The effect of bank ownership and deposit insurance on monetary policy transmission revisited: the role of precautionary savings

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Abstract

We generalize the Model of Andries and Billon (2010) by allowing for a general type of consumer‘s preferences that allows the presence of prudent behavior. Having precautionary savings changes the model's implication that the existence of public banks diminishes the effectiveness of monetary policy. Indeed, the new setup shows that the existence of public banks may increase or decrease the effect of monetary policy on the level of loan supply depending upon the degree of relative risk aversion.

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Introduction

Andries and Billon (2010) develop a model where the ownership of a representative bank is shared, between the government and the private sector, to study the effect of bank ownership and deposit insurance on the transmission of monetary policy. They show that increasing the public ownership of the bank , which can be interpreted as increasing the presence of public banks in the banking sector, decreases the effect of monetary policy on the level of loan supply. Thus, the co-existence of public ownership of the bank and public insurance of deposits diminishes the effects of monetary policy.

This result is important because it implies that the existence of state-owned banks in an economy may alter the effect of monetary policy on loan supply and ultimately on output, and given the widespread existence of public banks in most countries, it may alter the efficacy of monetary policy to smooth out economic cycles.

By incorporating preferences that give rise to precautionary savings, we show that Andries and Billon's result is a particular case of a general framework, in which we could also observe that the existence of public banks may actually strength the effect of monetary policy on the loan supply.

A skecht of Andries and Billon (From hereafter A&B) Model

Firms are bank dependent and produce using the technology $f(k)$ with $f'(k) > 0$ and $f''(k) < 0$, with k being investment. Firms may confront two productivity states: high productivity ($\overline{f}(k)$) with probability (1-P_s) and low productivity ($\underline{f}(k)$) with probability P_s.

There exist a banking sector that is perfectly competitive, and is represented by a bank that has compulsory reserves, treasury bills (B) and loans (L) in the asset side of its balance sheet. Compulsory reserves are given by αD, where α is the mandatory fraction of deposits, D, that banks must hold. Banks face a probability of failure given by P_D, which only occurs in the low productivity state.

A fraction θ of the bank ownership is held by the government and the other $(1-\theta)$ percent is held by the private sector. The fraction owned by the state is fully insured by the government for a premium of $P_D r_D$, where r_D is the interest rate on D. Deposits corresponding to the private sector are privately insured with a deposit guarantee fund. The bank has to pay a premium per unit of deposit of $\mu P_D r_D$ for this insurance, where $\mu \in (0,1)$.

The bank's profit function is thus $\pi_b = (r_L - r)L + (r_B - r)B + [r(1-\alpha) - r_D(1-P_D^*)]D - C(D,L)$, where r represents the interest rate of the interbank market, r_B the rate on treasury bills, $P_D^* = P_D(1-\theta)(1-\mu)$ is the actual probability customers do not get their deposits back, and $C(D,L)$ is a convex management cost function. The bank chooses L, B, and D to maximize profits.

From the three first-order conditions (FOC) of the Bank, A&B derive the deposit demand function $D = D(r_L, r_D, r_B, r)$, the loan supply function $L = L(r_L, r_D, r_B, r)$, and the Treasury bills demand function $B = B(r_L, r_D, r_B, r)$.

Households

Households live two periods, and are born with an endowment w. In the first period they consume (C_1) or save (S) from w. In the second period, savings and interests are subject to the firms' productivity state and the banks' risk of failure. In the high productivity state customers receive back $(1+r_D)S$, in the low productivity state without bank failure customers also receive back $(1+r_D)S$, and in the low productivity state with bank failure customers recover $(1+r_D)S(\theta + (1-\theta)\mu)$. A&B assume that households preferences are quasi-linear $U(C_1, C_2) = u(C_1) + C_2$ with $u' > 0$ and $u'' < 0$. The FOC from the household's problem gives rise to the savings supply function $S(1+r_D)(1-P_D^*)$.

The following three expressions, derived from the model's equilibrium, are central in their arguments:

E1: $\frac{\partial r}{\partial B} = -[K'(r_L) - (1-\alpha)^2 S'((1+r_D)(1-P_D^*))]^{-1} > 0$

This expression indicates that a liquidity reduction (a sales of Treasury bills by the central bank) increases the interest rate in the interbank market.

E2: $\frac{\partial L}{\partial B} = -K'(r_L)[K'(r_L) - (1-\alpha)^2 S'((1+r_D)(1-P_D^*))]^{-1} < 0$ since $K'(r_L) < 0$

which indicates that an open market operation through a sale of securities by the central bank decreases lending by the banks.

