# Eleventh BIS Consultative Council of the Americas Research Conference “The Economics of the Covid-19 Pandemic?

# Unconventional Credit Policy in an Economy under Zero Lower Bound[1]

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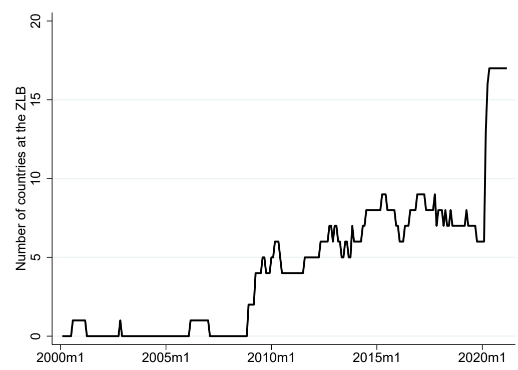
[1]The views expressed in this paper are solely those of the authors and do not necessarily reflect those of the Central Reserve Bank of Peru.This paper was prepared under the sponsorship of BCC RESEARCH PROGRAMME and supervision of Professor Céline Poilly (Aix-Marseille University). All errors are our own.

# Motivation

- The Covid-19 global shock has tested the limits of standard policy tools.
- One important constraint faced by several central banks is the ZLB in the monetary policy rate.
- To alleviate the firms's liquidity shortage shock, governments promptly adopted unconventional credit policies such as public guarantees for corporate loans and/or central bank liquidity facilities.




*Note*: Source: IMF, BIS. Own computations. Monthly data: 2000m1-2021m3. Indeed, this is the number of countries whose monetary policy rate becomes equal or lower than 0.25%.

# Research Question and Results

**Research Question:**

- What is the effectiveness of the unconventional credit policy in a ZLB environemtn in a framework with credit demand and supply frictions?

**Methodology:**

- A two-period model: Sticky prices + demand side credit frictions (a la Bernake, Gertler and Glichrist 1999) & supply credit frictions (a la Gertler and Karadi 2011) + unconventional credit policy + ZLB.

**Main conclusions:**

- Credit supply and demand frictions distort capital allocation.
- Unconventional credit policy diminishes the size of the distortion.
- While credit frictions might negatively affect the implementation of an expansionary conventional MP, unconventional credit policy might give more space for conventional MP.

## Outline of the simple two-period model

- Closed economy and no aggregate uncertainty.
- 5 types of agents:
- Households consume an save via deposits.
- Banks give loans to entrepreneurs and screen entrepreneur's projects .
  - Credit supply frictions (a la GK 2011). Moral hazard problem.
- Entrepreneurs create capital.
  - Credit demand frictions (a la BGG 1999). Idiosyncratic risk + Costly State Verification
- Intermediate goods firms demand capital to produce. We assume a share of them can't update prices.
- Final goods firms demand intermediate goods to produce final goods.
- Households own banks, entrepreneurs, and firms.

# Households

Households make deposits, decide consumption, take profits as lump-sum transfers:

$$\max_{C_1, C_2, D_2} u(C_1) + \beta u(C_2)$$

$$\text{s.t.}$$

$$C_1 + D_2 = Y_1 + \pi_1$$

$$C_2 = R_2 D_2 + \pi_2$$

where $\pi_1 = -N_{b,1} - N_{e,1}$, $\pi_2 = \pi_2^e + \pi_2^b + \pi_2^f$, where $Y_1$, $N_{b,1}$ and $N_{e,1}$ are exogenous.
Euler equation:

$$u'(C_1) = \beta R_2 u'(C_2),$$

If $u(c) = \frac{c^{1-\sigma}}{1-\sigma}$ where $\sigma$ is the CRRA coefficient, it becomes

$$C_2 = C_1 \left(\beta R_2\right)^{1/\sigma},$$

which is a **deposit supply curve**.

