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The Long Stagnation and Monetary Policy in Japan: A Theoretical Explanation *

Masanao AOKI†, Hiroshi YOSHIKAWA‡

and Toshihiro SHIMIZU§

1 Introduction

The long stagnation of the Japanese economy during the 1990's (and now it appears even during the 2000's!) is a historical event. Explanation of this long stagnation of such a vigorous economy once is surely a great challenge to macroeconomists. In fact, a number of possible causes of the long stagnation of the Japanese economy have been offered: falls of asset price, hangover of bad loans, liquidity trap, policy mistakes both fiscal and monetary, "hollowing out" due to rising China, and so on. Most likely, causes are

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†University of California, Los Angeles, E-mail:aoki@econ.ucla.edu

‡Faculty of Economics, University of Tokyo, E-mail:yoshikawa@e.u-tokyo.ac.jp

§Faculty of Economics, Kanagawa University, E-mail:shimit35@kanagawa-u.ac.jp

multiple rather than single. Granted, in this paper, we focus on a particular factor, namely *uncertainty*. Specifically, using a theoretical model, we show that mounting uncertainty possibly traps the economy into a long stagnation. We also discuss its implication for the efficacy of monetary policy.

Kuttner and Posen (2001, p.96), in their analysis of what they call the Great Recession of Japan, draw the following conclusion.

> "In short, the basic lesson of Japan's Great Recession for policy maker is to trust what you learned in intermediate macroeconomics class: even under difficult economic circumstances, and even in institutional contexts far removed from those in which they were developed, the stabilization policy framework of the mainstream textbooks still applies."

We certainly do not recommend policy makers in Japan or elsewhere to throw the mainstream macroeconomics textbooks away. We, of course, believe in macroeconomics. However, in our view, the Japanese economy today *does* present economists and policy makers with the real difficulties the textbook remedies cannot easily handle.

A case in point is monetary policy. In Japan, the nominal interest rate has been basically zero. Many economists argue that in this "liquidity trap," the Bank of Japan (BOJ) can still lower the real interest rate by generating the expected inflation. Toward this goal, what the BOJ must do is just to supply base money amply enough. This argument is popular in Japan. Abroad, proponents are, among others, such eminent economists as Krugman(1998), Bernanke (2000), Blanchard (2000) and Rogoff (2002). In the mainstream macroeconomics class, this answer would get full marks. In this paper, we explain a theoretical reason why we cannot necessarily give full marks for the standard approach. In our analysis, uncertainty plays the central role.

Tobin (1972, p.9), in his presidential address to the American Economic Association, proposes a notion of "stochastic macro-equilibrium." He argues

that it is "stochastic, because random interesectoral shocks keeep individual labor markets in diverse states of disequilibrium, macro-equilibrium, because the perpetual flux of particular markets produces fairly definite aggregate outcomes." Our model is stochastic, and our approach is akin to what Tobin called "a theory of stochastic macro-equilibrium."

This approach is very different from the main stream macroeconomics such as real business cycle theory (Kydland and Prescott (1982)) in that it rejects the assumption of the representative agent. It takes heterogeneity of economic agents as essential in analyzing the macro economy. Since the macroeconomy consists of a large number of economic units, for example, 10^7 households and 10^6 firms, the precise optimizing behavior of each unit is irrelevant for understanding the behavior of the macroeconomy. Stochastic approach is necessary; See Aoki (1996, 2000) and Yoshikawa (2003).

The paper is organized as follows. Section 2 briefly surveys the Japanese economy and macroeconomic policies during the 1990's. Section 3 presents our model. It underlines the importance of uncertainty as a hindrance to the economy. Section 4 gives some evidences which suggest that the degree of uncertainty indeed appears to have risen in the Japanese economy. Section 5 provides concluding remarks. The appendix explains microeconomic foundations for the macro model in Section 3.

2 The Japanese Economy during the 1990's

In the buoyant 1980's when some even suggested "Japan as Number One," who would have imagined such gloomy 90's? As it turned out, Japan suffered from the decade long stagnation during the 90's. This section briefly surveys the Japanese economy and macroeconomic policies during the 1990's

The Economy

The past fifteen years saw an extreme surge and then a subsequent fall in stock and land prices in Japan. The "bubbles" became the key word. Thus, it is natural and understandable that many economists both home and abroad have turned to the 'wealth effects' one way or another to understand the Japanese economy during the period. However, it is actually not so trivial whether and how changes in asset prices affected the economy. As we will explain later, the credit crunch occurred during the 1997-98, and it was the major cause of -2.5% growth of real GDP (the worst record in the postwar Japan) in 98. There is no denying that a fall in asset prices and bad loans are the major problem which Japan still faces today. And yet, they are far from the whole story.

After the asset price bubbles bursted, the Japanese economy officially entered the recession in 1991. At first, it appeared as a normal cyclical down turn, but it was actually only the beginning of the decade long stagnation. The average growth rate of Japan during 1992-98 is exactly 1.0% (The first column of Table 1). During the same period, the U.S. economy enjoyed the 3% growth. The 1% growth is even lower than that of the EU which suffers from such high unemployment.

As shown in Figure 1, during the high growth era of the 1950's and 60's, the Japanese economy grew by almost 10% every year. After the first oil shock of 1973-74, the growth rate fell,[1] but still it was 4% on average through the end of the 1980's. It was higher than those of most OECD economies. Then the growth rate declined further from 4% to 1% during the 1990's. The important question is, of course, why the Japanese economy suffered from such a long stagnation.

[1]Many economists attribute the end of the high growth era to the first oil shock in 1973-74. However, the fall of the growth rate around 1970 was actually *not* caused by the oil shock, but rather by a change in the internal structure of the Japanese economy. For details, see Yoshikawa (1995, chapter 2).

On a close examination of Table 1, one finds that the generally depressed 1990's is actually divided into three sub-periods: (1) the 1992-93 recession, (2) the 1994-96 recovery, and (3) another recession[2] during 1997-98. A sensible way to get an overview of the Japanese economy during the 1990's is to look at the demand-decomposition of the growth rate of real GDP. Table 1 presents contribution of demand components such as consumption, investment, and exports to growth of GDP. The contribution is here defined as the growth rate of each demand component, say investment, times its share in real GDP. By construction, the figures sum up to the growth rate of GDP.

The table shows that fixed investment is by far the most important factor to account for the 1992-93 recession, the 1994-96 recovery, and also the 1997-98 recession. In fact, investment is the most important explanatory variable for the Japanese business cycles throughout the post-war period (Yoshikawa, 1993). This stylized fact applies to the 1990's. When the growth rate fell from 3.8 to 0.3% during 1991-93, for example, the contribution of investment fell from 1.2 to -1.9%, accounting for nearly 90% of a fall in the growth rate. Similarly, when growth accelerated from 0.3 to 5.1% during 1993-96, the contribution of investment rose from -1.9 to 1.8%, again accounting for 80% of the recovery.

Thus, to explain the long stagnation of the Japanese economy during the 1990's, we must explain depressed fixed investment. For the 1991-94 recession, we must refer to normal stock adjustment after the long boom during the bubble period (Yoshitomi, 1998). And for the 1997-98 recession, the credit crunch played the major role. However, we need to explain why investment stagnated for such a long period *on average*. After all, investment basically responds to demand; When demand grows, investment also grows whereas if demand stagnates, so does investment. We must, therefore,

[2]The recession which started in May 1997 officially ended in January 1999. According to the government, the Japanese economy subsequently entered the expansionary phase during February 1999-October 2000. A recession then started in November, 2000.

explain the long stagnation of demand.

