

Working
Papers 2019

17

Time vs. Risk Preferences, Bank Liquidity Provision and Financial Fragility

Ettore Panetti



BANCO DE
PORTUGAL
EUROSYSTEM

Working Papers 2019 **17**

Time vs. Risk Preferences, Bank Liquidity Provision and Financial Fragility

Ettore Panetti

NOVEMBER 2019

The analyses, opinions and findings of these papers represent
the views of the authors, they are not necessarily those of the
Banco de Portugal or the Eurosystem

Please address correspondence to
Banco de Portugal, Economics and Research Department
Av. Almirante Reis, 71, 1150-012 Lisboa, Portugal
Tel.: +351 213 130 000, email: estudos@bportugal.pt



BANCO DE PORTUGAL
EUROSYSTEM

Lisbon, 2019 • www.bportugal.pt

Time vs. Risk Preferences, Bank Liquidity Provision and Financial Fragility

Ettore Panetti

Banco de Portugal, CRENoS, UECE
and Suerf

November 2019

Abstract

How important is it to distinguish relative risk aversion (RRA) from the intertemporal elasticity of substitution (IES) to understand bank liquidity provision and financial fragility? To answer this question, I develop a banking theory in which depositors feature Epstein-Zin preferences. In equilibrium, banks provide liquidity when RRA is sufficiently high (low) only for IES larger (smaller) than 1. Under the same conditions, banks might be fragile, i.e. subject to possible self-fulfilling depositors' runs. A time-consistent deposit freeze resolves banks' fragility if RRA is sufficiently low and IES is sufficiently larger than 1.

JEL: D81, G21, G28

Keywords: Financial intermediation, risk vs. time preferences, liquidity, financial fragility, deposit freezes.

Acknowledgements: I gratefully acknowledge the financial support from Fundação para a Ciência e Tecnologia, grant (Pest-OE/EGE/UI0436/2014). The analyses, opinions and findings of this paper represent the views of the authors, which are not necessarily those of Banco de Portugal or the Eurosystem.

1. Introduction

Since the seminal contribution by Diamond and Dybvig (1983), banks have been seen as a mechanism to insure risk-averse depositors against idiosyncratic uncertainty, that forces them to consume before the maturity of a risky investment (Allen and Gale 2007). Because of depositors' high risk aversion banks provide them liquidity by engaging in maturity transformation, i.e. by issuing short-term liabilities backed by long-term assets. The risk of this investment makes banks subject to fundamental uncertainty. Furthermore, the balance-sheet mismatch resulting from maturity transformation also makes them subject to self-fulfilling runs: All depositors might withdraw their deposits only because they expect everybody else to do that, and are afraid that the banks completely liquidate their assets to serve them, thus leaving little or nothing if they do not withdraw, too. This coordination failure justifies a deposit freeze, that might or might not calm depositors' expectations depending on the government commitment to a tough freeze (Ennis and Keister 2009).

To sum up, this narrative highlights the role of idiosyncratic uncertainty (driving time preferences) and fundamental uncertainty (driving risk preferences) for the existence and stability of the banking system. In decision theory, time preferences are summarized by the intertemporal elasticity of substitution (IES) and risk preferences by relative risk aversion (RRA). With the homogenous, time- and risk-separable preferences generally employed in the banking literature (like those represented by CRRA utility) these two measures are one the reciprocal of the other. Yet, an established empirical evidence shows that this assumption is unfounded (Attanasio and Weber 1989; Epstein and Zin 1991).

These arguments raise the question of how important it is to distinguish RRA from IES to understand bank liquidity provision and financial fragility. To provide an answer, I develop a banking theory with idiosyncratic and aggregate shocks, in which depositors exhibit preferences à la Epstein and Zin (1989). These allow a useful separation of RRA from IES, and have been employed in macroeconomics to analyze issues like precautionary savings and the equity premium (Backus *et al.* 2004). I start in section 2 by studying bank liquidity provision. Then, in section 3 I study financial fragility stemming from a government lack of commitment to a tough deposit freeze. Finally, in section 4 I conclude.

