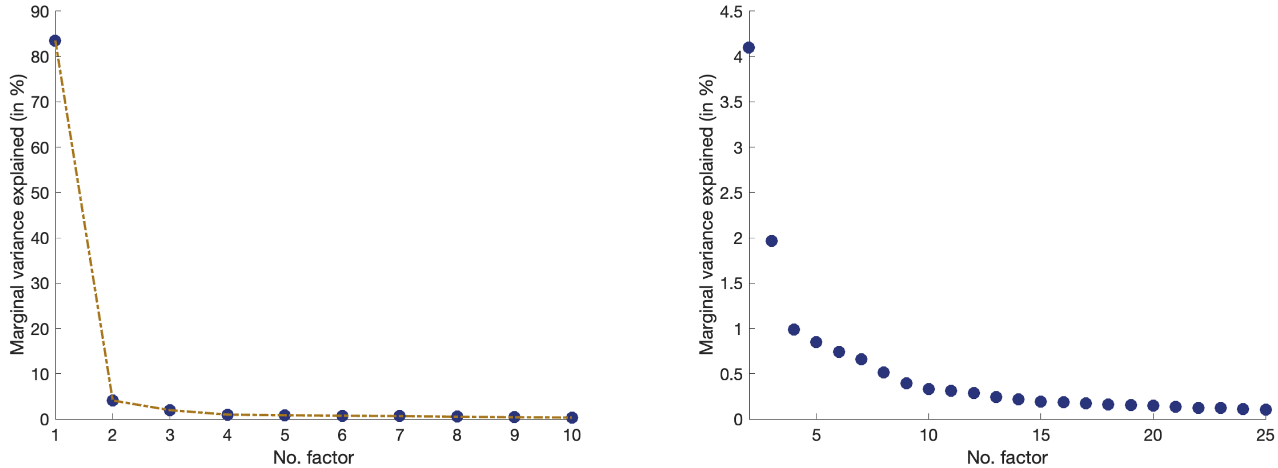
The model estimated and used for the splitting is:

$$y_{t+h} = \beta_0 + \sum_{p=1}^{12} \beta_p y_{t-p+1} + \nu_{t+h} \tag{8}$$

States		1	2	3	4	5
CAPM	Intercept	0.0072	-0.0104*	-0.0217***	0.0100	-0.0062
	Market	-0.0039	0.0060	0.0079	-0.0186*	0.0112
FF3	Intercept	0.0117***	-0.0115**	-0.0172***	0.0013	-0.0041
	Market	-0.0075*	0.0053	0.0013	-0.0115	0.0088
	Size	-0.0012	0.0030	0.0048	-0.0020	0.0010
	Value	0.0034*	0.0010	0.0024	0.0105***	-0.0046
FF5 + MOM	Intercept	0.0100***	-0.0102**	-0.0210***	-0.0028	-0.0030
	Market	-0.0056	0.0045	0.0046	-0.0079	0.0079
	Size	-0.0012	0.0030	0.0044	-0.0020	0.0008
	Value	0.0035*	0.0015	0.0023	0.0106***	-0.0027
	Oper. Profit.	0.0004	0.0007	-0.0028	-0.0001	0.0049*
	Investments	0.0008	0.0012	0.0052**	0.0003	-0.0066**
	Momentum	-0.0000	0.0054	0.0012	-0.0063*	0.0036
Macro	Intercept	0.0110***	-0.0100*	-0.0128*	-0.0096*	0.0008
	Dollar-Yen Exch. Rate	1.1437	-2.3084	0.5689	4.6417	3.9567
	1st Prin. Comp.	0.0413	-0.0052	-0.0009	0.0319	-0.0260
	2nd Prin. Comp.	-0.0203	-0.0354	0.1358	-0.1295	-0.0967
	3rd Prin. Comp.	-0.0271	0.0032	0.0761*	-0.0760**	-0.0606
	4th Prin. Comp.	0.0460*	0.0237	0.0084	-0.0160**	0.0458
	5th Prin. Comp.	0.0034	-0.0300	-0.0087	-0.0002	-0.0197
	6th Prin. Comp.	0.0106	-0.0000	-0.0260	-0.0338	0.0667
News	Intercept	0.0049	-0.0128	-0.0132*	-0.0165**	0.0023
	1st Prin. Comp.	-0.0059	0.0006	0.0079*	-0.0040	-0.0032
	2nd Prin. Comp.	0.0021	-0.0020	0.0017	0.0036**	-0.0008

Table 5.1.3: Risk Premia, according to Fama-Macbeth approach

5.2 Principal Components Analysis



(a) Factors 1:10 (b) Factors 2:25

Figure 5.2.1: PC's, Explained Marginal Variance in Returns

It can be seen that the explained variance for the first factor is above 80 percent, and the explained marginal variance decreases significantly for the following factors.