Beside fixed investment, depressed consumption is notable.[3] For 1998, we even observe an unprecedented *decline* in consumption. Contrary to the common belief, however, a fall in asset prices had relatively small effects on consumption. One might expect that the negative wealth effects depressed consumption after the bubble bursted in the early 1990's. Altogether, households enjoyed almost 1,200 trillion yen worth of capital gains on their assets (200 trillion yen on stock, and 1000 trillion yen on land, respectively) during the bubble period of 1986-90. Subsequently they suffered from the 400 trillion yen worth of capital losses during 1990-92. The analysis of consumption by type of household reveals that capital losses on stock did exert the negative wealth effects on consumption of the retirees and a portion of the self-employed who were the major stock owners. These types of households shares only 12%, however.

The major capital gains and subsequent losses accrued on land. As one would expect, most land which households own is indivisibly related to housing. Therefore, to the extent that housing service and other consumables are weak substitutes, and that land and housing are indivisible, it is not so surprising nor irrrational as it might first appear, that sizable capital gains and losses on land left most households to keep their houses and their consumption basically intact. Capital gains and losses on stock and land affected household consumption only marginally. Bayoumi(1999) using VAR's also finds that the effects of land prices on output largely disappears once bank lending is added as an explanatory variables, and concludes that the "pure" wealth effects are quite limited.

Among the factors to explain unprecedentedly depressed consumption, here we take up job insecurity. It is well known that the unemployment rate in Japan had been very low by international standard. During the 1980's when

[3]We can formally show that by historical standard consumption has been *unusually* weak throughout the 1990's. See table 2 of Motonish and Yoshikawa (1999).

the unemployment rate reached 10% in many EU countries, that in Japan remained 2%. The unemployment rate was traditionally low in Japan for several reasons. Thanks to bonus payments and the synchronized economy-wide wage settlements called the *Shunto* (Spring Offense), wages in Japan are believed to be more flexible than in other countries.[4] Besides, the necessary adjustment of labor is done through changes in working hours per workers rather than changes in the numbers of workers. On the supply side, cyclical fluctuations in the labor force participation rate are large; In recessions, when the so-called 'marginal' workers (typically female) lose jobs, they often get out of labor force rather than remain in the labor force and keep searching for jobs. These factors kept the unemployment rate from rising.[5] Even during the 1992-94 recession, the unemployment rate, though rising, did not reach 3% (Table 2).

However, the long stagnation during the 1990's has thoroughly changed the structure of the Japanese labor market. Most important, with the slogan of "restructuring," firms are now ready to discharge workers. Table 2 shows that the number of involuntary job losers has been more than tripled between 1992 and 99. In 1999, the unemployment rate in Japan finally became higher than the U.S. counterpart. Until five years ago, nobody had expected that it would ever happen.

In the autumn of 1997, big financial institutions such as the *Hokkaido Takushoku Bank* and the *Yamaichi Security* went into bankruptcy. These events made an unmistakable announcement that the celebrated life-time employment in Japan was over. Understandably, job insecurity depressed consumption. In 1998, consumption actually fell. This unprecedented event can be well explained by a sharp rise in the unemployment, particularly involuntary unemployment. Nakagawa (1999) demonstrates that uncertainly surrounding the public pension system has also depressed consumption.

[4]Taylor(1989), for example, emphasizes the role of *Shunto* for wage flexibility in Japan.
[5]For details, see Yoshikawa (1995), Chapter 5.

Beside the major factors such as fixed investment and consumption, there were other relatively minor but still important factors to explain the stagnation of the Japanese economy. For example, a sharp increase in imports during 1994-96 hindered the feeble economy from recovery. Imports are much more cyclical in Japan than in other countries such as the U.S. However, an increase in imports during 1994-96 (the average growth rate 12%) was anomalous even by the Japanese standard; Namely, the propensity to import sharply rose during the period.

Some economists such as McKinnon and Ohno (1997), in fact, attribute the stagnation of the Japanese economy to the high yen.[6] However, the appreciation of the yen from 240 per dollar (1985) to 120 (1988) was actually caused by high productivity growth in the Japanese export sector, and, therefore, followed the purchasing power parity with respect to tradables (Yoshikawa (1990)). Therefore, it is not plausible to regard the appreciation of the yen as the major cause for the long stagnation of the Japanese economy. In fact, as shown in Table 1, exports had been the most stable component of GDP throughout the 90's except for 1998 when the Asian financial crisis rather than the appreciation of the yen hindered exports.

[6]McKinnon and Ohno (1997) advanced the argument that what they called 'fears of ever higher yen' was the fundamental cause of the long stagnation of the Japanese economy, and that the introduction of the adjustable peg was the key solution. Their argument rests on the premise that fluctuations of the exchange rates was the basic cause of the troubles. They even attribute the fall in the growth rate in the early 1970's to the end of the Bretton Woods system and flexible exchange rates. However, at least for the Japanese economy, the contribution of net exports which are naturally most significantly affected by exchange rates, to growth was much *higher* in the 1970's and 80's when exchange rates were flexible than in the 1950's and 60's when the exchange rate was fixed (Yoshikawa (1995), Chapter 2).

McKinnon and Ohno emphasize a possibility of misalignments (deviations from the PPP) under the flexible exchange rate regime. The misalignment does occur. However, for the Japanese economy, the most important misalignment was the overvaluation of the dollar or *the undervaluation of the yen* under the Reagan Administration in the 1980's. This misalignment is, therefore, not consistent with 'fears of ever higher yen.'

Finally, they argue that responding to the appreciation of the yen, the Bank of Japan initially eases money, but is, in the medium run, prone to tighten money to produce deflation. This simply contradicts to the facts. The Bank of Japan does easy money responding to the yen appreciation not only in the short-run but also in the medium-run.

Having briefly seen the Japanese economy during the 1990's, we now turn to macroeconomic policies. We begin with fiscal policy.

Fiscal Policy

Fiscal Policy in the 1990's was in sharp contrast to that in the 1980's. In the fiscal year 1980, after two oil shocks during the 1970's, the budget deficits had become a serious problem; Debt finance shared one third of the budget, and the outstanding debt reached 70 trillion yen. Throughout the 1980's, the single objective of the Ministry of Finance (MOF) was to balance the budget. With the key phrase of the 'minus ceiling', the MOF effectively constrained expenditures. Thanks to an increase in tax revenues during the bubble boom, the MOF's goal had been basically achieved by 1990. As of 1990, the deficits/GDP ratio of Japan was lowest among major OECD countries (Figure 2); If the social security account is taken into account, the budget was actually in surplus.

However, as the recession deepened beginning 1992, the expansionary fiscal policy was called for, and with it deficits mushroomed. The deficit/GDP ratio had reached 10.9% by 1999, which is comparable to that of Italy at the beginning of the 1990's. The monotonous worsening of Japan's budgetary position during the 1990's is indeed in sharp contrast to the trend observed for other OECD countries.

With such high costs, how do we assess the fiscal policy during the 1990's? Pessimists say that it was simply a failure because it did not produce any sustained growth. The contribution of public expenditures to growth can been seen in Table 1. The table shows that fiscal expenditures sustained growth during 1992-93, and also in 1996. Without fiscal expansion, the Japanese economy would have almost surely suffered from the negative growth in 1993. Posen (1998) goes so far to argue that the 1994/96 recovery was also generated by fiscal expansion. Posen may exaggerate the role of fiscal expansion

in that fixed investment was clearly the most important factor to explain the 1995/96 recovery, and that a recovery of investment may not be directly linked to fiscal expansion. However, one can reasonably argue that without fiscal expansion during 1992-93, a prolonged recession with negative growth would have made the 1995/96 recovery impossible, and that in this sense fiscal expansion contributed to the 1995/96 recovery.

