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# Optimal monetary policy under incomplete markets and aggregate uncertainty: A long-run perspective

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ABSTRACT

This paper examines the role of monetary policy in an environment with aggregate risk and incomplete markets. In a two-period overlapping-generations model with aggregate uncertainty, optimal monetary policy attains the ex-ante Pareto optimal allocation. This policy aims to stabilize the savings rate in the economy by changing real returns of nominal bonds via variation in expected inflation. Optimal expected inflation is procyclical and on average higher than without uncertainty. Simple inflation targeting rules closely approximate the optimal monetary policy.



## 1. Introduction

What is the role of monetary policy in an environment with aggregate risk and incomplete asset markets? We study a two-period overlapping-generations model (OLG) in which aggregate-income uncertainty and incomplete markets lead to suboptimal levels of savings and consumption. The ex-ante Pareto optimal allocation can be achieved through monetary policy. The optimal monetary policy stabilizes savings rates by affecting the expected real return on nominal bonds. It is characterized by: (1) expected inflation that on average is higher than without uncertainty, (2) a positive correlation between expected inflation and income, and (3) volatility of expected inflation that is inversely related to income persistence.

The characteristic properties of the optimal monetary policy stem from the tension between individually optimal savings decisions under incomplete markets, and the socially optimal allocation of consumption across generations. When faced with uninsurable income risk and a constant rate of return on savings, risk-averse individuals smooth their consumption by varying their savings with income. When current income is higher than expected future income, individuals save more to move part of the current "windfall" into the future. When current income is lower than expected future income, individuals save less taking advantage of the anticipated increase in future income. In the presence of income heterogeneity across individuals, the lack of risk-sharing leads to savings rates that are more volatile and on average higher than those chosen by the social planner. When income is correlated across individuals, as in our model, due to aggregate shocks, the level of *aggregate* savings is not socially optimal.

We first analyze a tractable endowment economy where aggregate endowment shocks create ex-post income heterogeneity across households. Limited trading opportunities between generations restrict risk-sharing leading to

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suboptimally high variations in the savings rates of young households who are trying to self-insure by varying their savings rates with income. With nominal assets being the only savings vehicle in this economy, the individual savings behavior of the young directly affects the allocation of goods between the young and the old because it determines the price of nominal assets sold by the old to the young. As a result of price-level fluctuations, the young face uncertainty regarding the ex-post real rate of return on their nominal savings. The ex-post return on nominal assets depends on the realization of income of the young next period and on inflation. Monetary policy can mitigate suboptimal fluctuations in savings rates by varying the expected inflation. In order to lower the average level and variability of savings rates, the optimal expected inflation is positive on average and procyclical. However, the degree to which expected inflation responds to income fluctuations depends on the persistence of income disturbances. When income fluctuations are long-lived, individual incentives to vary savings are weak, which makes sizeable variations in the expected inflation unnecessary. Whereas when income movements are transitory, individuals have a strong incentive to vary their savings rates to smooth consumption across time. As a result, optimal inflation becomes more responsive to transitory income fluctuations. This implies that the volatility of optimal expected inflation decreases with income persistence.

Next, we consider an extension of the benchmark model to a production economy, in which physical capital is combined with the labor supply of young individuals to produce consumption goods. In this richer model, money is held as a store-of-value only if it provides the same expected return as capital. As a result, monetary policy is more restricted, but still can improve allocations via its effect on the value of nominal assets. Despite this richer structure, the same qualitative results are obtained for optimal monetary policy as in our simpler endowment economy.

Finally, for the production economy, we show that the optimal monetary policy is well approximated by an inflation targeting (IT) rule that sets the expected future inflation at a target that is an increasing function of current inflation and current output. This kind of targeting policy, is often favored by central banks due to the uncertainty surrounding economic mechanisms in the real economy, or uncertainty associated with data revisions. Another potential advantage of using targeting policies is the alleviation of the ''inflation bias'' that stems from the time-inconsistency problem faced by the monetary authority.[1]

An important contribution of policy rules is their stabilizing effect on future expectations and subsequently on long-term decisions. Doepke and Schneider (2006) have shown that monetary policy can have sizable welfare consequences in an economy with heterogeneous sectors and nominal assets, via redistributive effects of inflation. Meh and Terajima (2011) have extended this insight beyond aggregate sectors and shown that different monetary policy regimes can lead to various patterns of wealth redistribution between households of different age groups. These findings suggest that price-level uncertainty in a monetary policy regime can have a significant impact on expected returns of long-term nominal assets (such as mortgages[2]) and on ex-post wealth redistributions between generations. This is where policy rules are of key importance as they reduce price uncertainty and improve conditions regarding long run planning. Our model captures the key elements of the redistributive nature of monetary policy from a household perspective by incorporating nominal contracts, heterogenous households and aggregate risk.

The paper contributes to macroeconomic theory and monetary policy analysis along several dimensions. First, it shows, using a tractable model, the consumption smoothing behavior in an OLG environment with aggregate-income shocks can lead to suboptimal variation in the savings rate. This result contrasts with the ''permanent income hypothesis'' literature in which the absence of agent heterogeneity makes the consumption smoothing behavior fully efficient.[3] Furthermore, our paper enriches the insights of the ''income fluctuations problem'' which focuses on the average or steady-state inefficiency of savings behavior in models with uninsurable idiosyncratic income risk (but no aggregate risk).[4] The model in this paper focuses on the savings behavior under aggregate uncertainty, income heterogeneity and incomplete risk-sharing, providing a rich yet tractable framework for monetary policy analysis.

To our knowledge, there is very little research on monetary policy in a stochastic OLG environment. Perhaps surprisingly, most of the previous research on monetary policy in OLG models focused exclusively on deterministic models. Suboptimality of positive inflation was one of the main findings of that literature.[5] Akyol (2004) also finds positive optimal inflation in an environment with infinitely lived agents, who are subject to uninsurable idiosyncratic endowment risk and borrowing constraints. With no aggregate uncertainty, the price level in Akyol's model increases over time in a deterministic fashion. In our model, we provide a full characterization of optimal monetary policy under aggregate uncertainty. A recent paper by Bhattacharya and Singh (2010) is related to ours. The authors use an

[1] Since the 1990s, 32 central banks announced inflation targeting as their monetary policy framework. See Walsh (1998) and Woodford (2003) for reviews of inflation targeting policy regimes. Ball and Sheridan (2005) provide a list of central banks that adopted inflation targeting, as well as timing details and performance evaluations for this policy change.

[2] In the US, Mortgage debt of households is quite sizable reaching one GDP (Source: Economic Report of the President, 2010).

[3] The fundamental idea was proposed by Milton Friedman, see Friedman (1957).

[4] Aiyagari (1994) shows that with uninsurable idiosyncratic income risk (but no aggregate risk), households facing a constant rate of return on their savings, tend to oversave for precautionary reasons. See also Sargent and Ljungqvist (2004, chapter 17) and references therein. Krusell and Smith (1998) add aggregate uncertainty, however, they do not focus on optimal policy.

[5] See, for example, Wallace (1992) or Champ and Freeman (2001).