However, after finding the optimal amount of PC's to include to be 3 or 4 across the different states, the R^2 of the PC's of the returns is shown to increase significantly for some of the states in Figure 5.2.2.

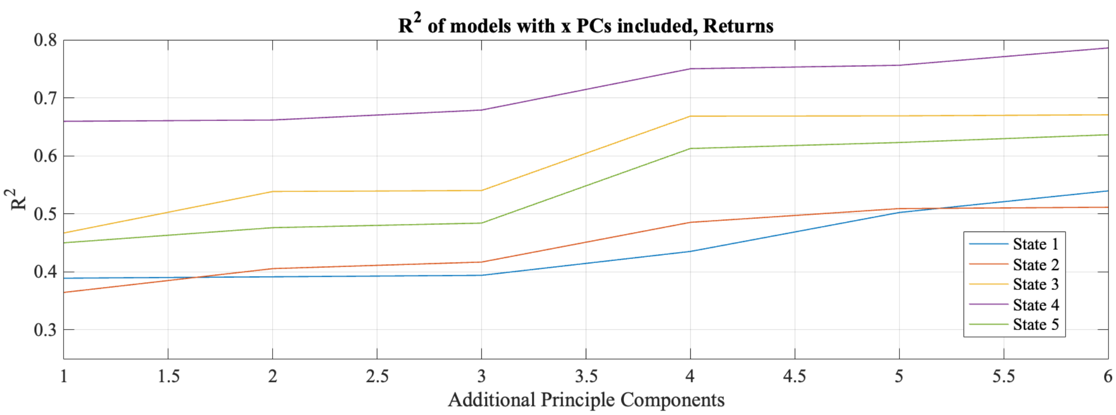
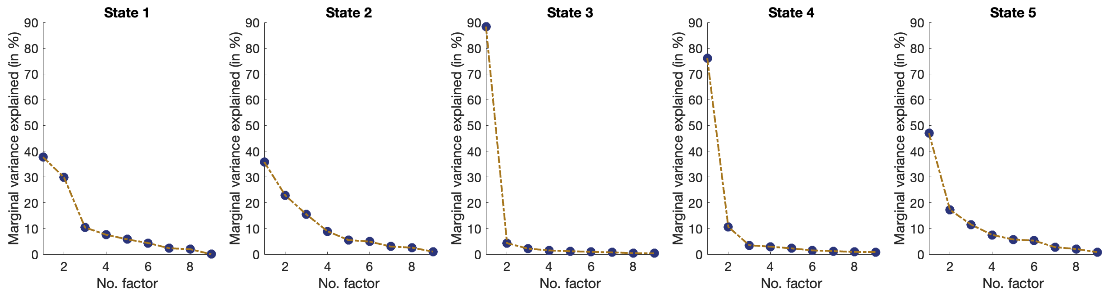
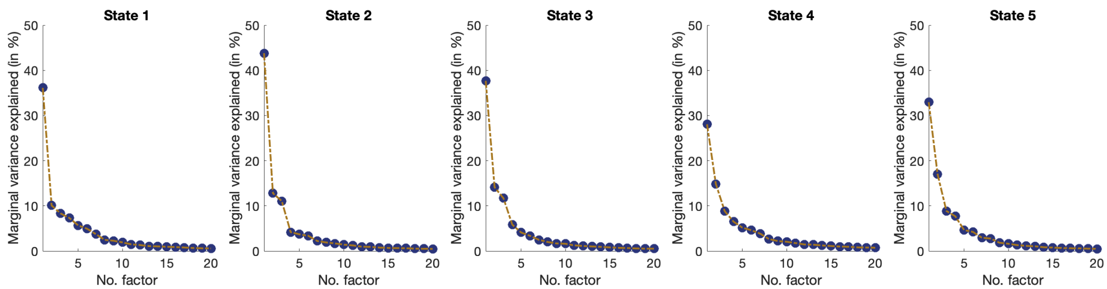


Figure 5.2.2: R^2 across States

When investigating the relevant amount of factors to include in the analysis of news and macro economic variables, the following figure will be relevant.