The 5% growth in 1996 made the MOF confident enough to pursue the holy goal of budgetary balance. Many economists observe that a rise in the consumption (value added) tax from 3% to 5% and other social insurance contribution amounting to 9 trillion yen, depressed consumption and thereby triggered the 1997-98 recession. The fiscal tightening was actually not confined to the revenues. Table 1 shows that public investment was drastically cut in 1997; Its contribution changed from 0.8% for 1996 to −0.9% for 1997, and, therefore, a cut in public expenditures by itself lowered growth of real GDP by 1.7%. Fiscal tightening through both revenues and expenditures, contributed to the 1997-98 recession.

As of the year 2002, the pessimism prevails around fiscal policy. For one thing, the current deficit situation is so bad as to be unsustainable. The primary balance is in deficit. The outstanding public debt is 700 trillion yen (140% relative to GDP); This roughly amounts to twenty million yen per family of four, three times as high as its average annual income of 6 million yen.

The pessimism does not stem not only from the size of debts and deficits. It also stems from mounting doubt about efficiency and justice behind deficits. In every economy, the public finance involves transfers of income among households and firms. Transfers of income are, in fact, one of the major purposes of the public finance and, therefore, in itself there is nothing wrong about it. However, there is a broad consensus that aside from the size of deficits, there is a serious problem about the current situation of the public finance in Japan.

To understand the problems facing Japan, one can visualize the Japanese economy as a two-sector economy: one consisting of highly efficient manufacturing sector, and the other consisting of inefficient small firms and the self-employed, particularly in the non-manufacturing sector including agriculture. The existing political system allows significant income transfers from the former to the latter through both public expenditures and taxes and other social security contributions.[7] There is a broad consensus that the hundred trillion yen spent by the public sector during the 1990's contributed

[7]Some of the public expenditures are believed to be so inefficient as almost equivalent to "digging holes". Construction industry is a symbolic case. Orders of public investment, which exceeds 30 trillion yen or 6% of GDP, are required by legislation to be made to small firms on quota. Many small firms which receive orders, pass them (namely, 'sell' the contracts with the government) to larger firms. In 1985, for example, there were 520 thousand construction firms, 99.9% of which were very small. Out of 520 thousand, only 250 thousand firms were actually engaged in any construction at all! Another example is agriculture. The public expenditures for agriculture sharing 4.2% in the 1999 budget almost amounts to a half of the value added of agriculture. These inefficient public expenditures are made at the sacrifice of necessary infrastructures for large cities, and information and other new technologies.

Questionable income transfers are not confined to expenditures. The tax system is also inflicted with serious problems. Take personal income tax which shares 20% of the revenue, for example. Income taxes for employees are automatically deducted out of their salaries and wages. However, for the self-employed who declare their earnings, incomes are usually significantly understated. This problem exists in every country, but in Japan it is particularly serious; The declared incomes of the self-employed are estimated to be only 50% of true incomes. As a result, income taxes are disproportionately borne by employees; 85% of employees pay income taxes, whereas only 45% of the self-employed in non-agricultural sectors, and only 14% of farmers do.

In 1999, for the purpose of encouraging consumption, the government distributed 0.7 trillion yen consumption coupons which were to expire within months. The politicians who promoted the idea argued that temporary coupons would effectively encourage consumption whereas tax cuts might only increase savings. On second thought, it is clear that this naive logic is wrong because coupons may simply replace cash and other means of payment, and, therefore, it may not result in an increase in consumption expenditures. In this sense, coupons are equivalent to tax cut. However, there is one difference. Tax cuts benefit those who pay income tax. Remember that the relatively few self-employed pay income tax. Politicians who get votes from the self-employed are understandably in favor of coupons even by appealing to a wrong logic!

The problem is not confined to personal income tax. Whether the economy is in boom or recession, about two thirds of 'corporations' consecutively declare losses, and pay no corporate income tax at all. Most of firms which declare losses and do not pay any tax are small inefficient firms, particularly in the non-manufacturing sector. As a result, corporate income taxes are borne disproportionately by large firms.

very little to raising profitability in the economy.

Kutter and Posen (2001) take the trouble to show that the fiscal multiplier in Japan is 1.7. Most Japanese economists would agree that this figure is reasonable, but think that the size of the multiplier is not really the issue. If not full marks, there is no denying that fiscal policy *was* on the whole expansionary during the 1990's (Figure 2). The fiscal pessimism does not stem from the fear that the multiplier is small, but from the fact that fiscal expansion did not bring about sustainable growth. Even now, an increase in public expenditures surely raises GDP, but may not necessarily produce sustainable growth. Some say that if not, spend more. But until when? The debt/GDP ratio is currently 140%, and many economists question whether the deficits are sustainable.

Monetary Policy

Monetary policy is widely believed to be responsible for the asset price bubbles during the late 80's and the subsequent long stagnation during the 90's.[8] According to this view, during the 80's, low interest rates produced the asset price bubbles, and the high land prices, in turn, allowed the liquidity constrained firms to make excessive investment by way of an increase in the collateral values. For the same reason but now to the opposite direction, the collapse of the asset market entailed the stagnation of investment during the 90's. Though this "standard" view contains a bit of truth, it does not actually stand up to careful analyses.

There are actually a number of studies which demonstrate a significant relationship between real variables such as investment and real GDP on the one hand, and asset prices, land prices in paticular, on the other. Since asset prices and GDP went up and down broadly in tandem, these findings are not surprising. The problem is interpretation. Most of the analyses interpret

[8]The background of Japanese monetary policy during the period, see Cargill, Hutchison and Ito(1997), and Bank of Japan (2001)

their findings as indicating that changes in asset prices affected investment of financially constrained firms by way of changes in their collateral values; Ogawa and Suzuki (1998), for example, find land prices significant in their investment functions. Bayoumi (1999) also finds in his vector autoregressions (VARs) that land price changes were an important factor behind the rise in the output gap over the bubble period and the subsequent decline.[9]

However, this is not exactly what happened in Japan during the late 80's and the 90's. During the bubble period, it was believed (falsely in retrospect) that land-intensive sectors, such as holiday resorts and office spaces in Tokyo, would command high profits in the near future. These (false) expectations made land prices explode, and *at the same time* induced firms to make land-intensive investment. Firms purchased land with money borrowed from banks, and banks, based on their expectations of higher land prices in the future, often allowed more than 100% (!) collateral values for land which firms just purchased. Therefore, theoretically firms could borrow money from banks without any collaterals in advance to purchase land. This is very different from the standard story explained above, according to which an increase in the price of land which firms had owned *in advance* made it possible for the liquidity constrained firms to borrow more money to make desired investment. In fact, the ultimate cause of *both* a rise in land prices *and* an extraordinary surge in land-intensive investment was false expectations on future profitability of holiday resorts and office spaces in Tokyo. In short, misallocation of capital was the ultimate cause.

After the bubbles bursted, the asset prices collapsed, and at the same time investment also fell. However, it is once again not self-evident that this fact suggests that a fall in the asset prices cut investment by way of a fall in the firms' collateral values. For example, investment of large firms and small firms fell during the 92-94 recession roughly in the same magnitudes.

[9]Kiyotaki and Moore (1997) offer a theoretical model which suggests this kind of interpretation.

Large firms do not finance their investment by borrowings from banks but rather by issueing bond, and new equities in capital market. They are not financially constrained, and, therefore, the collateral story does not hold true for large firms at the outset. And yet, investment of large firms fell in the same magnitude as that of small firms. Meltzer (2001), and Hayashi and Prescott (2002) also express skeptical views against the significance of financial constraints. Thus, a careful study is necessary to determine how a fall in the asset prices affected investment during the 90's.

