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Citation for published version:
Caglayan, M & Xu, B 2014, 'Allocation effects of uncertainty on resources in Japan', *Economics Letters*, vol. 122, no. 1, pp. 23-26. https://doi.org/10.1016/j.econlet.2013.10.023

Digital Object Identifier (DOI):
10.1016/j.econlet.2013.10.023

Published In:
Economics Letters

Allocation Effects of Uncertainty on Resources in Japan

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August 17, 2013

Abstract

This paper provides evidence of a negative association between macroeconomic uncertainty and the cross sectional dispersion of investment rate for a panel of Japanese manufacturing firms. We show that an increase in uncertainty leads to the narrowing of the cross section dispersion of investment rate and *vice versa*. This finding suggests that firms' fixed capital investment behavior becomes more homogenous in times of increased uncertainty.

Keywords: Uncertainty; investment dispersion; panel data; Japan
JEL classification: C21, D81 and E22

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1 Introduction

Empirical researchers have expended considerable effort to understand the impact of uncertainty on firm's fixed investment expenditures. These studies have generally shown that an increase in uncertainty will lead to a reduction in fixed investment expenditures.[1] In contrast, Beaudry et al. (2001) focus on the association between changes in uncertainty and the time-variation of the cross-sectional distribution of investment. They argue that low (high) uncertainty will yield a wider (narrower) cross-sectional distribution of investment as firm managers take advantage of more (less) precise knowledge of different investment opportunities. Given findings from a panel of UK manufacturing firms, they claim that increased uncertainty leads to inefficient allocation of resources. Despite the importance and the relevance of the question at hand, to our knowledge, the literature does not present us another study which examines the distributional effects of uncertainty on firm's capital investment expenditures.[2]

In this paper, using a similar approach to that in Beaudry et al. (2001), we scrutinize uncertainty effects on the cross-sectional distribution of firms' fixed capital investment for a panel of manufacturing firms for Japan. Our investigation shows that an increase in uncertainty leads to the narrowing of the cross sectional dispersion of investment rate. That is firms' fixed capital investment behavior becomes more homogeneous in times of increased uncertainty. Our results obtained from time-series and panel data analysis are robust to the inclusion of several other variables controlling for changes in energy prices, energy price volatility, industrial production and interest rate. Our findings support Beaudry et al. (2001) and provide further evidence that macroeconomic uncertainty distorts the allocation of resources.

2 Empirical Analysis

2.1 Data

Our dataset is comprised of an unbalanced panel of 636 manufacturing Japanese firms drawn from the DATASTREAM database. The dataset covers the period 1987-2010. In this respect the time series dimension of our dataset is 24 and the cross sectional dimension is 12.[3] Prior to carrying out our analysis we trim the top and the bottom 2.5 percentile of the distribution of the investment rate to remove the impact of outliers which exhibit substantial changes.[4] We then compute both time-series and sector specific cross-sectional dispersion of investment rate.

We proxy for the macroeconomic uncertainty by the conditional variance of the consumer

[1] Among others see for example, Leahy and Whited (1996); Carruth et al. (2002); Bond and Cummins (2004); Bulan (2005); Bloom et al. (2007); Baum et al. (2010) and Lee et al. (2011).

[2] Using a similar approach Baum et al. (2009) and Quagliariello (2009) examine the effects of uncertainty on the cross sectional distribution of banks loans to asset ratio for the US and Italy, respectively, while Baum et al. (2008) investigate the uncertainty effects on the cross-sectional dispersion of firms' cash holdings.

[3] Firms in the dataset are allocated to one of the following 12 manufacturing sectors: Topix Chemical, Topix Electric Machine, Topix Glass and Ceramic, Topix Iron and Steel, Topix Machinery, Topix Non-Ferrous Metals, Topix Metal Products Topix Oil and Coal Products, Topix Precision Instruments, Topix Transportation Equipment, Topix Rubber Product, and Topix Pulp Paper.

[4] See Beaudry et al. (2001) for similar screening procedures.

price inflation (data on CPI is drawn from DATASTREAM). In particular, this measure is based on an ARCH(1) model, where the mean equation is an AR(1) process. The conditional variance derived from this ARCH model is used as our measure of macroeconomic uncertainty.[5]

Figure 1, which depicts a scatter plot of the dispersion of investment rate and the inflation uncertainty, provides a *prima facia* evidence that there is a negative association between the two series. Note that the correlation between the two series is about 53%.

