**Manuscript**
**Macroeconomic Theory Presentation 2017 Fall**

*%(Today I am talking about uncertainty in business cycles. As you can see from this title, the paper is written by Bloom.)*

Title: Take Bloom Seriously
Sub-Title: Understanding Uncertainty in Business Cycle

Paper: Bloom, N., Floetotto, M., Jaimovich, N., Saporta-Eksten, I. and Terry, S.J. *Really Uncertain Business Cycles*. R&R *Econometrica*.
Cited by: 755

*%(The paper is still unpublished yet, it's currently under revision and resubmission to Econometrica. What we discuss today is a recent working paper version in December 2016, and you can see it's one of the most cited unpublished papers in recent years. On the one hand you can see how good the paper is, on the other side you can see how long does it take to publish on top econ journals nowadays.)*

## Introduction

*%(I have been thinking about how to start my presentation. I was kind of being inspired by Prof. Xie. So, do you remember what we talked about so far in this course? At the very beginning of this course?*
*Yes, it's Paul Krugman. You guys should still remember that Krugman writes something titled How Did Economists Got It So Wrong? Now we see him again.)*

Let me get back to the point.
Does uncertainty matter in business cycles or macroeconomics?
Paul Krugman thinks uncertainty doesn't matter.

*%(He said so for several times.*
*You can see from this page that he published, sorry, posted intensively on this topic in his own column at New York Times, and obviously, these articles are NOT peer reviewed.)*
Krugman's view is that slow economic activity is routine after financial crises, not closely related to uncertainty which is inherited since 1850s because of what he called the most ruthless, self-absorbed opposition party.
Krugman, Paul. 2011. Phony Fear Factor. *New York Times*. September 29.
Krugman, Paul. 2011. Varieties of Uncertainty. *New York Times*. October 13.
Krugman, Paul. 2017. The Republicans' Uncertainty Strategy. *New York Times*. June 29.
Krugman, Paul. 2012. The "Uncertainty" Scam. *New York Times*. October 22.
*"…even if you accept the Bloom et al paper[1] as gospel (which you shouldn't) …"*
Krugman, Paul. 2012. Asymmetrical "Uncertainty". *New York Times*. October 31.
*"…The paper[2] never deserved this much weight…"*

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[1] Baker, Scott, Nicholas Bloom and Steven Davis (2012), "Measuring Economic Policy Uncertainty', Stanford mimeo.
[2] As above.

*"…Baker et al[1] have what I think is meant to be a response to this point, except that it isn't really a response..They declare that 'in our view' the responsibility lies with both parties, and list some talking points; but that's not evidence…"*

%(All these critics are targeted at one single paper by Bloom and his coauthors that was later published on QJE in 2016, with more than 1400 citations so far:
Baker, S.R., Bloom, N. and Davis, S.J., 2016. Measuring economic policy uncertainty. *The Quarterly Journal of Economics*, *131*(4), pp.1593-1636.)

These comments give Bloom very strong motivation to write another paper: *Really Uncertain Business Cycles*, the one we discuss today. But I guess Bloom might want to re-title his article as How Did Paul Krugman Get It So Wrong, Again.

Before we look at some details of this paper, let me first introduce the structure:

1) First build up some general intuitions over uncertainty in business cycles.
2) With those intuitions in mind we then look at some stylized facts about uncertainty. *%(Some of these empirical findings might be consistent with your prior belief while others may not.)*
3) After that we focus on the model introduced in this article, including model set-up, parameter calibration, as well as some simulations to see responses to an uncertainty shock.
4) Lastly, we investigate with some policy implications of this paper.

## Part A: Intuitions on Uncertainty in Business Cycles

Now we first talk about how uncertainty affects business cycles.
Very intuitively, crisis leads to uncertainty. And uncertainty affects behaviors, which lead to the crisis.

To be more specific, uncertainty affects portfolio decisions. It has led to a dramatic shift away from risky assets to riskless assets, or at least assets perceived as riskless. It sometimes looks as if investors around the world only want to hold American Treasury bills.