Now, let us briefly review the record of monetary policy during the period. The call rate (the overnight money market rate), the most important instrument of monetary policy in Japan, was kept high at the level of 7.5% during 1990-91 (see Table 3). The stock price which reached 38,915 yen at the end of 1989 had fallen below 15,000 yen by 1992. The land price also started falling in the same year. The economy was in deep recession in 1992. The BOJ had already lowered the discount rate from 6.0% to 5.5% in July 1991. Through five successive cuts within a year, it had fallen to 3.25% by July 1992.

Despite the further cuts in the interest rates during 1993-94, the economy hardly revived. The annual growth rate of money supply (M2+CD) which was 12% in 1990, had fallen to zero by 1992. Since a sharp decline in bank lending was basically responsible for this fall in money growth, the probem was why this sharp decline in bank lending occurred. Bayoumi (1999) interprets his finding that bank lending is more important than land price itself in explaining output gap as supporting the financial disintermediation hypothesis. He argues that "undercapitalized banks responded to falling asset prises and other balance sheet pressures by restraining lending to maintain capital adequacy standards." Some economists in Japan suggested the same, and argued that the credit crunch was responsible for the weak investment. However, as shown in Table 3, during 1991-93, the interest rates kept declining. If the credit crunch occurred the interest rate would have risen. Therefore, the

major cause of a sharp decline in bank lending during 1991-93 was a downward shift of demand curve (a fall in demand for bank lending) rather than an upward shift of supply curve (the credit crunch or a cut in supply of bank lending). As shown in Figure 1, the diffusion index of "Lending Attitude of Financial Institutions" of the BOJ Tankan (Short-term Economic Survey of Corporations) indeed shows that responding to successive cuts in the call rate, banks' lending attitudes improved during 1992-95. Gibson (1995) also concludes that although a firm's investment is sensitive to the financial health of its main bank, the effect of the problems in the banking sector on aggregate investment during 1991-92 was small. The private risk premium defined as the difference between the long lending rate and the ten year government bond rate, also declined during the period (Table 3). In summary, the effects of a fall in land prices and consequent bad loans on bank lending was not significant during the 1992/94 recession. By looking at bank level data, Woo (1999) draws the same conclusion.

The economy recovered during 1994-96. With easy monetary policy, the call rate had kept declining. However, the long term interest rate had stopped declining to raise the term premium (Column (4) of Table 3). This is actually something one should expect when the economy is on the road to recovery. In fact, the growth rate of real GDP reached the respectable 5.1% in 1996. Facing this recovery, the Ministry of Finance (MOF) decided to tighten budget for 1997.

Meanwhile, a fall in the stock price created a serious problem for the Japanese banks to meet the BIS capital adequacy standards. The new legislation in April 1996 allowed the authority to step in a bank likely to fail to meet the BIS requirement. This new policy regime was to start in April, 1998. In March 1997, the MOF made clear the new capital adequacy requirements. Very unfortunately, this basically correct policy action was taken at the worst timing. Desperate to raise the capital/asset ratio within a short period of time, banks squeezed their assets by cutting lendings. In the autumn,

the bankruptcy of big financial institutions such as the *Yamaichi Security*, and the *Hokkaido Takushoku Bank* triggered the real credit crunch. Figure 3 shows that the *Tankan* DI of lending attitude of banks abruptly worsened during this period despite of the BOJ's efforts to ease money.[10]

What was the impact of this credit crunch? Motonishi and Yoshikawa (1999) assess the macroeconomic magnitude of the credit crunch by estimating investment functions separate for large/small firms in both the manufacturing/non-manufacturing sectors. The explanatory variables are from the BOJ's *Tankan*, which has the diffusion indeces for business conditions and for credit constraints facing firms shown in Figure 3. As one might expect, they find that credit constraints are not significant for investment of large firms, but are significant for small firms, particularly in the non-manufacturing sector. They conclude that the credit crunch, by way of depressing investment of financially constrained firms, lowered the growth rate of real GDP by 1.3% during 1997-98. Their analysis takes into account only fixed investment, but actually, two thirds of bank lendings is for running costs and inventory investment rather than fixed investment. We can, therefore, reasonably argue that at the minimum, the credit crunch accounts for one half of -2.5% growth of real GDP in 1998. The low interest rates were no help in the credit crunch.

The renewed recession forced the BOJ to lower interest rates further. The call rate became 0.3% in 1998, and finally 0.03% in 1999. With transaction costs, 0.03% effectively means zero interest rate, the absolute minimum for nominal interest rate. The BOJ, thus, lost the instrument for traditional monetary policy.

Economists then started discussing how monetary policy could possibly affect the economy facing zero interest rate. Krugman (1998) argues that with zero nominal interest rate, the Japanese economy is caught in the *liq-*

[10]The *Tankan* DI of lending attitude of banks normally deteriorates at the time of tight money whereas it improves at the time of easy money.

uidity trap, and that the BOJ must create expected inflation to lower the real interest rate to get the economy out of this trap. How to generate inflationary expectations? Increase money supply! The answer seems so obvious. Is this policy effective and/or feasible?

In Krugman's model and the similar proposals for lowering the real interest rate by way of generating inflationary expectations, demand is assumed to be interest elastic. However, in the Japanese economy during the 1990's, a major problem facing monetary policy is low interest elasticity of demand, in particular, investment. Indeed, the Japanese economy was not trapped in the zero interest rate from the beginning. Table 2 shows that in 1992, the call rate was still 4.7%, and that it had been lowered to zero by 1999. Low interest rates, in fact, together with preferential taxes, pushed housing investment, but did not revive fixed investment. Based on the interest elasticity for the U.S. economy, Krugman suggests that to fill the 5% GDP gap, the 3-3.75% inflationary expectations would be enough. However, with low interest elasticity which appears to hold for the Japanese economy during the 1990's, the necessary expected inflation will easily become as high as 30%!

Beyond that, in Krugman's model, the 'future' is not in liquidity trap, and the simple quantity theory of money is assumed to hold in the future; Price is proportional to money supply in the future. Thus, in theory it is easy for the central bank to generate the expected inflation despite of the absence of the current actual inflation. The only thing the central bank must do is to persuade the public *now* to believe that money supply will increase enough to generate inflation *in the future.* However, in reality, the most important factor of determine the expected inflation is the current *actual* inflation. Whatever the policy actions of the central bank, who would believe in inflation so easily in the economy actually facing deflation? As long as we believe in the Phillips curve wisdom, namely the story that only high pressure in the real economy produces inflation, then we are likely to be led to the catch 22 in our effort to cure recession by generating inflationary

expectations!

Blanchard (2000, p.190-93) states that "the Phillips curve wisdom remains largely true in modern treatments of the determination of prices, wages, and output: If output is above its natural level, then we are likely to see inflation increase." Despite of this remark of his, he is optimistic that the BOJ can generate inflationary expectations to lower the real interest rate; "All that is needed is to convince markets that money growth will be cumulatively higher over the next 10 years by 20 percent."[11] He notes that monetary policy affects long term interest reates "mostly—entirely?—through its effects on expectations," and continues that "the only thing specific to Japan today is that emphasis is not on changes in future expected nominal interest rates, but on the expected future price level. This is not an essential difference." We believe that there is an essential difference in the role of expectations in the determination of prices in goods and financial markets. For this reason, facing the zero interest bound, we take depreciation of the yen as a more plausible and effective transmission mechanism than a decline in the real interest rate: See Meltzer (2001) and Svensson (2001).