2. Bank liquidity provision with Epstein-Zin preferences

The basic environment comes from Diamond and Dybvig (1983). The economy lives for three dates, $t = 0, 1, 2$. The available investment technology yields:

$$Z = \begin{cases} R & \text{with probability } p, \\ 0 & \text{with probability } 1-p, \end{cases} \quad (1)$$

at $t = 2$ for each unit invested at $t = 0$. The probability of success of the investment is uniformly distributed over the interval $[0, 1]$, and satisfies $\mathbb{E}[p]R > 1$.¹ Moreover, the investment technology can be liquidated at $t = 1$ at zero costs.

The economy is populated by a unitary continuum of agents, with endowments $e = 1$ at $t = 0$ and zero afterwards. At $t = 1$, each agent observes a private idiosyncratic shock θ , taking value 0 with probability π and 1 with probability $1 - \pi$. The shock affects the date when the agent wants to consume, according to the Epstein-Zin preferences:

$$U(c_1, c_2, \theta) = \left[\mathbb{E}[(c_1 + \theta c_2)^{1-\gamma}] \right]^{\frac{1-\frac{1}{\psi}}{1-\gamma}}, \quad (2)$$

where $\gamma \in (0, 1)$ is RRA, and I will show that ψ is IES.²

To hedge against the idiosyncratic shocks, the agents deposit their endowments at $t = 0$ in a competitive bank. The bank maximizes depositors' welfare by offering a deposit contract that state the “early” consumption c_1 and the “late” consumption $c_2(R)$ that they can withdraw at $t = 1$ and $t = 2$ (in case of successful investment), respectively. As the shocks are private, the deposit contract must be incentive compatible, i.e. $c_1 \leq c_2(R)$.

Guess that the latter constraint is slack. The banking problem reads:

$$\max_{c_1} \int_0^1 \left[\pi c_1^{1-\frac{1}{\psi}} + (1-\pi) \left(p \left(R \frac{1-\pi c_1}{1-\pi} \right)^{1-\gamma} \right)^{\frac{1-\frac{1}{\psi}}{1-\gamma}} \right] dp. \quad (3)$$

The first-order condition of (3) yields:

$$c_1^{-\frac{1}{\psi}} = \frac{1-\gamma}{1-\frac{1}{\psi}+1-\gamma} R(c_2(R))^{-\frac{1}{\psi}}, \quad (4)$$

where $c_2(R) = R(1-\pi c_1)/(1-\pi)$. Notice that if $\psi = 1/\gamma$ (as with CRRA utility) we obtain a standard Euler equation:

$$c_1^{-\gamma} = \mathbb{E}[p]R(c_2(R))^{-\gamma}. \quad (5)$$

If instead $\psi \neq 1/\gamma$, (4) implies that:

$$IES \equiv \frac{\partial \ln(c_2(R)/c_1)}{\partial \ln(R)} = \psi, \quad (6)$$

as posited above. Moreover, the deposit contract is incentive compatible if:

$$\left(\frac{1-\gamma}{1-\frac{1}{\psi}+1-\gamma} R \right)^{\psi} > 1. \quad (7)$$

1. The assumption of uniform distribution comes at no loss of generality.

2. For $\gamma > 1$, I need to substitute $c^{1-\gamma}$ with $(c+F)^{1-\gamma} - F^{1-\gamma}$ to ensure that $u(0) = 0$. For F positive and asymptotically close to zero, RRA is constant and all results hold.

If $\psi = 1/\gamma$, this becomes $(\mathbb{E}[p]R)^{1/\gamma} > 1$ which is always true as $\mathbb{E}[p]R > 1$. If instead $\psi \neq 1/\gamma$, condition (7) is never satisfied for $\gamma > 2 - 1/\psi$, and it is satisfied when:

$$(1 - \gamma)(R - 1) > 1 - \frac{1}{\psi}. \quad (8)$$

The definition of $c_2(R)$ and (4) yield the equilibrium early consumption:

$$c_1^* = \frac{1}{\pi + (1 - \pi)\frac{1}{R} \left[\frac{1 - \gamma}{1 - \frac{1}{\psi} + 1 - \gamma} R \right]^\psi}. \quad (9)$$

If $\psi = 1$, then $c_1^* = 1$: The bank provides no liquidity to the depositors at $t = 1$, i.e. it offers an amount of early consumption equal to their initial deposit. Assume instead that $\psi \neq 1$. Then, the bank provides liquidity when $c_1^* > 1$, which happens if the denominator of (9) is smaller than 1, i.e. if:

$$\left(\frac{1 - \gamma}{1 - \frac{1}{\psi} + 1 - \gamma} R \right)^\psi < R. \quad (10)$$