(a) PC's of Macro Factors from Ludvigson and Ng (2009)



(b) PC's of News factors from Bybee et al. (2020)

Figure 5.2.3: PC's, Explained Marginal Variance of Macro and News models

5.3 Robustness Checks

When including more Priniple components factors in the analysis, according to theory, the estimates of the risk premia should become more precise. Due to this, the coefficients for an additional 5 Priniple components are shown in the table below.

Additional PC's		0	1	2	3	4	5
CAPM	Intercept	0.0112	0.0108	0.0101	0.0102	0.0093	0.0090
State 1	Market	-0.0070	-0.0065	-0.0057	-0.0058	-0.0048	-0.0045
CAPM	Intercept	-0.0018	0.0046	0.0025	-0.0018	0.0020	0.0022
State 2	Market	-0.0020	-0.0061	-0.0048	-0.0012	-0.0037	-0.0039
CAPM	Intercept	-0.0154	-0.0127	-0.0113	-0.0128	-0.0130	-0.0137
State 3	Market	-0.0003	-0.0026	-0.0038	-0.0029	-0.0027	-0.0021
CAPM	Intercept	0.0037	0.0021	-0.0027	0.0012	-0.0002	-0.0021
State 4	Market	-0.0136	-0.0120	-0.0078	-0.0108	-0.0094	-0.0075
CAPM	Intercept	-0.0025	-0.0030	-0.0019	-0.0078	-0.0056	-0.0047
State 5	Market	0.0072	0.0076	0.0065	0.0127	0.0106	0.0095
FF3	Intercept	0.0112	0.0108	0.0101	0.0102	0.0093	0.0090
State 1	Market	-0.0070	-0.0065	-0.0057	-0.0058	-0.0048	-0.0045
	Size	-0.0011	-0.0012	-0.0011	-0.0012	-0.0012	-0.0012
	Value	0.0026	0.0027	0.0027	0.0032	0.0034	0.0036
FF3	Intercept	-0.0018	0.0046	0.0025	-0.0018	0.0020	0.0022
State 2	Market	-0.0020	-0.0061	-0.0048	-0.0012	-0.0037	-0.0039
	Size	0.0033	0.0032	0.0033	0.0029	0.0029	0.0029
	Value	0.0007	0.0008	0.0010	0.0012	0.0016	0.0016
FF3	Intercept	-0.0154	-0.0127	-0.0113	-0.0128	-0.0130	-0.0137
State 3	Market	-0.0003	-0.0026	-0.0038	-0.0029	-0.0027	-0.0021
	Size	0.0049	0.0046	0.0046	0.0043	0.0043	0.0043
	Value	0.0012	0.0014	0.0014	0.0030	0.0030	0.0029
FF3	Intercept	0.0037	0.0021	-0.0027	0.0012	-0.0002	-0.0021
State 4	Market	-0.0136	-0.0120	-0.0078	-0.0108	-0.0094	-0.0075
	Size	-0.0019	-0.0020	-0.0018	-0.0023	-0.0023	-0.0023
	Value	0.0098	0.0100	0.0099	0.0099	0.0100	0.0100
FF3	Intercept	-0.0025	-0.0030	-0.0019	-0.0078	-0.0056	-0.0047
State 5	Market	0.0072	0.0076	0.0065	0.0127	0.0106	0.0095
	Size	0.0010	0.0012	0.0012	0.0009	0.0008	0.0008
	Value	-0.0039	-0.0047	-0.0045	-0.0035	-0.0033	-0.0030
FF5 + MOM	Intercept	0.0112	0.0108	0.0101	0.0102	0.0093	0.0090
State 1	Market	-0.0070	-0.0065	-0.0057	-0.0058	-0.0048	-0.0045
	Size	-0.0011	-0.0012	-0.0011	-0.0012	-0.0012	-0.0012
	Value	0.0026	0.0027	0.0027	0.0032	0.0034	0.0036
	Oper. Profit.	-0.0003	-0.0005	-0.0004	-0.0009	-0.0002	-0.0003
	Investments	0.0008	0.0008	0.0006	0.0015	0.0013	0.0007
	Momentum	-0.0025	-0.0025	-0.0023	-0.0012	-0.0000	-0.0010
FF5 + MOM	Intercept	-0.0018	0.0046	0.0025	-0.0018	0.0020	0.0022
State 2	Market	-0.0020	-0.0061	-0.0048	-0.0012	-0.0037	-0.0039
	Size	0.0033	0.0032	0.0033	0.0029	0.0029	0.0029
	Value	0.0007	0.0008	0.0010	0.0012	0.0016	0.0016
	Oper. Profit.	0.0004	0.0008	0.0008	0.0012	0.0009	0.0007
	Investments	0.0004	0.0007	0.0011	0.0007	0.0005	0.0008
	Momentum	0.0013	0.0018	0.0027	0.0054	0.0065	0.0066
FF5 + MOM	Intercept	-0.0154	-0.0127	-0.0113	-0.0128	-0.0130	-0.0137
State 3	Market	-0.0003	-0.0026	-0.0038	-0.0029	-0.0027	-0.0021
	Size	0.0049	0.0046	0.0046	0.0043	0.0043	0.0043
	Value	0.0012	0.0014	0.0014	0.0030	0.0030	0.0029
	Oper. Profit.	-0.0008	-0.0022	-0.0020	-0.0029	-0.0028	-0.0029
	Investments	0.0015	0.0037	0.0038	0.0051	0.0050	0.0052
	Momentum	-0.0017	-0.0023	-0.0028	0.0008	0.0008	0.0011