Anyway, a large increase in the supply of money coupled with inflation targeting is such a popular solution to the problems facing the Japanese economy today. Abroad, proponents are, among others, Krugman (1998), Bernanke (2000), Blanchard (2000), and Rogoff (2002).

We noted above that consumption and investment stagnated so long despite the BOJ's continueing efforts to ease money. In the next section, we present a theoretical analysis which suggests that the problem facing Japan may not be so easily cured by the ready made textbook prescription.

[11]Blanchard (2000) recommends for the Bank to jump *base money* initially. This is basically what the BOJ did during 1997-2002!

3 The Model

[12] In this section, we present a theoretical model which shows the importance of *uncertainty* as a hindrance to the economy. The model is highly abstract, but is still useful in understanding the Japanese Economy.

Suppose that there are N economic agents in the economy. There are K possible levels of production. Each agent, as a result of respective optimization, chooses one of K levels. Without loss of generality, we can assume that K is just two, "high" and "low". This assumption simplifies our presentation. The "high" level of production is denoted by y^* whereas the "low" level by y ($0 < y < y^*$).

If the number of economic agents which produce at the high leve, y^* is n (n=1, ... N), then total output in the economy or GDP is

$$Y = ny^* + (N - n)y \tag{1}$$

We denote the share of ecnomic agents which produce at y^* by x.

$$x = \frac{n}{N} \quad (n = 1, \ldots, N) \tag{2}$$

Using x, we can rewrite Y as follows:

$$Y = N[xy^* + (1 - x)y] \tag{3}$$

When N is large, x can be regarded as a real number ($0 \leq x \leq 1$). Equation (3) shows that Y and x correspond to each other. While x fluctuates between 0 and 1, so does Y between Ny and Ny^*.

Changes in x are assumed to follow a particular jump Markov process, known as the birth-death process. For a short period of time Δt, there are three possibilities; Namely, no economic agent changes its production level, or one either raises or lowers its production level. This property is similar to the Poisson process, and is very robust in continuous time models. The

[12]The analysis of section 3 draws heavily on Aoki and Yoshikawa (2003).

process is then characterized by two transition rates, one from state y to y^* and the other from y^* to y.

The probability that one economic agent producing at the low level, y raises its production to high procution level y^*, naturally depends on the number of agents producing at y, $N(1-x)$. Similary, the transition rate from y^* to y depends on Nx.

Moreover, transition rates are assumed to be state-dependent in that $N(1-x)$ and Nx are modified by $\eta_1(x)$ and $\eta_2(x)$, respectively. Specifically, the transition rate from y to y^*, r is

$$r = \lambda N(1-x)\eta_1(x) \qquad (\lambda > 0) \tag{4}$$

And, the transition rate from y^* to y, q is given by

$$q = \mu N x \eta_2(x) \qquad (\mu > 0) \tag{5}$$

The transition rates r and q depend not only on the number of economic agents in each state, but also on $\eta_1(x)$ and $\eta_2(x)$. $\eta_1(x)$ and $\eta_2(x)$ mean that *the optimal strategy taken by each agent depends on the state of the economy,* x or Y. For example, equation (4) means that a switch of strategy by an economic agent from "bear" who finds y as optimal, to "bull" who finds y^* as optimal depends on the share of bulls. Equation (5) means that the same is true for a switch of strategy from y^* to y.

Here $\eta_1(x)$ and $\eta_2(x)$ are defined as

$$\eta_1(x) = Z^{-1}e^{\beta g(x)} \qquad (\beta > 0) \tag{6}$$

$$\eta_2(x) = 1 - \eta_1(x) = Z^{-1}e^{-\beta g(x)} \tag{7}$$

$$Z = e^{\beta g(x)} + e^{-\beta g(x)} \tag{8}$$

Z simply makes sure that the sum of $\eta_1(x)$ and $\eta_2(x)$ is equal to one as it must be. At first sight, the above equations may look arbitrary or even odd. However, they are actually quite generic. The appendix explains how

naturally equations (6) and (7) arise in microeconomic models of choice under uncertainty.

The function $g(x)$ in (6) indicates how advantageous a switch of strategy from bear to bull is. The greater is $g(x)$, the more advantageous is a switch from bear to bull, and *vice versa.* We assume that $g(x)$ becomes zero at $\bar{x}$. Note that at $\bar{x}$, $\eta_1(\bar{x})$ and $\eta_2(\bar{x})$ are both 1/2, and, therefore that a switch from y and y^*, and that from y^* to y are equally probable. We assume that $g(x)$ has a stable critical value $\bar{x}$ as shown in Figure 4.

Obviously, $g(x)$ function plays an important role. We note that most of standard economic analyses can be interpreted as shifts of this $g(x)$ function in our present analysis. Take the IS/LM analysis, for example. Suppose that a decline in profitability made the IS curve shift down. GDP or Y declines. This situation corresponds to the case where given x, economic agents now find more advantageous to switch from bull to bear, namely $g(x)$ function shifts down to the left as shown in Figure 5 (a). The stable critical point moves to the left accordingly. Next, suppose that the authority lowered the interest rate to fight against this recession. The LM curve moves downward to the right leading Y to rise. This now corresponds to the case where thanks to the expansionary monetary policy, given x, economic agents find more advantageous to switch from bear to bull than otherwise. The $g(x)$ function shifts up to the right as shown in Figure 5 (b).

The other important parameter in transition rates is β. The appendix shows that β in equations (6) and (7) is a parameter which indicates the degree of uncertainty facing economic agents. Suppose, for example, that the pay off facing agent is normally distributed. Then β is simply the inverse of its variance. Thus, when the degree of uncertainty rises, β declines, and *vice versa.* In the limiting case, when β becomes zero, both $\eta_1(x)$ and $\eta_2(x)$ become 1/2. In this case, uncertainty is so great that economic decisions become equivalent to tossing a coin.

Now, the share of bulls, x changes stochastically, and so does GDP (re-

call equaion (3)). Specifically, it follows the jump Markov process with two transition rates (4) and (5). Denote the expected value of x by ϕ:

$$\phi = E(x) \tag{9}$$

Then ϕ follows the following ordinary differential equation (note that ϕ is not stochastic)[13]

$$\dot{\phi} = (1-\phi)\eta_1(\phi) - \phi\eta_2(\phi) \tag{10}$$

The steady state of equation (10) is given by

$$\frac{\eta_1(\phi)}{\eta_2(\phi)} = \frac{\phi}{1-\phi} \tag{11}$$

Thanks to equations (6) and (7), this equation is equivalent to

$$2\beta g(\phi) = \log\Big(\frac{\phi}{1-\phi}\Big) \tag{12}$$

We observe that when there is little uncertainty, namely β is very large, equation (12) becomes equivalent to

$$g(\phi) = 0 \tag{13}$$

Thus, when there is little uncertainty (large β), the expected value of x, ϕ is equal to the zero of $g(x)$ function, that is $\bar{\phi}$ which satisfies

$$g(\bar{\phi}) = 0 \tag{14}$$

This $\bar{\phi}$ is the unique stable equilibrium which satisfies $g'(\phi)$ <0, namely a critical point $\bar{x}$ in Figure 4. In this case, x changes stochastically, but spends most of time in the neighborhood of $\bar{\phi}$. Accordingly, GDP fluctuates stochastically but spends most of time in the neighborhood of

$$Y = N[\bar{\phi}y^* + (1-\bar{\phi})y] \tag{15}$$

As we explained it above with respect to $g(x)$ function, the standard analyses hold without any problem in this case. If policy makers find the

[13]For derivation of equation (10), see Aoki (1996, 1998).

current average level of Y too low, for example, then they can raise fiscal expenditures or lower the interest rate. These policies would shift $g(x)$ function upward to the right as shown in Figure 5 (b). The expected value of Y would increase since in this case of low uncertainty (large β), it is basically determined by the zero of $g(x)$ function (equation (14)).