## Bankers: Demand of deposits and credit supply frictions

Credit Supply friction a la Gertler and Karadi 2011: **A moral hazard problem** between bankers and depositors. Bankers:

| Period 1 | Period 2: No Divert | Period 2: Divert |
|---|---|---|
| | Pay to Households: | |
| Take deposits: $D_2$ | $R_2 D_2$ | $(1-\lambda)(N_{b,1}+D_2)R_2^l$ |
| Make loans: $B_2 = N_{b,1} + D_2$ | Receive from loans: $R_2^l(N_{b,2}+D_2)$ | |
| | Bank's profits: | |
| | $R_2^l(N_{b,1}+D_2) - R_2 D_2$ | $\lambda(N_{b,1}+D_2)R_2^l$ |

where $R_2^l$ is the lending rate, and the bank can abscond with share $\lambda$ of the assets.
**Problem of Banks:**

$$\max_{D_2} \quad R_2^l(N_{b,1}+D_2) - R_2 D_2$$

$$\text{s.t} \quad \text{Incentive constraint (IC): choose no divert}$$

$$R_2^l(N_{b,1}+D_2) - RD_2 \geq \lambda(N_{b,1}+D_2)R_2^l$$

We parametrize the model so that **IC binds** (e.g., $N_{b,1}$ is sufficiently low). This arises a **credit risk premium** $R_2^l - R_2 > 0$.

## Deposits demand and Credit supply curves

We rewrite the binding IC to obtain the **deposit demand curve**:

$$D_2 = N_{b,1}\frac{(1-\lambda)R_2^l}{R_2-(1-\lambda)R_2^l}, \qquad \text{with} \quad \frac{\partial D_2}{\partial R_2} < 0,$$

and which also determines the **credit supply curve**, via $B_2 = N_{b,1} + D_2$:

$$B_2 = N_{b,1}\frac{R_2}{R_2-(1-\lambda)R_2^l}, \qquad \text{with} \quad \frac{\partial B_2}{\partial R_2^l} > 0.$$

Consequences of credit supply frictions:

- Higher Bank's equity, $N_{b,1}$, increases the availability of credit supply.
- Higher credit supply frictions, $\lambda$, decreases the availability of credit supply.

## Entrepreneurs: Lending diversification and credit demand frictions

- The modeling device as in Bernanke, Gertler and Gilchrist (1999): a Costly State Verification (CSV) problem
- Balance sheet: An entrepreneur with net worth $N_{e,1}$ goes to bank and receives a loan $B_2$ and produce capital, $K_2$:

$$K_2 = N_{e,1} + B_2.$$

- **Risky project:** The ex-post gross return of capital at $t = 2$ is $\omega_2 R_2^k$, $\omega_2$ is a idiosyncratic shock, i.i.d. across entrepreneurs, is lognormal, $\mathbb{E}_1\{\omega_2\} = 1$.
- Banks lend $B_2$ at the non-default bank loan rate $Z_2$
- Entrepreneurs with bad luck, $\omega_2 < \bar{\omega}_2$, default and lose everything.
- $\bar{\omega}$ is given by the break-even point: firm pays a fixed amount to the banker

$$\bar{\omega}_2 R_2^k K_2 = Z_2 B_2 \quad \Rightarrow \quad \bar{\omega}_2 = \frac{Z_2}{R_2^k} \frac{B_2}{B_2 + N_{e,1}}, \tag{1}$$

$F(\bar{\omega}_2)$ is the entrepreneur default probability.

# Entrepreneurs (II)

- Bank loan contract: $Z_2$, $B_2$.
- **Asymmetric information problem**: banks do not observe $\omega_2$ but can pay a monitoring cost $\mu\omega_2 R_2^k K_2$ to know $\Rightarrow$ Monitor only a bankrupt entrepreneur.
- Bank agrees to lend if it keeps **a safe portfolio (diversify idiosyncratic risk)**, with $R^l$ being the bank's opportunity cost:

$$\underbrace{\left[1 - F(\bar{\omega_2})\right] Z_2 B_2}_{\substack{\text{Bank loans} \\ \text{repayment from} \\ \omega > \bar{\omega} \text{ firms}}} + \underbrace{(1-\mu)\int_0^{\bar{\omega}_2} \omega dF(\omega) R_2^K K_2}_{\substack{\text{Debt collection} \\ \text{net of monitoring costs} \\ \text{from } \omega < \bar{\omega} \text{ defaulting firms}}} = \underbrace{R_2^l B_2}_{\substack{\text{Opportunity cost} \\ \text{or required return on loans}}}, \qquad (2)$$

  where $F$ is the cdf of the r.v. $\omega_2$; with $Z_2 > B_2$.