Uncertainty also affects consumption and investment decisions. If you think that another Depression might be around the corner, you'd better to be careful and save more instead of consuming more. You'd better to wait and see how things turn out. Consumption on durable goods, such as buying a new house, a new car or a new laptop can surely be delayed for a few months. The same goes for firms: given the uncertainty, firms want to postpone their decisions to build a new plant or introduce a new product? They would pause until the smoke clears. This is perfectly understandable behavior on the part of consumers and firms—but such behavior has led to a collapse of demand, a collapse of output and to the deep recession we are in.

For the latter, we sometimes refer to it as Delay Effect, that higher uncertainty leads firms to postpone decisions. So, net investment (and hiring) falls. To see this, we use a simple Ss model. In this model, firms do not invest until productivity reaches an upper threshold (the capital S) and they do not disinvest until productivity hits a lower threshold (the small s). And the blue line reflects the density distribution of firms. When uncertainty is low, firms to the right of the grey investment line will invest, firms to the left of the grey disinvestment line

[1] As above

will disinvest, and those in the middle will be inactive for the period. An increase in uncertainty raises the investment threshold and reduces the disinvestment threshold, thus some firms b/w grey and red line that used to invest or disinvest decide to postpone their decisions and remain inactive in high uncertainty.
(P11 of slide Bloom RUBC)

Another effect from uncertainty is Caution Effect, that higher uncertainty reduces firm's response to other changes, like prices or TFP. To see this intuitively, here only a small number of firms are still sensitive to marginal changes or stimulations. We will return to this effect later. (P13 of slide Bloom RUBC)

%(The analysis here is rather primitive. We will get back to this later and to see if the results from the DSGE model are consistent with what we have here.)

## Part B: Some Stylized Facts

%(Before we show some empirical findings about uncertainty, I think we should first briefly discuss the definition of uncertainty in our context.)

We assume a firm has a production function like this:
(Equation 1)
where y denotes the output of firm j at time t, k and n are idiosyncratic, or in other word firm-specific capital and labor. This form of production function indicates two components of productivity: A, an aggregate productivity and Z, a firm-specific productivity.
Then we define the process of these two productivity:
(Equation 2)
(Equation 3)
which are two AR(1) processes, with two different \rhos and \sigmas.
Here \sigmas can be regarded as the variance of innovations that move over time according to a two-state Markov Chain, if you still remember this term from our lecture in asset pricing, these two states generate periods of low and high macro and micro uncertainty.

So, in this paper we use the dispersion (variance) of TFP shocks as a proxy for uncertainty. Later we will discuss whether this is a good proxy.

You should know these two shocks are driven by different statistics, for example,
Z: volatility in z is measured using cross sectional measures of firm performance, such as the variance of production output, sales, stock market returns;
A: to measure aggregate volatility, we use aggregate variables like GDP growth and S&P500 index.

If we understand the definition of uncertainty, now let's look at some stylized facts. We will show that uncertainty is observed to increase during economic recession at firm, industry and macro level. In other word, in this section we want to show uncertainty is countercyclical.

Let's first look at some firm-level facts.
As you can see here, (Figure 1)
The mean value of TFP shocks in economic recessions is smaller than that before economic recessions. Also, according to this graph, the distribution is apparently more dispersed, which indicates an increase in variance of TFP shocks during economic recessions.

Similarly, in Figure 2, which shows the distribution of establishment-level sales growth rates, it's also clear that there is a decrease in the mean value and there is an increase in variance. These two figures show that in recessions there seems to be a negative first-moment (mean decreases) and positive second moment (variance increases) impact on firm-specific productivity and sales.

In the following figure 3, we depict the dispersion of TFP shocks on a yearly basis for a longer time range, from 1970s to 2010. The interquartile range of TFP shocks, which is the red line, shows a very clear countercyclical behavior. This is particularly striking from year 2007 to 2009, when the dispersion displays the highest value since 1970s. The paper also runs some regressions and robustness test to confirm this result.

Now we turn to industry level uncertainty.
Here we run a specific form of regression,
(Equation page 8-1)
As in Figure 3, IQR here denotes interquartile of TFP shocks of industry i at time t. a is a full set of industry fixed effects and b denotes year fixed effects. \delta y measures the growth rate of output b/w time t and t+1. So, the coefficient \gamma here is what we are curious about. If \gamma is positive, the uncertainty might be somewhat pro-cyclical, that the degree of uncertainty is higher when economic growth rate is higher; and if \gamma is estimated to be negative, we can say that uncertainty at industry level is countercyclical, that uncertainty is higher in economic recessions. The regression result is presented in column (1) of table 2.
(Table 2)
So here you can see that \gamma is estimated to be significantly negative, we can say that within-industry dispersion of TFP shocks is significantly higher when industry is growing more slowly.