When the degree of uncertainty rises, however, the Kuttner/Posen (2001, p.96) proposition that the stabilization policy framework of the mainstream textbooks applies does not hold. There are several reasons. Firstly, as uncertainty rises and β gets small, there is a possibility that multiple equilibria emerge, and that the economy may be trapped into a 'bad' equilibrium. Secondly, when the degree of uncertainty is high, the response of the economy to any policy action *necessarily* becomes small, namely standard macroeconomic policies become less effective.

To explain these points, it is useful to introduce the *potential* function. It is given by

$$U(x) = -2\int^{x} g(y)dy - \frac{1}{\beta}H(x). \tag{16}$$

The function $g(y)$ and β are the same as the ones in equations (6) and (7), and $H(x)$ is the Shannon entropy

$$H(x) = -x\ln x - (1-x)\ln(1-x). \tag{17}$$

It would be necessary to explain $H(x)$. Recall that each of N economic agents faces a binary choice of being either bull or bear. $H(x)$ is nothing but the logarithm of binominal coefficient ${}_NC_n$, namely the number of cases where n out of N agents are bulls. Using the Stirling formular that $\log N! \cong N(\log N - 1)$, we obtain

$$\begin{aligned}
\log_N C_n &= \log\Big(\frac{N!}{(N-n)!n!}\Big) \\
&= N\Big[-\Big(\frac{n}{N}\Big)\log\Big(\frac{n}{N}\Big) - \Big(1-\frac{n}{N}\Big)\log\Big(1-\frac{n}{N}\Big)\Big] \\
&= NH(x)
\end{aligned}$$

The function $H(x)$ expresses the combinatory aspect of our problem in which a large number of economic agents *stochastically* make binary choices. It is this combinatory aspect that standard economic analysis entirely ignores, and yet that plays a crucial role in the analysisi of any system, either physical or social, consisting of a large number of entities.

Let us keep this in mind, and go back to the analysis of the expected value of Y. The expected value of x, ϕ which determines the expected value of Y, obeys ordinary differential equation (10). Now, it is easy to see that locally stable critical points of this dynamics given by equation (10) are local minima of the potential function (16):

$$U'(\phi) = -2g(\phi) - \frac{1}{\beta}H'(\phi) = -2g(\phi) + \frac{1}{\beta}\log\Big(\frac{\phi}{1-\phi}\Big) = 0 \qquad (18)$$

When β is large (little uncertainty), $U'(\phi) = 0$ is basically equivalent to $g(\phi) = 0$, and, therefore, the potential function has a unique minimum. The standard textbook results hold.

When β is small, however, the expected value of x, ϕ is not the zero of $g(\phi)$, but is determined by both $g(\phi)$ and $H'(\phi)/\beta$. This should be clear from equation (18). In this case, several problems arise which make standard macroeconomic policies less effective than in the case where there is little uncertainty (large β). We take up two issues in what follows.

Multiple Equilibria

Suppose that $g(x)$ function has multiple critical points as shownin Figure 6. Points a, c are unstable whereas point b is stable. The stable equilibrium is unique. When uncertainty is insignificant (large β), the potential function has a unique stable equilibrium. As explained above, this unique stable equilibrium is determined by $g(\phi) = 0$. The dynamics in this case is illustrated in Figure 7 (A). In this case, monetary policy is surely expected to affect the

equilibrium. When the real interest rate is lowered, for example, more economic agents would find a switch from "bear" to "bull" more advantageous than othewise; Namely the function $g(x)$ changes when the interest rate is lowered in such a way that $g(x)$ is greater for any x than previously. Therefore, the stable equilibrium ϕ which satisfies $g(\phi) = 0$ as shown in Figure 4 gets large, and GDP rises accordingly. If the nominal interest rate remains unchanged, a rise in inflationary expectations would bring about the same result.

When the degree of uncertainty facing economic agents rises (small β), however, the same story does not hold. Although $g(x)$ has a *unique stable* equilibrium, $U'(\phi)$ may have *multiple stable* equilibria. In that case, the economy may be trapped into a "bad" equilibrium (point a in Figure 7(B)). In this case, the fundamental problem is uncertainty or small β. Even if we change the function $g(x)$ by lowering the real interest rate, it dose not really help; Monetary policy may affect the bad equilibrium, but does not help the economy escape from it.

Note, in passing, that in this model, the economy stochastically fluctuates, and that unlike in deterministic models with multiple equilibria, the problem of *equilibrium selection* dose *not* arise. Tha is, Krugman (1991)'s problem of "history versus expectations" does not arise in our stochastic approach. Although monetary policy is not really helpful, the economy stochastically escapes from the bad equilibrium moving to the good equilibrium. The problem is that it may take unbearably long period.

The dynamics in the neighborhood of an equilibrium can be analyzed in the following way. Suppose that ϕ^* is a stable equilibrium; Namely ϕ^* satisfies equation (18) or $U'(\phi^*) = 0$. Since ϕ follows the differential equation (10), we can easily find that the dynamics of the deviation ϕ from ϕ^*. That is, $\delta\phi = \phi - \phi *$ obeys the following equaton:

$$\frac{d}{dt}[\delta\phi] \;=\; \beta\phi^*(1-\phi^*)\frac{d^2U}{dx^2}\Big|_{x=\phi^*} \tag{19}$$

Thus, when β is small or the potential function is flat, i.e., d^2U/dx^2 is small at the bottom,the move of ϕ toward ϕ^* is slow, and *vice versa.*

The Effectiveness of Macroeconomic Policies

Suppose once again that $g(x)$ function has a unique stable equilibrium as shown in Figure 4. And, for the sake of definiteness, consider the case where an "expansionary" policy such as lowering the real interest rate was taken. This is equivalent to an upward shift of $g(x)$ function as shown in Figure 5 (b). Namely, we change $g(x)$ in transtion rates (6) and (7) to

$$g(x) + h(x)$$

where

$$h(x) > 0, \qquad h'(x) \cong 0.$$

With this change in $g(x)$ function, ϕ^* which satisfies equation (18) or $U'(\phi^*) = 0$, changes to $\phi^* + \delta\phi$. By definition, $\phi^* + \delta\phi$ satisfies

$$-2[g(\phi^* + \delta\phi) + h(\phi^* + \delta\phi)] + \frac{1}{\beta}\log\Big(\frac{\phi^* + \delta\phi}{1 - \phi^* - \delta\phi}\Big) = 0 \tag{20}$$

This can be solved out to be

$$\delta\phi = \frac{2h(\phi^*)}{\frac{1}{\beta}\Big(\frac{1}{\phi^*(1-\phi^*)}\Big) - 2g'(\phi^*)} > 0 \tag{21}$$

Here we used the assumptions $h'(x) = 0$ (no particular bias in policy) and $g'(\phi^*) < 0$ (ϕ is a stable equilibrium).