Table 5.3.1: Robustness Checks, part 1

Additional PC's		0	1	2	3	4	5
FF5 + MOM	Intercept	0.0037	0.0021	-0.0027	0.0012	-0.0002	-0.0021
State 4	Market	-0.0137	-0.0121	-0.0080	-0.0110	-0.0096	-0.0078
	Size	-0.0019	-0.0020	-0.0018	-0.0023	-0.0023	-0.0023
	Value	0.0098	0.0101	0.0100	0.0099	0.0101	0.0101
	Oper. Profit.	-0.0013	-0.0014	-0.0002	0.0003	0.0004	0.0001
	Investments	0.0025	0.0025	0.0017	0.0007	0.0008	0.0005
	Momentum	-0.0025	-0.0017	-0.0026	-0.0045	-0.0045	-0.0067
FF5 + MOM	Intercept	-0.0025	-0.0030	-0.0019	-0.0078	-0.0056	-0.0047
State 5	Market	0.0072	0.0076	0.0065	0.0127	0.0106	0.0095
	Size	0.0010	0.0012	0.0012	0.0009	0.0008	0.0008
	Value	-0.0039	-0.0047	-0.0045	-0.0035	-0.0033	-0.0030
	Oper. Profit.	0.0016	0.0021	0.0020	0.0040	0.0043	0.0044
	Investments	-0.0038	-0.0045	-0.0047	-0.0054	-0.0057	-0.0061
	Momentum	0.0038	0.0025	0.0021	0.0044	0.0046	0.0038
Macro	Intercept	0.0112	0.0108	0.0101	0.0102	0.0093	0.0090
State 1	Dollar-Yen Exc.R.	0.4210	0.4932	0.5694	0.8260	0.8414	0.9023
	1st Prin. Comp.	0.0072	0.0053	0.0030	-0.0010	0.0070	0.0168
	2nd Prin. Comp.	-0.0078	-0.0067	-0.0068	-0.0005	0.0058	0.0041
	3rd Prin. Comp.	-0.0181	-0.0181	-0.0171	-0.0192	-0.0145	-0.0121
	4th Prin. Comp.	0.0114	0.0114	0.0105	0.0146	0.0166	0.0135
	5th Prin. Comp.	-0.0092	-0.0083	-0.0077	-0.0033	0.0000	-0.0003
	6th Prin. Comp.	-0.0010	-0.0010	-0.0009	-0.0012	-0.0050	-0.0039
Macro	Intercept	-0.0018	0.0046	0.0025	-0.0018	0.0020	0.0022
State 2	Dollar-Yen Exc.R.	0.9689	1.8773	1.6076	0.6903	1.1291	1.1283
	1st Prin. Comp.	-0.0033	-0.0036	-0.0043	0.0055	-0.0060	-0.0046
	2nd Prin. Comp.	0.0015	0.0205	0.0151	0.0091	0.0218	0.0225
	3rd Prin. Comp.	-0.0088	-0.0182	-0.0158	-0.0105	-0.0151	-0.0157
	4th Prin. Comp.	-0.0068	-0.0141	-0.0142	-0.0061	-0.0121	-0.0140
	5th Prin. Comp.	-0.0046	-0.0068	-0.0082	-0.0043	-0.0028	-0.0034
	6th Prin. Comp.	0.0044	0.0074	0.0064	0.0068	0.0078	0.0067
Macro	Intercept	-0.0154	-0.0127	-0.0113	-0.0128	-0.0130	-0.0137
State 3	Dollar-Yen Exc.R.	0.1018	0.1931	0.3026	0.1982	0.1928	0.1244
	1st Prin. Comp.	0.0201	0.0800	0.0736	-0.0086	-0.0066	-0.0008
	2nd Prin. Comp.	0.0118	0.0233	0.0243	0.0367	0.0377	0.0382
	3rd Prin. Comp.	0.0026	0.0007	0.0010	0.0066	0.0064	0.0047
	4th Prin. Comp.	-0.0002	-0.0021	-0.0033	0.0040	0.0040	0.0040
	5th Prin. Comp.	-0.0010	-0.0040	-0.0033	-0.0079	-0.0078	-0.0073
	6th Prin. Comp.	-0.0015	-0.0037	-0.0030	-0.0028	-0.0027	-0.0038
Macro	Intercept	0.0036	0.0007	-0.0031	0.0010	-0.0004	-0.0040
State 4	Dollar-Yen Exc.R.	-0.2025	-0.0256	0.2266	-0.0382	0.1580	0.4848
	1st Prin. Comp.	0.0014	0.0009	-0.0052	0.0410	0.0317	0.0027
	2nd Prin. Comp.	-0.0332	-0.0319	-0.0322	-0.0338	-0.0370	-0.0371
	3rd Prin. Comp.	-0.0101	-0.0128	-0.0161	-0.0159	-0.0162	-0.0193
	4th Prin. Comp.	-0.0060	-0.0069	-0.0073	-0.0030	-0.0018	0.0016
	5th Prin. Comp.	0.0089	0.0047	0.0011	0.0035	0.0013	0.0006
	6th Prin. Comp.	-0.0105	-0.0095	-0.0090	-0.0056	-0.0052	-0.0039