Some people might wonder why the industry-level dispersion of TFP shocks is higher during industry slowdowns, or whether industry growth slow-down has different impact on different types of industry. We proceed to run another regression that add some industry characteristics, x to our previous regression.
(Page 9, equation2)
For example, we assign the median growth rate as x, here we are asking whether faster growing industries are more volatile in economic recessions. No, because the coefficient here is not significant.
Similarly, we ask if industries with larger variance in growth rates are more countercyclical in their dispersion, so we denote x as interquartile of growth rate. Here still we got an insignificant coefficient.
Actually, for the rest set of variables that capture some of other industry characteristics, we all find insignificant coefficients, which indicates that the countercyclical relations we get appear to be robust.

Lastly, we look at some macro evidence.
In fact, existing literature has intensively addressed macroeconomic uncertainty and come to a consensus that macroeconomic measures of uncertainty are also countercyclical.
An additional accounting for countercyclical behaviour of aggregate uncertainty is presented here in figure A2. The grey bars here represent economic recessions. The black solid line is one measurement for aggregate uncertainty. It's clear that during economic recessions uncertainty is higher in macro perspective.

So far, we show some empirical evidence on the countercyclical behaviour of uncertainty at firm-, industry- and macro- level. You should remember that in previous discussion we use establishment level TFP shocks as a proxy for what we called uncertainty. Before we move on, we might as well check this credibility of this measurement.
A simple and straightforward way to do so is what is shown here in Figure 4, where our baseline measurement comoves with more sophisticated measures.
A more rigorous check is shown in table 3 where we compare establishment TFP shocks with other commonly adopted measures of uncertainty, for example, volatility of daily or monthly firm-stock returns, standard deviation of quarterly sales growth, variation of industry level output. And according to the table, these different measures of uncertainty are correlated, which justifies our approach of using establishment level TFP shocks as a proxy for uncertainty.

## Part C: Model

So far we build up some general intuitions on uncertainty, the delay effect and caution effect if you still remember; and we show some empirical findings on the countercyclical behavior of uncertainty, on micro, industry and macro level.
Now we proceed to take a closer look at the model introduced in this paper.
The author tries to keep most features of the model as closely as possible to the standard frictionless real business cycle (RBC) model, so it's easier for us to compare this paper with existing literature.
In three ways does the model depart from frictionless standard RBC models.
The first is that in this model uncertainty is time-varying. Not only that uncertainty varies b/w first moment and second moment, but also at both micro- and macroeconomic levels. I will explain this in the next slide.
In this model, we have different type of firms, the different firms are subject to different shocks.
Another difference is there is adjustment cost for both capital and labor.

Now let's talk the first and the second features.
Recall before I show you the empirical findings, I first defined a production function like this.
Now the f function is specified in a Cobb-Douglas form that exhibits diminishing returns to scale. Y is the firm j's output at time t, k and n are firm j's capital and labor.
Again, productivity can be decomposed into two parts: A denotes an aggregate component and Z denoted a firm-specific component.
These two components are subject to some AR(1) processes, with different \rho and \sigma here.
Now we introduce a two state Markov chain for \sigma. For example, \sigma A can take two values, H or L.
Another departure from literature is adjustment cost. For capital, law of motion here is typical. For adjustment cost, if i is greater than zero, adjustment cost equals y times a fixed rate, where y is function of productivity and inputs of production. When net investment i is negative, it's a bit different here.
Similarly for labor, we assume law of motion like this. Here \delta represent destruction rate of working hours, such as illness or retirement, which is exogenous. Labor adjustment cost here also consists of some fixed rate and a variable rate.
The following part is typical when we solve a competitive equilibrium. Firm maximizes a value function like this, household maximizes a utility function. Market clearing conditions hold for asset markets, good markets and labor markets. The solution here is standard more complicated, we will skip the solution and look at some calibration.