2.2 The reduced form model and the results

To examine the link between the cross sectional dispersion of investment rate and macroeconomic uncertainty we consider the following reduced form model:

$$Var(\frac{I_{t+1}}{TA_t}) = \alpha + \beta_1 \sigma_t^2 + \epsilon_t \tag{1}$$

where $Var(\frac{I_{t+1}}{TA_t})$ is the variance of the investment rate across firms at the end of time t. Macroeconomic uncertainty, σ_t^2, is measured by the conditional variance of CPI inflation evaluated at the beginning of time t, and the $i.i.d$ error term is denoted by ϵ_t. Given the model above, we expect to find that β_1 takes a negative sign.

Table 1 presents our results for five different specifications. The first column presents the results for the basic model given in equation (1). In the remaining columns we introduce several control variables to check the robustness of our observations. These variables include the percentage change in energy prices and its volatility, lagged industrial production and the interest rate. Observing each column we see that uncertainty measure is always significant and takes a negative sign while the other variables do not assume a statistically significant coefficient.

To gain some insight on the economic significance of these results, we compute the elasticity of the dependent variable with respect to uncertainty for each model. Using the point estimates, we find that the cross sectional dispersion of investment rate narrows in excess of 44% on an annual basis in response to doubling of the uncertainty: a substantial magnitude in economic terms pointing out the extent of distortion uncertainty causes in allocation of resources.[6]

To gain further insight into the impact of macroeconomic uncertainty on allocation of resources, we examine the impact of uncertainty on the industry specific dispersion of investment rate. Given we have 12 sectors in the dataset, we examine the following model:

$$Var(\frac{I_{j,t+1}}{TA_{j,t}}) = \alpha + \beta_1 \sigma_t^2 + \nu_j + \epsilon_t \tag{2}$$

Different from equation (1), in this model we account for industry specific fixed effects captured by the term ν_j where j indexes for the industry. The results depicted in Table 2 provide further support for the hypothesis that uncertainty distorts efficient allocation of resources. In all cases the coefficient associated with uncertainty is significant and takes a negative sign.

[5] Details of the model are given in the Appendix.

[6] In fact this impact varies in the range 44%–55%.

Different from the time series analysis, in this table we also see that change in the price of energy, its volatility and interest rate play a significant role in the relationship, yet significance of these variables does not nullify the importance of uncertainty variable. When we compute the elasticities associated with the models, we find that doubling of uncertainty leads about 26.8%-to-40.7% reduction in the dispersion of industry-specific cross sectional distribution of investment rate. These results confirm our findings reported in Table 1 indicating that increased uncertainty leads to resource allocation problems. This is so because during periods of higher uncertainty firm specific differences in profit opportunities are harder to predict. Hence, in periods of high uncertainty managers behave conservatively leading to the narrowing of the cross-sectional dispersion of investment rate. Yet, during periods of low uncertainty, as firm managers take advantage of more precise knowledge of different investment opportunities, they invest in different investment opportunities leading to a more unequal distribution of investment across firms.

3 Conclusion

In this paper we examine the impact of uncertainty on the cross sectional dispersion of fixed capital investment for a panel of Japanese manufacturing firms. The data cover the period 1987-2010 on an annual basis. Using this dataset we show that an increase in uncertainty leads to a substantial narrowing of the dispersion of investment rate suggesting severe resource allocation problems. Given the data span a period that Japan experienced both an inflationary period and a deflationary period, this paper shows that stability in an economy is essential to achieve efficient allocation of resources as Friedman (1977) point out in his lecture.