Equation (21) shows how equilibrium ϕ, which determines the expected value of Y, responds to a change in function $g(x)$, here represented by $h(\phi^*)$ >0. To put it simply, it shows the effectiveness of macroeconomic

policy. Since we are considering an expansionary policy, $\delta\phi$ is positive, or ϕ^* rises. However, the extent of an increase in ϕ^* depends crucially on β or uncertainty. When uncertainty is negligible, β is so large that $\delta\phi$ approaches its maximum value $-h(\phi^*)/g'(\phi^*)$ >0. On the other hand, as the degree of uncertainty rises (β declines), $\delta\phi$ gets smaller and smaller approaching zero. This result is quite generic. When uncertainty rises, the effectiveness of macroeconomic policies which affect agents' economic incentives *necessarily* weakens. In the limit, the economy facing infinite uncertainty is trapped into a chaos in which no economic policy works (or, in fact, no economic decision makes sense).

4 Some Suggestive Evidences

The model in the previous section suggests that when the degree of uncertainty rises, the effectiveness of macroeconomic policies weaknes. In this section, we provide some evidences which suggest that the degree of uncertainty indeed appears to have risen in the Japanese economy during the 1990's.

GDP is, of course, the most important macroeconomic variable, and, therefore, is expected to significantly affect the economic perception of agents. Therefore, first we measure the degree of uncertainty using the GDP growth rates. Figure 8 shows the coefficient of variation (standard deviation divided by mean) of the quarterly GDP growth rates for 5 years (20 quarters). For the sake of comparison, we also show it for the U.S. We observe that the coefficient of variation has, in fact, risen extraordinarily in Japan during the 1990's, especially in the latter half.

We also estimate AR(2) for quarterly GDP by applying the rolling regression. Uncertainty is now measured by the standard error of regressions (SER). Specifically, we estimate the following equation for the sample period

1961:1-2001:1,

$$\Delta \ln Y_t = \alpha_0 + \alpha_1 \Delta \ln Y_{t-1} + \alpha_2 \Delta \ln Y_{t-2} + u_t,$$

where Y_t is real GDP (quarterly, seasonally adjusted).

Figure 9 shows the rolling SER divided by the mean . Again, we show it for the U.S. for the sake of comparison. A glance at Figure 9 reveals that SER/Mean has risen extraordinarily in Japan during the 1990's. Figures 8 and 9 suggest that the degree of uncertainty has, in fact, risen in Japanese economy.

So far for the economy as a whole. In what follows, we take up some microeconomic data for household and firm, respectively. The growth rates of real wages for 1980-2001 are shown in Figure 10. It shows that real wages in 90's are more volatile than in 80's; The standard deviation for 1986.4-91.1 is 0.73 while that for 1991.2-2001.4 is 1.10. Consistently, Figure 11 shows that a change in the index of consumption has also become more volataile in the 1990's: The standard deviation for 1976.1-89.12 is 1.7 while that for 1990.1-99.12 is 2.3. Figures 10 and 11 both suggest that households face greater uncertainty in the 1990's than in the previous period.

The same proposition applies to firms as well. The Cabinet Office (formerly the Economic Planning Agency) compiles the survey every year, asking firms how they predict the GDP growth rates for the next year, next three years, and five years, respectively. The frequency is reported for each class by 1 percent. The share of the modal class in the survey is shown for each year in Figure 12. The share of the modal class can be interpreted as indicating how broad is consensus about future prediction; If the share is high, there is a broad consensus on growth rate in the future, and *vice versa.*

One would expect that the longer the time horizon is, the greater is the variance of predictions. In this survey, therefore, less consensus is expected for the three- and five-year predictions than for the one-year prediction. Such a result is indeed obtained for the 1980's (Figure 12). However, for the 1990's,

a broad consensus is not obtained even for the one-year prediction. In fact, for the latter half of the 90's, the longer the time horizon of prediction is, the broader is consensus! Moreover, the share of the modal class tends to decrease. In the sense that the prediction made by firms widely varies, firms appears to face greater uncertainty during the 1990's than in the previous period.

Finally, we present data on business failures. Figure 13 shows that the total liabilities which bankrupt firms bear. It suggests that bankruptcies of large corporations have increased in the 1990's.

5 Concluding Remarks

Although there was a mini recovery during 1995-96, the average growth rate of the Japanese economy during the 1990's was a mere 1%. With historically low interest rates and a series of fiscal stimuli, the economy did not really revive. What is the fundamental cause of this long stagnation? Can monetary policy overcome the zero interest bound by generating inflationary expectations?

Various explanations have, in fact, been proposal. One very influential view focuses on a demographic trend. The Japanese economy is rapidly aging. The population is expected to peak in 2004 and decline by 6.8% in the next twenty five years. The share of the aged 65 and older in total population will become one thirds which is almost twice as high as the current level. The labor force, on the other hand, is expected to decline by 0.6% per year for the next twenty-five years, namely during 2000-2025. Because the labor force declines, growth rate of the economy is bound to decline, and anticipating this trend, firms start adjusting their capital stock by curbing investment. According to this view, with a declining labor force the potential growth rate of the Japanese economy declined from 4% to 2 or 1.5%.[14] This is the basic

[14]Krugman (1998) suggests that the demography has made the equilibrium real interest

reason why the growth rate remained 1% despite such expansionary fiscal and monetary policies. The 1998 *White Paper* of the Japanese government endorsed this view (Economic Planning Agency, 1998).

Facing a rapid aging and declining labor force, is the Japanese economy bound to concede the growth rate as low as 1%? The standard growth accounting, however, shows that to account for the growth of the Japanese economy, labor is a relatively minor factor. One can not explain high growth during the 1960's nor a fall in the growth rate in the 70's by labor. Growth must be basically explained by capital and TFP. Beyond that, economists find that more than a half of salaries/wages is a remuneration for human capital rather than 'raw labor'. A declining labor force means a declining number of heads, but does not necessarily mean a parallel decline in human capital. Therefore, an apparently persuasive thesis that declining labor force necessarily lowers economic growth is, actually, too simple.

Hayashi and Prescott (2002) focus on TFP. They conclude that the fundamental problem facing the Japanese economy is a low productivity growth rate. They argue that the old Solow (1956) growth theory, treating TFP as exogenous, accounts well for the Japanese lost decade of growth. It is certainly true that the TFP stagnated in Japan during the 1990's. However, it is well known that the measured productivity reflects, at least in part, the performance of the economy (See Basu (1996), for example). Namely, the stagnation of the economy entails low measured TFP growth.

Although the supply factors are surely important for economic growth, they are not the whole story. Aoki and Yoshikawa (2002) suggest that 'saturation of demand' is an important factor to restrain growth. In the less mathematical literature and causal discussions, the idea of 'demand saturation' has been very popular. In fact, plot a time series of production of any representative product such as steel and automobile, or production in

rate negative and caused troubles for Japan.

any industry against year, one obtains a S-shaped curve. An obvious implication of the S-shaped growth of an individual product/industry is that the economy enjoys high growth if it successfully keeps introducing new products or industries for which demand grows fast, and allocates capital to growing sectors. The ordinary TFP raises the growth rate by making production function 'shift up'. In the Aoki/Yoshikawa model, technical progress raises the growth rate by creating new products and industries for which demand grows fast.[15] The Aoki/Yoshikawa model suggests that the fundamental cause of the poor growth performance of the Japanese economy is basically demand deficiency, or more precisely a lack of creation of sectors/industries which enjoy high growth of demand.

In this paper, we proposed another explanation of the long stagnation of the Japanese economy. When the degree of uncertainty rises, the economy may be trapped into "bad" equilibrium, and the effectiveness of macroeconomic policies weaknes. The model presented in Section 3 is highly abstract, but is generic.