There are two types of parameters here. The first category of parameters are what we commonly see in literature, like discount factor, intertemporal rate of substitution, these are calibrated as in the RBC literature to simply comparison with them.

Next group of parameters, what we called uncertainty parameters, are estimated using a SMM method. Recall what we have here for two-state Markov chain.
There are six uncertainty parameters to estimate, and results are presented in table 5.

## Part D: Implications of the Model

Firstly, like we often do, we compare out results with real data. As in the data, investment and hours commove with output. Output and consumption commove, although not as much as in the data. Investment is more volatile than output, while consumption is less volatile. Overall, we can conclude that the business cycle implications of this model fit data pretty well.

Now we proceed to analyze the aggregate impact of uncertainty by impose a one-time pure uncertainty shock. Figure 6 shows the impact of an uncertainty shock on output. For graphical purposes period 0 here is pre-shock period. Figure 6 displays a drop in output of just over 2.5% within one quarter, and then a recovery back to normal levels within one year. This significant fall is one of the key results of the paper as it shows that uncertainty shocks can be quantitatively important contributor to business cycles within a general equilibrium framework. It is also noticeable here that output exhibits a double-dip recession, that after some periods of recovery there is another recession that is less significant but last for longer. We will address this double dip phenomenon later.

So what's mechanism behind the dynamics of output? There are at least three channels: labour, capital and misallocation of factors of production. First, in the top-left panel we plot the time path of hours worked. When uncertainty increases, most firms pause hiring, and hours worked begin to drop because workers are continuing to leave from firms without being replaced. Similarly, in the top-right panel we plot the time path of investment, which drops rapidly due to the increase in uncertainty. Since investment falls but capital continues to depreciate, there is also a drop in the capital stock.

The channel of misallocation of resources is a bit sophisticated: In normal times, unproductive firms contract and productive firms expand, helping to maintain high levels of aggregate productivity. But when uncertainty is high, firms reduce expansion and contraction, which shuts off the mechanism of reallocation for economic adjustment.
In the lower-right panel of Figure 7 we plot the time profile of consumption. The impulse response is less intuitive compared to the other three, because there is an initial jump after uncertainty shock. To understand this, increased misallocation acts as a negative first-moment shock to aggregate productivity and thus lowers the expected return on savings, making immediate consumption more attractive and thus leading to an increase. But clearly, this rise in consumption at the start of recessions is an unattractive feature of a pure uncertainty shock model of business cycles, because it is against our intuition that when uncertainty is higher people postpone consumptions, especially consumption on durable goods.

Let's see if we can fix the issue. The author proposes at least three resolutions. The first is what I call an approach, which is to allow save in other technologies besides capital, for

example, in foreign assets. In an open economy model a domestic uncertainty shock induces agents to increase their savings abroad (capital flight). But for a closed model like ours here this approach seems to be implausible. Another approach we should be familiar with is to use a different type of utility function, specifically the one by greenwood. Prof. Xie just mention this form this Monday when he gives the second counter example. Here again we want to use a utility function with complementarity b/w consumption and hours in preference structures. This method should work in a closed model but would computationally very complicated. What the author choses is the third approach I referred to as a compound shock approach. Instead of using just a pure uncertain shock we combine it with a negative first moment shock.

The rationale behind this approach is, if you still remember, that we have just shown that uncertainty normally have a negative first moment and a positive second moment impact on economic variables. Using a pure uncertainty shock is a second moment shock and now we want to have some first moment impact on the economy as well. The figure shows the results and you can see the issue of initial jump in consumption is resolved. Moreover, this additional shock magnifies the drop in output, investment, and hours. Thus, we conclude here that a combination of first- and second-moment shocks leads to dynamics that resemble recent macro fluctuations in U.S. data.

Now I think we might be in a right procession to address the double dip we mentioned before. First, as we have discussed on impact in periods 1-2 the real option effect dominates, leading to inactive hiring/investment activity, misallocation, and thus to a significant drop in output. Later, in periods 3-5, the economy exhibits a "rebound" as the high micro volatility is realized and some firms draw significantly higher productivity shocks than before.
If we go back to slide P26, first, upon entry to the double-dip recession the level of misallocation remains high, which acts as a drag on output and is a large contributor to the slowdown of the recovery. The second factor contributing to the double dip in output is a declining path for investment starting around period 6. At this stage, the real option effects have subsided, and the economy has a low but growing capital stock. As capital stock increases, the interest rates exhibits a declining path so it's optimal to have a declining path of investment as well.