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Figure 1: **Cross sectional distribution of investment *versus* uncertainty**

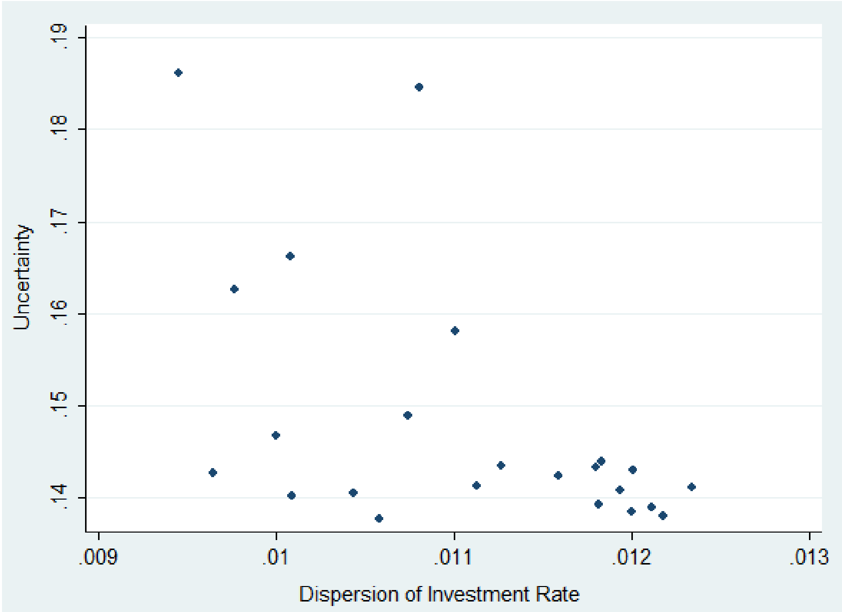

Table 1: Impact of Uncertainty on the Dispersion of Investment Rate: Time series analysis

	(1)	(2)	(3)	(4)	(5)
$Volatility(\sigma_t^2)$	-0.0347***	-0.0330**	-0.0340**	-0.0424***	-0.0399***
	(-2.85)	(-2.78)	(-2.71)	(-3.57)	(-3.18)
$\Delta EnergyPrice_t$		0.260	0.187	0.158	0.158
		(1.56)	(1.13)	(1.00)	(0.99)
$EnergyPriceVolatility_t$		0.0407	0.0318	0.0149	0.00623
		(1.23)	(0.95)	(0.45)	(0.18)
$IndustrialProduction_{t-1}$			-0.00705		-0.0186
			(-0.27)		(-0.71)
$InterestRate_{t-1}$				0.00902	0.0103
				(1.49)	(1.61)
$Constant$	0.0162***	0.0157***	0.0159***	0.0173***	0.0170***
	(8.93)	(8.81)	(8.52)	(9.53)	(8.94)
N	23	23	22	22	22
adj. R^2	0.244	0.296	0.289	0.369	0.350

t statistics in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

All coefficients except $Volatility(\sigma_t^2)$ and $Constant$ are multiplied by 10^3

Table 2: Impact of Uncertainty on the Dispersion of Investment Rate: Panel data analysis

	(1)	(2)	(3)	(4)	(5)
$Volatility(\sigma_t^2)$	-0.0170**	-0.0148*	-0.0162*	-0.0225***	-0.0214**
	(-2.07)	(-1.81)	(-1.86)	(-2.61)	(-2.37)
$\Delta EnergyPrice_t$		0.222*	0.191*	0.166	0.166
		(1.93)	(1.67)	(1.44)	(1.44)
$EenergyPriceVolatility_t$		-0.0134	-0.0156	-0.0343	-0.0382
		(-0.59)	(-0.68)	(-1.43)	(-1.50)
$IndustrialProduction_{t-1}$			0.00189		-0.00829
			(0.10)		(-0.45)
$InterestRate_{t-1}$				0.00853*	0.00909**
				(1.94)	(1.98)
$Constant$	0.0107***	0.0104***	0.0106***	0.0117***	0.0115***
	(8.78)	(8.44)	(8.23)	(8.86)	(8.47)
N	276	276	264	264	264
R^2	0.016	0.032	0.035	0.049	0.050

t statistics in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

All coefficients except $Volatility(\sigma_t^2)$ and $Constant$ are multiplied by 10^3

A Appendix A

Table A.1: Proxying macroeconomic uncertainty: ARCH(1) model

	(1)
ΔCPI_{t-1}	0.492***
	(0.09)
ΔCPI_{t-2}	-0.441***
	(0.07)
C	0.0440***
	(0.02)
$AR(1)$	-0.320***
	(0.09)
$ARCH(1)$	0.137***
	(0.05)
$Constant$	0.131***
	(0.01)

Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$