E3: $\frac{\partial^2 L}{\partial B \partial P_D^*} = \frac{K'(r_L)[(1-\alpha)^2 S''((1+r_D)(1-P_D^*))]}{[K'(r_L)-(1-\alpha)^2 S'((1+r_D)(1-P_D^*))]^2} < 0$

Since the state's share in the bank ownership θ is part of P_D^*, then E3 shows that the greater θ is, the weaker the monetary policy effectiveness.

Introducing Precautionary Savings

As can be inferred from above, households in the A&B's model confront uncertainty about the return of their deposits. Since this return is materialized in the second period, uncertainty is then faced in that period. As Eeckhoudt et al. (2005, p.108) states "The uncertainty affecting future income introduces a new motive for saving. The intuition is that it induces consumers to raise their wealth accumulation in order to forearm themselves to face future risk." However, household preferences of the form $U(C_1, C_2) = u(C_1) + C_2$ do not allow uncertainty to affect saving decisions. Indeed, a utility function of this form shows risk neutrality in the second period, which is exactly the period where uncertainty shows up in the model. Shutting down the link between uncertainty and saving decisions does not allow precautionary savings to materialize. We show below that opening this link, by permitting general household preferences, may change the results of A&B. Furthermore, we show that their model is a particular case of a general framework. Remember that the return of households'savings (S) is dependent on three states of nature: A high productivity state, which returns $(1+r_D)$ with probability $(1-P_s)$, a low productivity state without bank failure, which returns $(1+r_D)$ with probability $P_s - P_D$, and a low probability state with bank failure, which returns $(1+r_D)S(\theta + (1-\theta)\mu)$ with probability P_D. The expected return on savings is then given by $E(\pi_H) = (1+r_D)S(1-P_D^*)$

Lets define the interest rates on deposits in the bankruptcy and non-failure of the banking sector states as $R_1 = (1+r_D)(\theta + (1-\theta)\mu)$, and $R_2 = (1+r_D)$ respectively. We can also define the expected savings rate as $R_0 = (1+r_D)(1-P_D^*)$.

The household problem is

$S^* \in arg\ max\ V(S) \equiv u(w-S) + \beta(P_D u(R_1 S) + (1-P_D)u(R_2 S))$

FOC is given by:

$$V'(S) = -u'(w-S) + \beta(P_D u'(R_1 S)R_1 + (1-P_D)u'(R_2 S)R_2) = 0 \quad (1)$$

SOC is:

$$V''(S) = u''(w - S) + \beta(P_D u''(R_1 S)R_1^2 + (1 - P_D)u''(R_2 S)R_2^2) < 0 \tag{2}$$

From the FOC, we can obtain the savings supply function as $S((P_D u'(R_1 S)R_1 + (1 - P_D)u'(R_2 S)R_2))$, or $S((1 + r_D)(P_D u'(R_1 S)(1 - (1 - \theta)(1 - \mu)) + (1 - P_D)u'(R_2 S))$. That is, the savings supply is a function of $(1 + r_D)$ and the expected marginal utility of future consumption. This is a well-known result in the literature of consumption under uncertainty (for instance see Eeckhoudt et al., 2005, p.108).

We will departure from A&B by showing directly the effect of θ on savings and loan supply, and not through the variable P_D^*.

We begin by showing the effect of government ownership of banks on the supply of savings, which is not explicitly developed in A&B.

The competitive equilibrium is characterized by 4 equations:

$$K(r_L) = L(r_L, r_D, r_B, r) \tag{3}$$

$$S(r_D, P_D, \theta, \mu) = D(r_L, r_D, r_B, r) \tag{4}$$

$$B = B(r_L, r_D, r_B, r) \tag{5}$$

$$L(r_L, r_D, r_B, r) + B(r_L, r_D, r_B, r) = (1 - \alpha)D(r_L, r_D, r_B, r) \tag{6}$$

Plugging (3)-(5) into (6), we obtain

$K(r_L) + B = (1 - \alpha)S(r_D, P_D, \theta, \mu)$

Proposition 1: The effect of government ownership of banks on the supply of savings.