Once the economy is trapped into bad equilibrium as the degree of un-

[15]We maintain that in addition to the standard total factor productivity (TFP) growth, namely an 'upward shift' of production function, technical progress creates demand. That TFP does not necessarily capture of technological progress is pointed out by (Wright (1997), p.1562):

> The identification of 'technological progress' with changes in total-factor-productivity, or with the 'residual' in a growth-accounting framework, is so widely practised that many economists barely give it a passing thought, regarding the two as more-or-less synonymous and interchangeable. ... Even with extensive quality adjustments, TFP is not generally a good index of technology. If a genuine change in technological potential occurs in a firm, an industry, a sector, or a country, in any plausible model this change will affect the mobilization of capital and labour in whatever unit is involved. In the new equilibrium, inputs as well as outputs will have changed; the ratio between these may convey little if any useful information about the initiating change in technology. We share Wright's concern. The economy always mobilize resources and accumulates capital whenever it finds goods or sectors for which demand grows rapidly. Technical progress creates goods/sectors for which demand grows fast and thereby sustains economic growth.

certainty rises, monetary policy, which corresponds to a change in the $g(x)$ function in the model, is not really effective. Many economists argue that the BOJ facing the zero nominal interest rate bound can still lower the real interest by generating inflationary expectations. In our model, it would change the $g(x)$ function, and induce more economic agents to find a shift from bear to bull advantageous. When uncertainty is insignificant, and the minimum of the potential function is almost equivalent to the zero of the $g(x)$ function, it certainly helps. This is a normal situation. However, when the combinatorial aspect cannot be ignored as the degree of uncertainty rises, policies which are effective in normal circumstances may not help.

Tobin (1975), in his "Keynesian models of recession and depression", suggests that "the system might be stable for small deviations from its equilibrium but unstable for large shocks." The same point was also made by Fisher (1933) long time ago.

In our analysis, *uncertainty* plays the key role. When uncertainty is insignificant, the economy would fluctuate around the (unique) "natural" equilibrium, and policies are effective. However, when the degree of uncertainty rises above a critical level, the economy may be trapped into a "bad" equilibrium, and if not, policies necessarily become ineffective.

It is generally agreed that the performance of the postwar economy is better than that in the prewar period. Baily (1978) argues that better safety nets provided by the government in the postwar period has contributed to this outcome. Our analysis suggests that uncertainty is indeed a very serious hindrance to the macroeconomy, and that once the economy faces mounting uncertainty, then the textbook remedies may not so readily work as we would wish.

Appendix

This appendix offers microeconomic foundations for the transition rate $\eta_1(x)$, equations (6) and (7) in the model in Section 3. Namely, it explains how $g(x)$ and β are obtained, and shows that β is a measure of uncertainty.

We offer two interpretations for our specifications of the function η. The first is based on approximate calculations of the perceived difference of the expected utilities, or advantages of one choice over the other. The second interpretation is based on discrete choice theory such as Anderson et al. (1993), or McFadden (1974).

(1) Representation of relative merits of alternatives

Denote by $V_1(x)$ the expected "return" from choice 1, given that fraction x has selected choice 1. For definiteness, think of the discounted present value of benefit stream based on the assumption that fraction x remain the same over some planning horizon. Define $V_2(x)$ analogously. Let

$$\eta_1(x) = \Pr\{V_1(x) \geq V_2(x)\}.$$

We omit x from the arguments of V from now on.

Assume that the difference $\Delta V = V_1 - V_2$ is approximately distributed as a normal random variable with mean $g(x)$ and variance σ^2. We calculate the probability that the difference is nonnegative, namely choice 1 is preferred to choice 2

$$\eta_1(x) = \Pr\{\Delta V \geq 0\} = \frac{1}{2}[1 + erf(u)],$$

where the error function is defined by

$$erf(u) := \frac{2}{\sqrt{\pi}} \int_0^u e^{-y^2} dy,$$

with $u = g(x)/(\sqrt{2}\sigma)$. See Abramovitz and Stegun (1968) for example. Then, we follow Ingber (1982) to approximate the error function by

$$erf(u) \approx tanh(\kappa u),$$

with $\kappa = 2/\sqrt{\pi}$. This approximation is remarkably good and useful. For example for small $|x|$, we note that

$$erf(x) = \kappa(x - \frac{x^3}{3} + \frac{x^5}{5} + \cdots),$$

and

$$tanh(\kappa x) = \kappa(x - \frac{x^3}{2.36} + \frac{x^5}{4.63} + \cdots).$$

By letting β to be $\sqrt{2/\pi}\sigma^{-1}$, we have deduced the desired expression

$$\eta_1(x) = \Pr\{\Delta u(x) \geq 0\} \approx X^{-1}\exp[\beta g(x)],$$

where $X = \exp\{\beta g(x)\} + \exp\{-\beta g(x)\}$.

This offers one interpretation of β that appears in the transition rates. Large variances mean large uncertainty in the expected difference of the alternative choices. Such situations are represented by small values of β. Small variance means more precise knowledge about the difference in the values of two choices, represented by large values of β. This situation is represented by small β. Alternately put, we may interpret $g(x)$ as the conditional mean of a measure that choice 1 is better than choice 2, conditional on the fraction x has decided on choice 1.[16]

(2) Discrete Choice Theory and Extreme Value Distributions

Next, suppose that we calculate the probability that the discounted present value one, V_1, is higher than value two, associated with alternative choices

[16] Aoki (1996, Chap. 3, and 8) shows how β arises as a Lagrange multiplier to incorporate macrosignals as constraints. Parameter β is related to the elasticity of the number of microeconomic configurations with respect to macrosignals. Small values of β mean that the number of microeconomic configurations responds little when macroeconomic signals change. This is in accord with the interpretaion that agents face large uncertainty in their choices. See Aoki (1996, p.216). Similar interpretation may be offered from the viewpoint of hazard function. See Aoki (2002, Section 6.2)

1 and 2 respectively. Suppose further that we represnt some of the incompleteness and impreciseness of information or uncertainty of consequences surrounding the value calculation by adding random terms to the present values as

$$\hat{V}_1 = V_1 + \epsilon_1,$$

and

$$\hat{V}_2 = V_2 + \epsilon_2.$$

One interpretation is that these ϵs are noises to account for inevitable fluctuations in the present values. A second interpretation is to think of them as (additional) evidence to support a particular choice. Other interpretations are certainly possible. For example, McFadden (1973) speaks of common or community preference and individual deviations from the common norm in the context of utility maximization.

One quick assumption to obtain a Gibbs distribution expression in the case of two alternative choices is to assume that $\epsilon = \epsilon_2 - \epsilon_1$ is distributed according to

$$\Pr(\epsilon \leq x) = \frac{1}{1 + e^{-\beta x}},$$

for some positve β. With this distribution, a larger value of ϵ supports more strongly the possibility that $V_1 > V_2$. Parameter β controls how much of changes in x translate into changes in probabilities. With a smaller value of β, a larger increase in x, that is, in "evidence" is needed to increase the probability that favors choice 1. The larger the value of β is, the smaller increase in x is needed to change the probability by a given amount.

With this distribution, then, it immediately follows that

$$P_1 = Pr(\hat{V}_1 \geq \hat{V}_2) = \frac{e^{\beta V_1}}{e^{\beta V_1} + e^{\beta V_2}} = \frac{e^{\beta g}}{e^{\beta g} + e^{-\beta g}},$$

with $g = (V_1 - V_2)/2$. We obtain also $P_2 = 1 - P_1$, of course.

To reiterate, a smaller value of β implies a smaller difference of $|P_1 - P_2|$. Namely, with a larger the value of β, one of the alternatives tends to dominate.

This type of approaches, which involve explicit calculations of probabilities of relative sizes of present values can be pursued further, but is omitted here to save space. See Aoki (2002, Sec. 6.2) and Aoki (1996, Sec.3.7, 3.8).

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