- but the lending contract must maximize Expected entrepreneur profits,

$$\int_{\bar{\omega}_2}^{\infty} (\omega_2 R_2^k K_2 - Z_2 B_2) dF(\omega) = \underbrace{\left(1 - \Gamma(\bar{\omega}_2)\right)}_{\substack{\text{Share of returns} \\ \text{to entrepreneurs}}} R_2^k K_2. \qquad (3)$$

- Solution: Maximize Entrepreneurs' profits (3), s.t. loan contract balance, (2).

# Entrepreneurs (III): Credit demand curve

The solution defines an optimal $\bar{\omega}$

$$\frac{R_2^k}{R_2^l} = \frac{1}{[1-\Gamma(\bar{\omega}_2)]\frac{1-F(\bar{\omega}_2)-\mu\bar{\omega}_2 f(\bar{\omega}_2)}{1-F(\bar{\omega}_2)} + (\Gamma(\bar{\omega}_2)-\mu G(\bar{\omega}_2))} > 1, \tag{4}$$

where $\Gamma(\bar{\omega}_2) = [\bar{\omega}_2(1-F(\bar{\omega}_2)) + G(\bar{\omega}_2)]$ with $G(\bar{\omega}_2) = \int_0^{\bar{\omega}_2} \omega dF(\omega)$. $\bar{\omega}_2$ is an increasing function of the market return spread, $R_2^k/R_2^l$.

Consequences:

- There is a **default probability risk premium**: $R_2^k - R_2^l > 0$
- The **credit demand curve** is given by the loan contract (2) and (4):

$$B_2 = N_2 \left[ \frac{\left(\Gamma(\bar{\omega}_2) - \mu G(\bar{\omega}_2)\right)\frac{R_2^k}{R_2^l}}{1 - \left(\Gamma(\bar{\omega}_2) - \mu G(\bar{\omega}_2)\right)\frac{R_2^k}{R_2^l}} \right]$$

  which is also the supply curve of capital, $K_2 = B_2 + N_2$.

# Intermediate and final goods producers

- **Final goods firms** combine substitute intermediate goods into a homogenous good using a CES technology. Intermediate goods are produced by **monopolistically competitive firms** indexed by $i \in [0,1]$,

$$Y_{i,2} = a\left(K_{i,2}\right)^{\alpha},$$

where $a$ is a productivity shock.

- **Price rigidities**: A fraction $\gamma$ cannot update prices, so $P_{i,2} = P_1$, and a fraction $1-\gamma$ can update prices. The problem of an intermediate firm $i$ that can update prices,

$$\max_{Y_{i,2}} \left[\left(\frac{P_{i,2}}{P_2}\right) Y_{i,2} - \mathcal{C}(Y_{i,2})\right],$$

subject to inverse demand curve $\frac{P_{i,2}}{P_2} = \left(\frac{Y_{i,2}}{Y_2}\right)^{-\frac{1}{\theta}}$, where $\mathcal{C}(Y_{i,2}) = R_2^k K_{i,2}$. The FOC is,

$$\frac{P_{i,2}}{P_2} = \frac{P_2^o}{P_2} = \left(\frac{1}{\alpha a^{1/\alpha}} R_2^k \left(Y_2\right)^{\frac{1-\alpha}{\alpha}}\right)^{\frac{\alpha}{\alpha+\theta(1-\alpha)}}.$$

which imposes a direct and positive relationship between prices and real variables in the economy in equilibrium.