Let's define the relative risk-aversion coefficient $R(R_1 S) = -\frac{R_1 S u''(R_1 S)}{u'(R_1 S)}$, then, the following two conditions are equivalent:

a) $\frac{dS^*}{d\theta} > (<)0$, and

b) $R(R_1 S) < (>)1$

Proof:

From (1) we define:

$$F \equiv -u'(w-S) + \beta((1-P_D)u'(R_2 S)R_2 + P_D u'(R_1 S)R_1) \tag{7}$$

Thus

$$\frac{dS^*}{d\theta} = -\frac{F_\theta}{F_{S^*}} \tag{8}$$

Note that the denominator of equation (8) is the SOC of the household optimization problem (equation (2)). Then, the expression sign depends upon the numerator of (8):

$$F_\theta = \beta P_D(1+r_D)(1-\mu)u'(R_1 S)[-R(R_1 S)+1] \tag{9}$$

Equation (9) is positive (negative) if the term $[-R(R_1 S)+1]$ is positive (negative), that is, if $R(R_1 S) < (>)1$. Then we have $\frac{dS^*}{d\theta} > (<)\ 0$ if and only if $R(R_1 S) < (>)1$.

This implies that an increase in the government ownership share of bank (θ), may increase or decrease the supply of savings depending upon the degree of relative risk aversion of households. Thus, what is argued in A&B ($\frac{dS^*}{d\theta} > 0$) is always true just for quasi-linear preferences. Indeed, as we show above, an increase in (θ) may actually decrease the supply of savings if the relative risk-aversion coefficient is greater than unity.

An increase in θ increments expected income and decreases the probability that clients do not recover their deposits P_D^*, that is, it decreases uncertainty. When individuals have quasi-linear preferences, they show risk neutrality in the second period, and thus they increase savings only as a consequence of the effect on expected income. Nonetheless, for general kind of preferences, uncertainty matters, and the value of the relative risk-aversion coefficient is central for knowing the effect on savings of a change in θ. If $R(R_1 S) > 1$ then an increase in θ will produce the same two effects as in the previous case, however since for this household the risk of not getting back the deposits is so important, once the government actually decreases that probability, the household does not need to save as much as before, and indeed it will increase consumption and thus decrease savings. In other words, a risk-averse individual will save more to confront the potential savings loses, then when the government involvement decreases the expected loses, he/she does not need to save as much as before. Under this condition ($R(R_1 S) > 1$), the household will lower its supply of savings (and increase consumption) when the government increases its share of ownership in the bank. Observe that the aforementioned effect would imply that the presence of state-owned banks would make monetary policy more effective because the greater θ, the more the households allocates to consumption, thus any change in the interbank rate would have a bigger effect on aggregate demand.

For simplicity of the arguments and exposition, we will assume from now on a Constant Relative Risk Aversion (CRRA) utility function. This type of preferences is widely used in the economic literature. Furthermore Szpiro (1986) and Szpiro and Outreville (1988) use insurance data from a sample of 31 countries, and find that for most of them CRRA preferences cannot be rejected.

Lemma 1

a) If households have preferences showing CRRA, then the effect of the interest rate on savings depends upon the coefficient of relative risk aversion. If the coefficient is lower (greater) than 1, the effect is positive (negative).

b) If households have preferences described by a quasi-linear utility function, then the effect of the interest rate on savings is positive. This is the case of A&B.

Proof:

From equation (7) we have:

$$\frac{dS^*}{dr_D} = -\frac{F_{r_D}}{F_{S^*}} \tag{10}$$

The denominator of expression (10) is the SOC of the household problem. To sign it, we need to evaluate the numerator: $F_{r_D} = \beta[(1-P_D)\frac{\partial R_2}{\partial r_D}[u''(R_2 S)SR_2 + u'(R_2 S)] + P_D\frac{\partial R_1}{\partial r_D}[u''(R_1 S)SR_1 + u'(R_1 S)]$, which can be expressed as

$$F_{r_D} = \beta[(1-P_D)\frac{\partial R_2}{\partial r_D}[-R(R_2 S)+1] + P_D\frac{\partial R_1}{\partial r_D}u'(R_1 S)[-R(R_1 S)+1]] \qquad (11)$$

where $R(R_i S) = -\frac{R_i S u''(R_i S)}{u'(R_i S)}$ for $i = 1, 2$ is the coefficient of relative risk aversion in the bank failure state ($i = 1$) and non failure state ($i = 2$).

If preferences are CRRA of the form $u(z) = \frac{z^{1-R}}{1-R}$, with R being the constant relative risk-aversion coefficient, then $R(R_1 S) = R(R_2 S) = R$. In this case, expresion (11) reduces to $F_{r_D} = \beta(1-R)[(1-P_D)\frac{\partial R_2}{\partial r_D}u'(R_2 S) + P_D\frac{\partial R_1}{\partial r_D}u'(R_1 S)]$, and given the assumptions, the square bracket is positive. Thus $F_{r_D} > (<) 0 \Leftrightarrow R < (>) 1$.