This can be rewritten as:

$$\gamma \leq 1 - \frac{1 - \frac{1}{\psi}}{R^{1 - \frac{1}{\psi}} - 1}, \quad (11)$$

depending on whether $\psi \leq 1$. Intuitively, the locus of RRA that ensures liquidity provision is increasing in IES. This happens because, as IES increases, a one-percent increase in the real interest rate triggers an increase in consumption growth between $t = 1$ and $t = 2$ that is compatible with liquidity provision only if counterbalanced by an increase in RRA. Figure 1 highlights how this result significantly differ from the one under CRRA utility, in which $c_1^* > 1$ only if RRA is sufficiently high.³

Proposition 1. *Assume that $\gamma > 2 - 1/\psi$ and $\psi \neq 1$. Then, with Epstein-Zin preferences a bank provides liquidity in an incentive-compatible way if:*

$$1 < \left[\frac{1 - \gamma}{1 - \frac{1}{\psi} + 1 - \gamma} R \right]^\psi < R. \quad (12)$$

3. Financial Fragility

In the present environment, a bank might be fragile if subject to possible self-fulfilling “runs”, when all depositors withdraw early because they expect everybody else to do that. This happens iff $c_1^* > 1$, i.e. the bank holds insufficient resources

3. The numerical example assumes $R = 5$ without loss of generality.

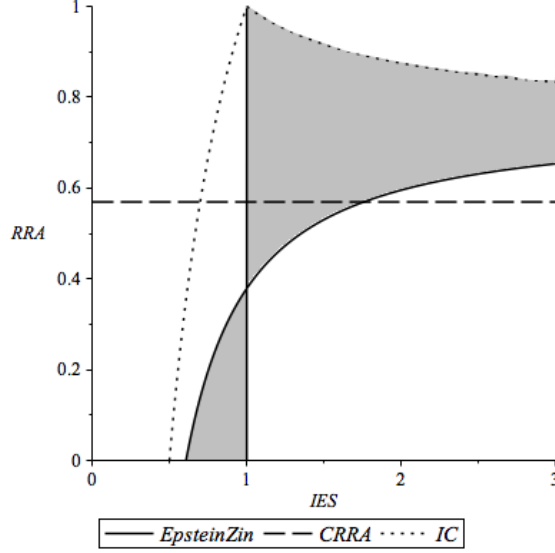


Figure 1: The parameter space for which a bank provides liquidity in an incentive-compatible way.

to pay early consumption to all depositors at a run, even by liquidating all its investments (Cooper and Ross 1998).

Under the conditions of Proposition 1, $c_1^* > 1$ and the bank might indeed be fragile. Against this scenario, here I study a time-consistent deposit freeze à la Ennis and Keister (2009), implemented by a benevolent government who cannot commit to a tough freeze that would completely resolve fragility. The government solves:

$$\max_{\pi_s} \int_0^1 \left[\pi_s c_1^{*1-\frac{1}{\psi}} + (1-\pi_s)(1-\pi) \left(p(c_2(\pi_s))^{1-\gamma} \right)^{\frac{1-\frac{1}{\psi}}{1-\gamma}} \right] dp, \quad (13)$$

where:

$$c_2(\pi_s) = R \frac{1 - \pi_s c_1^*}{(1 - \pi_s)(1 - \pi)}. \quad (14)$$

Intuitively, at $t = 1$, the depositors arrive at the bank in random order and are served sequentially. The government chooses the fraction $\pi_s \geq \pi$ of depositors (that might be early or late consumers) that are served at $t = 1$ before the freeze and get c_1^* , and the remaining $1 - \pi_s$ depositors among whom only $1 - \pi$ are late consumers and get $c_2(\pi_s)$, and the others get zero. The optimal freeze point π_s^* is implicitly characterized by the first-order condition:

$$c_1^{*1-\frac{1}{\psi}} - \frac{(1-\pi)(1-\gamma)}{1-\gamma+1-\frac{1}{\psi}} (c_2(\pi_s))^{1-\frac{1}{\psi}} + \frac{\left(1-\frac{1}{\psi}\right)(1-\gamma)}{1-\gamma+1-\frac{1}{\psi}} (c_2(\pi_s))^{-\frac{1}{\psi}} R \frac{1-c_1^*}{1-\pi_s} = 0. \quad (15)$$