## Part E: Policy Implications

Recall that at the beginning of this presentation we mention a caution effect, that when uncertainty is higher firms and individuals are reluctant to react to stimulus policies. Here we conduct a policy experiment to check our intuitions. We use a 1% wage subsidy financed by lump-sum tax, and compare the effect in two scenarios. Economy A is a normal one without uncertain shock, and economy B has uncertainty shock. We simulate the policy impulse to both economies, and see the effect. The method we use here is somewhat like difference in difference.
This is the result. The black bar is pure policy effect on Economy A without uncertainty, and the red bar is that on Economy B with uncertainty. It's straightforward to see that with uncertainty the effect of wage policy is reduced by over two-thirds. The reason is that as soon as uncertainty rises, the Ss thresholds jump out, so many firms are far away from their hiring and investment thresholds, making them less responsive to any policy stimulus.

As a summary, at the instant an uncertainty shock hits, policy is not as effective relative to normal times. Hence, uncertainty shocks not only impact the economy directly but also indirectly change the response of the economy to any potential reactive stabilization policy.

So far we have taken Bloom very seriously. But my point here is even if this paper seems to be compelling to you that uncertainty generates business fluctuations and reduces policy effect, you'd better not take it too seriously to think it's good to remove all uncertainty in our economy.
To some extent uncertainty is a valuable constraint on the economy, and this we learn from the Great Recession. We took it too certain about the rise of housing price in the U.S. but it turned out to be a bubble. We took it too certain about the stability of the giant financial system under which risk emerged and eventually dominated. If you refer to uncertainty as known unknown, so that we acknowledge that there are something that might happen but we can't forecast or we might have overlooked, then this awareness of ignorance is a virtue for human being.

If there is something I would like you to take away from today's lecture. It would be this, not much to do with the paper but has a lot to do about the recessions we are in today.

**Reference:**

*Bloom, N. (2014), Fluctuations in Uncertainty, JEP.*
*Bloom, N. (2009), The Impact of Uncertainty Shocks, Econometrica.*
*Baker, S. R. et al. (2016). Measuring economic policy uncertainty. QJE.*
*Bloom, N., et al. (2016).Really Uncertain Business Cycles. Working paper.*
*Bachmann, R. et al (2013), Wait-and-See Business Cycles?, JME.*
% (The first bunch of reference is on uncertainty.
You might want to start with the JEP paper. Normally JEP papers are less involved in sophisticated models or math, but deliver clear messages that introduce you to the topic. Following the JEP paper are another two papers by Bloom and his coauthors. Bloom, Baker and Davis are some of the leading macroeconomists investigating economic uncertainty. The paper we discuss today is also related to another stream of literature on investment in business cycles, and I list a JME paper on wait-and-see business cycles we have discussed.)

*Bachmann, R.et al. (2013), Aggregate Implications of Lumpy Investment: New Evidence and a DSGE Model, AEJ:Macro.*
*Khan, A. et al. (2008), Idiosyncratic Shocks and the Role of Nonconvexities in Plant and Aggregate Investment Dynamics, ETCA.*
*Young, Eric R. (2010),Solving the incomplete markets model with aggregate uncertainty using the Krusell-Smith algorithm and non-stochastic simulations, JEDC.*
%(Next bunch of papers cover the techniques used to solve the competitive equilibrium in the paper and to estimate uncertainty parameters with a simulated method of moment.)

*Bernanke. The courage to act: A memoir of a crisis and its aftermath.*
*Geithner. Stress test: Reflection on financial crises.*
*%(The last two books are recommended for understanding the Great Recession, and I took them as good bedtime reading but I think I should take them seriously. Ben Bernanke as macroeconomist and an expert on the Great Depression, his book has rigorous and consistent economic logic, and provide good insight from the perspective of a central banker. Geithner is not an rigorous economist and he doesn't even have a doctor degree. But he served as the president of Federal Reserve at New York city and later as the Secretary of the Treasury. Compared with Bernanke his views and strategies are more diplomatic but still comprehensibly straightforward enough to deliver clear messages. I would say these two books are good complements.)*