Non-neutrality from heterogeneity of beliefs

Christopher A. Sims
Princeton University
sims@princeton.edu

July 29, 2008

1   Motivation

Low interest rates $\Rightarrow$ bubbles?

- Newspaper columnists often suggest that low US nominal interest rates in the 90's might have caused our recent bubbles.

- But it is hard to see how this could be true, except via some sort of friction, non-neutrality or sub-rationality.

Heterogeneity in beliefs engenders betting, leverage, and volume-with-price-change correlation

- Early literature on this (Harrison and Kreps) considered environment with no short sales, no risk aversion, emphasized result that heterogeneity of beliefs about an asset's return could increase investment in it above what any single investment type would have invested in it.

- Zaki Wahhaj (Yale UG thesis) showed that with risk aversion, no short sales constraint, the overinvestment result ceases to be generic, but that leverage and response of transactions and prices to new information does remain generic.

- But these results focus on the effects of heterogeneity of beliefs about an investment on investment in that asset.

2 The model in words

This paper's model

- The nature of the model, the results it produces, and why it produces them, can all be described non-mathematically.

- (Even though I could not have done so before I had solved the model dozens of times.)

    - Two-period model.
    - Lump sum taxes.
    - Nominal government debt is paid off in the second period with the tax revenues.
    - Real investment is possible, has a return with no uncertainty, diminishing returns.

model, continued

- Uncertainty about whether taxes in period 2 will be high or low, therefore whether inflation is low or high.

- If all agents have the same beliefs about the probabilities of low or high inflation, the real allocation is unaffected by the nature of those beliefs.

- Why? They correctly perceive the connection between taxes and inflation, and thus that their real budget sets are unaffected by the inflation-tax combination. Ricardian equivalence.

The non-neutrality

- With differences in beliefs about inflation, those (half the population) who believe high inflation is less likely will see nominal lending (or buying nominal bonds) as offering a high return, while those who believe high inflation is more likely will see nominal borrowing (or selling nominal bonds) as a cheap source of financing.

- Because the agents have different beliefs about expected returns, equilibrium requires that each ends up with a portfolio in which the high-return asset is highly correlated with consumption. The inflation-optimists will load up on bonds. The inflation-pessimists will load up on real capital, and each may short the other type of investment.

- In the second period, whoever was right will collect large payments from whoever was wrong.

Effects on real investment

- If both types of agents have log utility, their net savings is unaffected by beliefs about returns, and, since bonds and loans produce no real saving, aggregate investment is unaffected by heterogeneity of beliefs.

- If both types of agents have rates of relative risk aversion less than one, i.e. are not very risk averse, the inflation-pessimists will invest in aggregate more in the real asset than what would have been invested with no heterogeneity.

- i.e., they each invest more than twice as much as they would have if there were no inflation-optimists, and shorting of real investment by inflation-optimists does not fully offset this.

- The opposite holds when the RRA exceeds one.

3   The model itself

The actual model

- Two types of agents $i = a, b$.

- Two possible states of the world in the second period: $j = f, m$.

- f: taxes low, inflation high.

- m: taxes high, inflation lower.

The problem of the agent of type i:

$$\max_{C_{i1}, B_i, S_i, C_{i2f}, C_{i2m}} U(C_1) + \beta(p_i U(C_{i2f}) + (1 - p_i) U(C_{i2m}))$$

subject to

$$C_{i1} + S_i + \frac{B_i - B_0}{P_1} = Y$$

$$C_{i2j} = \rho S_i + R B_i / P_{2j} - \tau_j + \delta, \quad j = f, m$$

Actual model: firms

- Fixed in number, each facing diminishing returns, able to produce $g(S)$ from capital S.

- All owned in equal shares by all agents, distributing profits to them. No trading in shares.

- Individuals rent capital to firms in period 2 at rental rate ρ.

$$\delta = g(S_a + S_b) - \rho(S_a + S_b)$$
$$\rho = g'(S_a + S_b)$$

Actual model: functional forms and FOC's

$$U(C) = \frac{C^{1-\sigma}}{1-\sigma}$$
$$g(S) = \frac{S^{1-\alpha}}{1-\alpha}$$

$$\partial S : \qquad C_{i1}^{-\sigma} = \rho \cdot (p_i C_{if}^{-\sigma} + (1-p_i)C_{im}^{-\sigma})$$

$$\partial B : \qquad \frac{1}{C_{i1}^{\sigma} P_1} = R\beta \left(\frac{p_i R}{P_{2f}} + \frac{(1-p_i)R}{P_{2m}} \right)$$

Parameters that stay fixed

Y	R	τ_f	τ_m	α	β	A	σ	B_0
1.60	1.10	1.10	1.65	0.30	0.90	1.20	0.50	1.50

Two solutions

	$p_a = .3, p_b = .7$	$p_a = p_b = .5$
C_{a1}	1.1189	1.1590
C_{a2f}	0.2356	0.7143
C_{a2m}	1.2828	0.7143
C_{b1}	1.1189	1.1590
C_{b2f}	1.2828	0.7143
C_{b2m}	0.2356	0.7143
B_a	4.3559	1.5000
B_b	-1.3559	1.5000
P_1	0.9270	0.9515
P_{2f}	1.5000	1.5000
P_{2m}	1.0000	1.0000
S_a	-2.5996	0.4409
S_b	3.5618	0.4409
ρ	0.8497	0.8722
δ	0.3504	0.3296

4 Connections to the real world?

Implications for monetary policy

- Monetary policy could after all contribute to bubble-like phenomena.

- Not simply by lowering interest rates, or failing to raise them to end bubbles.

- Instead by acting, or communicating, in such a way as to cause divergences in beliefs.

Where do belief divergences come from?

Rational agents will tend increasingly to agree over time if they see the same stream of information. But:

- A sucker born every minute.

- Rational inattention. Stable inflation may make it rational to pay little attention to inflation, assume it to be zero or low.

- Unlikely, but important, contingencies.

Can a central bank do anything about belief divergences?

- It can eliminate or minimize uncertainty about its own current and future policy reactions, thereby removing one set of states over which divergent beliefs could emerge.

- It can monitor financial markets to identify situations where leverage and betting on future inflation or interest rates seems to be emerging. Where one side of the betting seems to be based on naïveté or inattention, it can make public warnings.

- As with any pattern of leveraged transactions in financial markets, it can monitor to ensure that eventual unwinding of leveraged positions will not freeze up financial markets.

Evaluating welfare with belief heterogeneity

- Is betting bad?

- Whose probabilities to use in evaluating welfare effects of policy?

- e.g., suppose there are difference of opinion about monetary policy, with one group having the same beliefs as the central bank, another, inattentive group having different beliefs.

- If the central bank makes a public statement that shifts the inattentive group's beliefs toward the central bank's own beliefs, the group who shared the CB beliefs from the start are worse off.