Table 5.3.2: Robustness Checks, part 2

Additional PC's		0	1	2	3	4	5
Macro State 5	Intercept	-0.0025	-0.0030	-0.0019	-0.0078	-0.0056	-0.0047
	Dollar-Yen Exc.R.	-0.0012	-0.0655	-0.0887	-0.1390	-0.0763	-0.1155
	1st Prin. Comp.	-0.0140	-0.0068	0.0004	-0.0147	-0.0089	0.0054
	2nd Prin. Comp.	0.0059	0.0112	0.0102	0.0159	0.0106	0.0110
	3rd Prin. Comp.	-0.0093	-0.0109	-0.0135	-0.0174	-0.0169	-0.0153
	4th Prin. Comp.	0.0028	0.0060	0.0054	0.0070	0.0055	0.0089
	5th Prin. Comp.	0.0043	0.0027	0.0008	0.0169	0.0126	0.0117
	6th Prin. Comp.	0.0103	0.0109	0.0120	0.0191	0.0193	0.0216
News State 1	Intercept	0.0114	0.0083	0.0080	0.0084	0.0098	0.0100
	1st Prin. Comp.	-0.0001	-0.0004	-0.0004	-0.0005	-0.0014	-0.0014
	2nd Prin. Comp.	0.0001	0.0001	0.0001	0.0001	0.0003	0.0003
News State 2	Intercept	-0.0123	-0.0030	-0.0048	-0.0079	-0.0063	-0.0026
	1st Prin. Comp.	0.0001	-0.0013	-0.0011	-0.0010	-0.0013	-0.0027
	2nd Prin. Comp.	0.0002	0.0012	0.0008	0.0003	0.0003	0.0008
News State 3	Intercept	-0.0126	-0.0082	-0.0116	-0.0125	-0.0131	-0.0132
	1st Prin. Comp.	0.0002	0.0002	0.0005	0.0006	0.0006	0.0006
	2nd Prin. Comp.	0.0002	0.0010	0.0009	0.0009	0.0009	0.0009
News State 4	Intercept	-0.0004	-0.0056	-0.0085	-0.0074	-0.0070	-0.0100
	1st Prin. Comp.	-0.0004	-0.0007	-0.0009	-0.0015	-0.0015	-0.0017
	2nd Prin. Comp.	0.0013	0.0015	0.0017	0.0012	0.0012	0.0015
News State 5	Intercept	-0.0046	-0.0047	-0.0044	-0.0100	-0.0088	-0.0071
	1st Prin. Comp.	-0.0004	-0.0002	-0.0002	-0.0003	-0.0004	-0.0004
	2nd Prin. Comp.	-0.0003	-0.0004	-0.0003	-0.0004	-0.0003	-0.0004

Table 5.3.3: Robustness Checks, part 3