# Monetary Policy Rule

- Taylor rule is:

$$i_1 = max(i_{min}, R^*(1+\pi_2)^{\phi}_{\pi} - 1),$$

where it holds $R_2 = (1+i_1)/(1+\pi_2)$.

- Inflation targeting (IT)

$$\pi_2 = 0.$$

- **We adopt IT**.

## Market Clearing

- Capital market requires,

$$K_2 = \int_0^1 K_{i,2} di = \left(\frac{Y_2}{a}\right)^{1/\alpha} \int_0^1 \left(\frac{P_{i,2}}{P_2}\right)^{-\theta/\alpha} di.$$

- Solving $Y_2$ we find,

$$Y_2 = \Delta^{-1} a K_2^{\alpha},$$

where $\Delta$ is the price dispersion that for simplicity we assume to be one.

- Market clearing in final goods market,

$$C_1 = Y_1 - K_2.$$
$$C_2 = Y_2 - \mu G(\bar{\omega}_2) R_2^k K_2.$$

- The Euler equation, or the **deposit supply curve**, becomes,

$$R_2 = \frac{1}{\beta}\left(\frac{a(D_2 + N_{1,b} + N_{1,e})^{\alpha} - \mu G(\bar{\omega}_2) R_2^k (D_2 + N_{1,b} + N_{1,e})}{y_1 - (D_2 + N_{1,b} + N_{1,e})}\right)^{\sigma}.$$

- Targets: $R_2 = 1.05^{1/4}$, $R_2^l - R_2 = 1.2\%$, $R_2^k - R_2^l = 1.2\%$, $F(\bar{\omega}_2) = 4\%$, $B_2/N_{b,1} = K_2/N_{e,1} = 4$. Capital is 1% inefficiently low.

## Deposit and Credit market determination

- In blue the interactions.
- **Deposit Market:**
  Supply of deposits:

$$R_2 = \frac{1}{\beta}\left(\frac{a(D_2 + N_{1,b} + N_{1,e})^{\alpha} - \mu G(\bar{\omega}_2) R_2^k (D_2 + N_{1,b} + N_{1,e})}{Y_1 - (D_2 + N_{1,b} + N_{1,e})}\right)^{\sigma}.$$

  Demand of deposits:

$$D_2 = N_{b,1}\frac{(1-\lambda)R_2^l}{R_2 - (1-\lambda)R_2^l}$$

  Observation: Demand frictions might additional feedback.
- **Credit Market:**
  Supply of credit:

$$B_2 = N_{b,1}\frac{R_2}{R_2 - (1-\lambda)R_2^l}.$$

  Demand of credit:

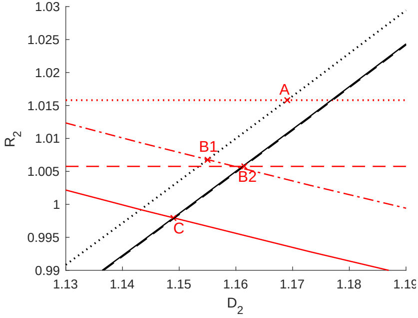
$$B_2 = N_2\left[\frac{\left(\Gamma(\bar{\omega}_2) - \mu G(\bar{\omega}_2)\right)\frac{R_2^k}{R_2^l}}{1 - \left(\Gamma(\bar{\omega}_2) - \mu G(\bar{\omega}_2)\right)\frac{R_2^k}{R_2^l}}\right]$$

  where $\bar{\omega}_2 = \bar{\omega}_2(R_2^k, B_2)$. Observation: Both credit and deposit markets are intertwined.

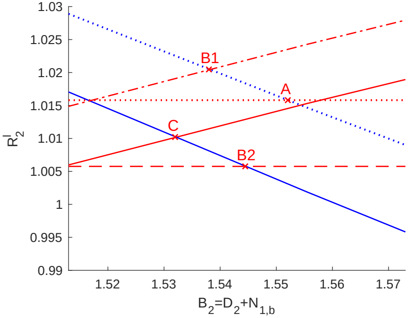
# Deposit and Credit market equilibrium

- A: No credit frictions.
- B1: Only credit supply frictions (moral hazard problem between banks and depositors)
- B2: Only credit demand frictions (asymmetric information and CSV)
- C: Both credit frictions.