Now, if preferences are quasi-linear, then $R(R_1 S) = R(R_2 S) = 0$, and in this case expression (11) reduces to $F_{r_D} = \beta[(1-P_D)\frac{\partial R_2}{\partial r_D}u'(R_2 S) + P_D\frac{\partial R_1}{\partial r_D}u'(R_1 S)]$, which is positive given the assumptions of the model.

Given that when $R > 1$, the individual will choose a consumption path that generates a higher level of savings, a rise of the interest rate on deposits reduces, at the margin, the amount of savings she needs to accumulate to maximize utility. This is a kind of endowment-income effect that makes the individual richer so she can raise her consumption levels without giving-up her target savings. However, a risk-neutral individual will save less because she does not care about uncertainty, then an increase in r_D will raise savings, thus the substitution effect will dominate.

Proposition 2: The effect of government ownership on the interbank interest rate.

We now differentiate $K(r_L) + B = (1-\alpha)S(r_D, P_D, \theta, \mu)$ with respect to r and B to obtain $\frac{dr}{dB} = -[\frac{\partial K(r_L)}{\partial r_L} - \frac{(1-\alpha)^2}{(1-P_D^*)}\frac{\partial S(r_D, P_D, \theta, \mu)}{\partial r_D}]^{-1}$

a) If households have quasi-linear preferences, then $\frac{dr}{dB} > 0$.

b) If households have CRRA preferences of the form $u(z) = \frac{z^{1-R}}{1-R}$, then $\frac{dr}{dB} > 0$ if $R < 1$. However, the sign of $\frac{dr}{dB}$ is ambiguous for $R > 1$.

Proof: The proof is direct from lemma 1.

Proposition 3: The effect of a sale of Treasury bills (B) on the (capital) loan demand.

Now, from the competitive equilibrium we have

$L(r_L, r_D, r_B, r) + B = (1-\alpha)S(r_D, P_D, \theta, \mu)$, and differentiating it we have

$\frac{dL}{dB} = -\frac{\frac{\partial K(r_L)}{\partial r_L}}{\frac{\partial K(r_L)}{\partial r_L} - \frac{(1-\alpha)^2}{(1-P_D)}\frac{\partial S(r_D,P_D,\theta,\mu)}{\partial r_D}}$, and from it:

a) If households have quasi-linear preferences (A&B), then $\frac{dL}{dB} < 0$.

b) If households have CRRA preferences of the form $u(z) = \frac{z^{1-R}}{1-R}$, then $\frac{dL}{dB} < 0$ if $R < 1$. However, the sign of $\frac{dL}{dB}$ is ambiguous if $R > 1$.

Proof: Proof is direct from proposition 1 and lemma 1.

Here we show that with moderate high relative risk aversion ($R > 1$), a sale of securities (increase in B) by the central bank (tightening of monetary policy) could increase, under certain parameter values, capital (loan) demand.

Lemma 2

a) If households have quasi-linear preferences (A&B), then $\frac{\partial^2 S^*}{\partial\theta\partial r_D} > 0$

b) If households have CRRA preferences, the sign of $\frac{\partial^2 S^*}{\partial\theta\partial r_D}$ is ambiguous for any value of the relative risk-aversion coefficient.

Proof:

$\frac{\partial^2 S^*}{\partial\theta\partial r_D} = -\frac{\frac{\partial F_{r_D}}{\partial\theta}F_{S^*} - F_{r_D}\frac{\partial F_{S^*}}{\partial\theta}}{(F_{S^*})^2}$

If we differentiate equation (11) with respect to θ:

$\frac{\partial F_{r_D}}{\partial\theta} = \beta P_D[\frac{\partial^2 R_1}{\partial\theta\partial r_D}[u''(R_1S)SR_1 + u'(R_1S)] + \frac{\partial R_1}{\partial r_D}[u'''(R_1S)\frac{\partial R_1}{\partial\theta}S^2R_1 + u''(R_1S)S\frac{\partial R_1}{\partial\theta} + u''(R_1S)S\frac{\partial R_1}{\partial\theta}]]$

which can be expressed as

$$\frac{\partial F_{r_D}}{\partial\theta} = \beta P_D[\frac{\partial^2 R_1}{\partial\theta\partial r_D}u'(R_1S)[-R(R_1S)+1] + \frac{\partial R_1}{\partial r_D}\frac{\partial R_1}{\partial\theta}[u'''(R_1S)S^2R_1 + 2u''(R_1S)S]] \qquad (12)$$

Note that $[u'''(R_1S)S^2R_1 + 2u''(R_1S)S] > (<)0$ depends upon

$P(R_1S) = -\frac{R_1Su'''(R_1S)}{u''} > (<)2$

$P(R_1S)$ is known as **relative prudence**. For the CRRA case it reduces to $(R+1) > (<)2 \Leftrightarrow R > (<)1$.