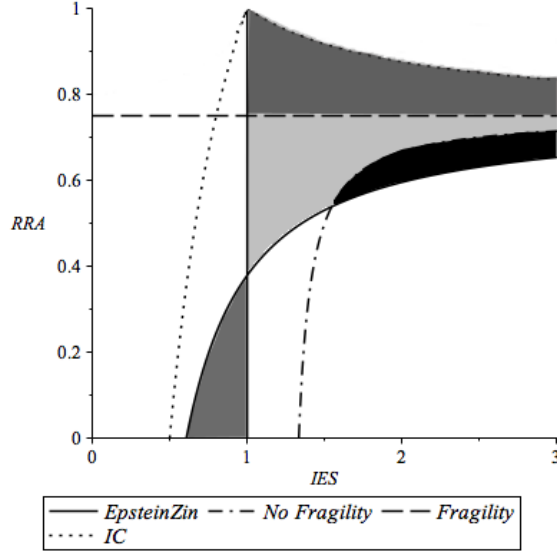


Figure 2: The parameter space for which a bank is never or always fragile.

From here, I can prove the following:

Proposition 2. *Under a time-consistent deposit freeze, a bank is fragile iff:*

$$\pi \geq \frac{\psi - 1}{1 - \gamma} \left[(R - 1)(1 - \gamma) - 1 \right] \equiv \bar{\pi}. \quad (16)$$

Proof (Ennis and Keister 2009). A bank is fragile iff the deposit freeze arrives too late to stop a run, i.e. iff $\pi_s \geq \pi^T$, defined as $c_1^* = c_2(\pi^T)$. For that to happen, the left-hand side of (15) must be non-negative at $\pi_s = \pi^T$, which is true iff (16) holds. $\square$

From (16), it is immediate to see that $\bar{\pi}$ is decreasing in γ and increasing in ψ . Put differently, financial fragility is increasing in RRA and decreasing in IES. Hence, a bank providing liquidity can be never fragile if IES is sufficiently larger than 1 and RRA sufficiently low, so that $\bar{\pi} \geq 1$ and (16) is never satisfied. In contrast, a bank can also be always fragile if $\bar{\pi} \leq 0$. This happens if RRA is either large or small enough, depending on whether IES is larger or smaller than 1.

Corollary 1. *Under a time-consistent deposit freeze, a bank is never fragile if ψ is sufficiently larger than 1 and γ is sufficiently low. A bank is always fragile if $\gamma < (R - 2)/(R - 1)$ when $\psi < 1$, and if $\gamma > (R - 2)/(R - 1)$ when $\psi > 1$.*

Figure 2 shows that, among the combinations of RRA and IES for which a bank provides liquidity in an incentive-compatible way as in Figure 1, there are cases in

which the bank is always fragile (dark grey area) when either RRA is sufficiently high or IES is lower than 1, but also cases in which it is never fragile (black area), despite the government lack of commitment to a deposit freeze.

4. Conclusions

The distinction between depositors' RRA and IES provides a novel perspective to understand bank liquidity provision and financial fragility. In particular, high depositors' RRA turns out to be not necessary to rationalize the two phenomena, especially if the depositors exhibits low IES. This calls for a reconsideration of some foundational results in the banking literature, that could be extended to the analysis of banks' liquidity management and endogenous financial fragility. I leave these issues for future research.

References

- Allen, Franklin and Douglas Gale (2007). *Understanding Financial Crises*. Oxford University Press.
- Attanasio, Orazio and Guglielmo Weber (1989). "Intertemporal Substitution, Risk Aversion and the Euler Equation for Consumption." *Economic Journal*, 99(395), 59–73.
- Backus, David K., Bryan R. Routledge, and Stanley E. Zin (2004). "Exotic Preferences for Macroeconomics." *NBER Macroeconomics Annual*, 19, 319–390.
- Cooper, Russell and Thomas W. Ross (1998). "Bank runs: Liquidity costs and investment distortions." *Journal of Monetary Economics*, 41(1), 27–38.
- Diamond, Douglas W. and Philip H. Dybvig (1983). "Bank Runs, Deposit Insurance, and Liquidity." *Journal of Political Economy*, 91(3), 401–419.
- Ennis, Huberto M. and Todd Keister (2009). "Bank Runs and Institutions: The Perils of Intervention." *American Economic Review*, 99(4), 1588–1607.
- Epstein, Larry G. and Stanley E. Zin (1989). "Substitution, Risk Aversion, and the Temporal Behavior of Consumption and Asset Returns: A Theoretical Framework." *Econometrica*, 57(4), 937–969.
- Epstein, Larry G. and Stanley E. Zin (1991). "Substitution, Risk Aversion, and the Temporal Behavior of Consumption and Asset Returns: An Empirical Analysis." *Journal of Political Economy*, 99(2), 263–286.