Deposit Market




Credit Market




Key result: The presence of credit frictions takes the economy closer to a ZLB equilibrium.

# Unconventional Credit Policy

- Unconventional credit policy' definition:
  i. Government-guaranteed loans are originated by Central Bank's liquidity injection.
  ii. The required return of loans originated by the credit policy is not the market required return of banks loans, but the monetary policy rate.

- To deal with credit frictions during a crisis the CB might implement unconventional credit policies.
  Basically,
  - A deposit transformation into loans with no moral risk
  - No credit spread due to monitoring.

# Unconventional Credit Policy (II)

- Central Bank (CB) facilitates lending ($B^g_{t+1}$) to firms through banks.

$$B_2 + B^g_2 = D_2 + B^g_2 + N_{b,2}.$$

- CB intervention is funded by lump-sum taxes at $t = 1$, and guarantees are funded by lump-sum taxes at $t = 2$.
- Entrepreneurs first exhaust all CB credit and then traditional bank loans.
- Banks' maximization problem is unaffected.
- Credit policy effects:
  - Aggregate credit supply: Since CB loans cannot be diverted by banks, there is a higher aggregate supply of credit.
  - Aggregate credit demand: Since the cost of CB loans is the risk-free interest rate and the lending rate does not have any risk-premium, entrepreneur default probability decreases, which in turn increases the marginal benefit of capital. This pushes up entrepreneurs' incentives to demand credit.

$$\bar{\omega}_2 R^k_2 K_2 = Z_2(K_2 - B^g_2 - N_{e,1}) + R_2 B^g_2. \tag{5}$$

  - Credit policy follows the following rule: $B^g_2 = \psi_{CB,2}(K_2 - N_{e,2})$, where, we assume:

$$\psi_{CB,2} = 6\%$$

## Deposit and Credit market determination

- In red credit policy implications.
- **Deposit Market:**
  Supply of deposits:

$$R_2 = \frac{1}{\beta}\left(\frac{a(D_2 + B_2^g + N_{1,b} + N_{1,e})^{\alpha} - \mu G(\bar{\omega}_2) R_2^k (D_2 + B_2^g + N_{1,b} + N_{1,e})}{Y_1 - (D_2 + B_2^g + N_{1,b} + N_{1,e})}\right)^{\sigma}.$$

  Demand of deposits:

$$D_2 = N_{b,1}\frac{(1-\lambda)R_2^l}{R_2 - (1-\lambda)R_2^l}$$

- **Traditional bank loans Market:**
  Supply of credit:

$$B_2 = N_{b,1}\frac{R_2}{R_2 - (1-\lambda)R_2^l}.$$

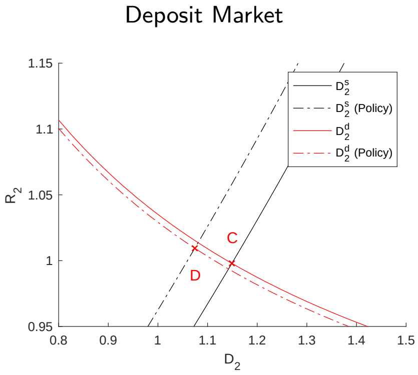
  Demand of credit:

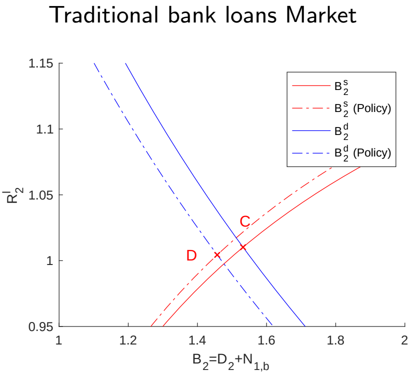
$$\frac{R_2^k(B_2, B_2^g)}{R_2^l} = \frac{1}{\Upsilon_2(R_2^k, R_2, B_2, B_2^g) + (1-\Gamma(\bar{\omega}_2))\frac{\Gamma'(\bar{\omega}_2) - \mu G'(\bar{\omega}_2)}{\Gamma'(\bar{\omega}_2)} + (\Gamma(\bar{\omega}_2) - \mu G(\bar{\omega}_2))}.$$

  where $\bar{\omega}_2 = \bar{\omega}_2(R_2^k, B_2, B_2^g, R_2)$; $\Upsilon_2 > 0$

## Unconventional Credit Policy

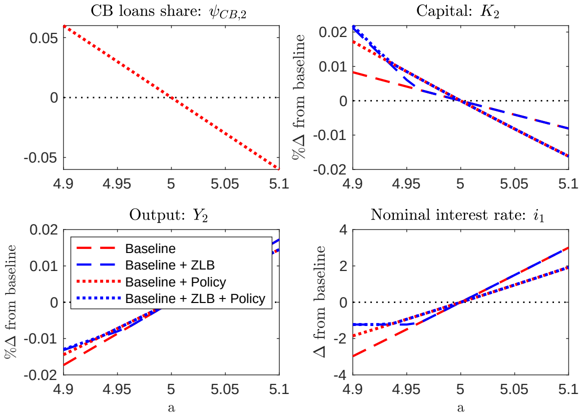
- C: No credit policy; D: Credit policy.
- Credit frictions distortions are reduced.
- There is a higher real interest rate and a smaller lending rate: a credit policy moves the economy away from being closer to the ZLB



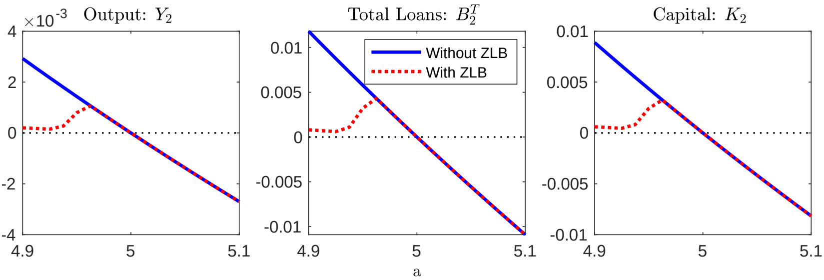
# An equilibrium under the ZLB (I)

- We assume changes in the productivity level, $a$, determines if the economy reaches the ZLB: a lower productivity level $\Rightarrow$ a lower nominal interest rate.
- ''Countercyclical'' credit policy intervention as a linear function of the size of the $a$ change: $\psi_{CB,2} = -3\Delta a$.
- Binding ZLB: Inflation moves above its target. This increases entrepreneurs' incentives to produce and hence to demand credit.



# An equilibrium under the ZLB (II)

- The unconventional credit policy can reduce the likelihood of reaching the ZLB.
- However, when the ZLB already binds (even after the policy intervention) the effectiveness of the credit policy to increases total credit (or capital) is reduced.
  - ZLB distorts the power of CB to control inflation. There is a stronger movement to the left of the credit demand curve due to the negative impact on future inflation when the ZLB binds.
  - When the ZLB is reached, the policy's benefits of providing relatively cheaper funding to entrepreneurs is diminished




*Note*: Figure shows the percentage difference between the equilibrium solutions of output, total loans and capital without and with unconventional credit policy for different values of *a*, the productivity level, for an economy with and without ZLB.

## Conclusions

- Credit supply and demand frictions distort capital allocation and make more likely that a ZLB equilibrium occurs.
- Unconventional credit policy diminishes the size of the distortion and reduces the likelihood of reaching the ZLB .
- Once the ZLB binds (even after the policy intervention) the effectiveness of the credit policy is diminished.

Thanks