Now, from the definition of R_1 we have

$\frac{\partial R_1}{\partial r_D} = \theta + (1-\theta)\mu$; $\frac{\partial R_1}{\partial \theta} = (1+r_D)(1-\mu)$; $\frac{\partial^2 R_1}{\partial\theta\partial r_D} = \frac{\partial^2 R_1}{\partial r_D\theta} = 1-\mu$, which can be plugged into (12) to obtain

$\frac{\partial F_{r_D}}{\partial\theta} = \beta P_D(1-\mu)u'(R_1S)[1 + R(R_1S)[P(R_1S)-3]]$

In the case of a CRRA utility function it reduces to

$\frac{\partial F_{r_D}}{\partial\theta} = \beta P_D(1-\mu)u'(R_1S)[1 + R(R-2)] > 0$, and from the SOC we have

$\frac{\partial F_{S^*}}{\partial\theta} = -u''(R_1S)\beta P_D\frac{\partial R_1}{\partial\theta}R_1(P(R_1S)-2)$

which is positive (negative) if $P(R_1S) > 2$, and in the CRRA case if $R > (<)1$.

Once again, the interaction of government ownership of banks and the effect of changes in the interest rate of deposits on the savings supply is ambiguous for preferences that differ from the A&B case.

Proposition 4: The effect of an open market operation on loan supply

a) If households have quasi-linear preferences (A&B), then $\frac{\partial^2 L}{\partial\theta\partial B} > 0$

b) If households have CRRA preferences, the sign of $\frac{\partial^2 L}{\partial\theta\partial B} > 0$ is ambiguous.

Proof:

If we differentiate $\partial L/\partial B$ with respect to θ, we have:

$$\frac{\partial^2 L}{\partial\theta\partial B} = -\left[\frac{k'(r_L)(1-\alpha)^2\left(\frac{\left(\frac{\partial^2 S}{\partial\theta\partial r_D}\right)(1-p_D^*)+\frac{\partial S}{\partial r_D}(p_D(1-\mu)}{(1-p_D^*)^2}\right)}{\left(k'(r_L)-\frac{(1-\alpha)^2}{(1-p_D^*)}\frac{\partial S}{\partial r_D}\right)^2}\right] \tag{13}$$

The sign of $\frac{\partial^2 L}{\partial\theta\partial B}$ depends upon the sing of $\frac{\partial S}{\partial r_D}$ and the sign of $\frac{\partial^2 S}{\partial\theta\partial r_D}$.

Inspecting the Mechanism

A change in the public ownership of banks, θ produces two effects: an increase on expected income from savings, and a drop in the variance of it. In A&B'world, the increase in the expected return on deposits raises household savings, and thus insuring the banks against a liquidity reduction, and then making monetary policy less effective. The change in the variance (uncertainty) does not affect consumption and savings decisions because quasi-linear preferences shut down this mechanism.

In our model, an increase in θ increases expected income and reduces uncertainty as before, however while the first effect makes savings to increase, a drop in the uncertainty surrounding income makes households to decrease savings because precautionary savings needed to confront income uncertainty are now lower. Therefore, the final effect on savings supply depends upon the magnitude of each effect. We have shown that when the relative risk-aversion coefficient is greater than unity, savings decrease, that is, the presence of public banks may actually increase the efficacy of monetary policy.

Conclusions

We expanded the model of Andries and Billon (2010) by including a general class of preferences, and show that the conclusions that they obtain remain always valid for quasi-linear type of preferences, as they assume. However, under preferences that allow the appearance of prudence, the conclusions depend upon the degree of relative risk aversion of households. Indeed, if the relative risk-aversion coefficient is greater than one, the presence of public ownership of banks, with explicit deposit insurance, may actually turn monetary policy more effective.

This paper does not contradict the one by Andries and Billon, to the contrary, it shows that their conclusions are a particular case in a more general framework, and as such it complements their article.

References

[1] Natalia Andries and Steve Billon. The effect of bank ownership and deposit insurance on monetary policy transmission. *Journal of Banking & Finance*, 34(12):3050–3054, 2010.

[2] Louis Eeckhoudt, Christian Gollier, and Harris Schlesinger. *Economic and Financial Decisions under Risk*. Princeton University Press, Princeton, 2005.

[3] George G Szpiro. Measuring risk aversion: An alternative approach. *The Review of Economics and Statistics*, 68(1):156–59, 1986.

[4] George G. Szpiro and Jean-Francois Outreville. Relative risk aversion around the world : Further results. *Journal of Banking & Finance*, 6(1, Supple):127–128, January 1988.