Working Papers

2017

- | | |
|---|---|
| <p>1 17 The diffusion of knowledge via managers' mobility
Giordano Mion Luca David Opromolla Alessandro Sforza</p> <p>2 17 Upward nominal wage rigidity
Paulo Guimarães Fernando Martins Pedro Portugal</p> <p>3 17 Zooming the ins and outs of the U.S. unemployment
Pedro Portugal António Rua</p> <p>4 17 Labor market imperfections and the firm's wage setting policy
Sónia Félix Pedro Portugal</p> <p>5 17 International banking and cross-border effects of regulation: lessons from Portugal
Diana Bonfim Sónia Costa</p> <p>6 17 Disentangling the channels from birthdate to educational attainment
Luís Martins Manuel Coutinho Pereira</p> <p>7 17 Who's who in global value chains? A weighted network approach
João Amador Sónia Cabral Rossana Mastrandrea Franco Ruzzenenti</p> <p>8 17 Lending relationships and the real economy: evidence in the context of the euro area sovereign debt crisis
Luciana Barbosa</p> | <p>9 17 Impact of uncertainty measures on the Portuguese economy
Cristina Manteu Sara Serra</p> <p>10 17 Modelling currency demand in a small open economy within a monetary union
António Rua</p> <p>11 17 Boom, slump, sudden stops, recovery, and policy options. Portugal and the Euro
Olivier Blanchard Pedro Portugal</p> <p>12 17 Inefficiency distribution of the European Banking System
João Oliveira</p> <p>13 17 Banks' liquidity management and systemic risk
Luca G. Deidda Ettore Panetti</p> <p>14 17 Entrepreneurial risk and diversification through trade
Federico Esposito</p> <p>15 17 The portuguese post-2008 period: a narrative from an estimated DSGE model
Paulo Júlio José R. Maria</p> <p>16 17 A theory of government bailouts in a heterogeneous banking system
Filomena Garcia Ettore Panetti</p> <p>17 17 Goods and factor market integration: a quantitative assessment of the EU enlargement
FLorenzo Caliendo Luca David Opromolla Fernando Parro Alessandro Sforza</p> |
|---|---|

2018

- 1|18 Calibration and the estimation of macro-economic models
Nikolay Iskrev
- 2|18 Are asset price data informative about news shocks? A DSGE perspective
Nikolay Iskrev
- 3|18 Sub-optimality of the friedman rule with distorting taxes
Bernardino Adão | André C. Silva
- 4|18 The effect of firm cash holdings on monetary policy
Bernardino Adão | André C. Silva
- 5|18 The returns to schooling unveiled
Ana Rute Cardoso | Paulo Guimarães | Pedro Portugal | Hugo Reis
- 6|18 Real effects of financial distress: the role of heterogeneity
Francisco Buera | Sudipto Karmakar
- 7|18 Did recent reforms facilitate EU labour market adjustment? Firm level evidence
Mario Izquierdo | Theodora Kosma | Ana Lamo | Fernando Martins | Simon Savsek
- 8|18 Flexible wage components as a source of wage adaptability to shocks: evidence from European firms, 2010–2013
Jan Babecký | Clémence Berson | Ludmila Fadejeva | Ana Lamo | Petra Marotzke | Fernando Martins | Pawel Strzelecki
- 9|18 The effects of official and unofficial information on tax compliance
Filomena Garcia | Luca David Opromolla | Andrea Vezulli | Rafael Marques
- 10|18 International trade in services: evidence for portuguese firms
João Amador | Sónia Cabral | Birgitte Ringstad
- 11|18 Fear the walking dead: zombie firms, spillovers and exit barriers
Ana Fontoura Gouveia | Christian Osterhold
- 12|18 Collateral Damage? Labour Market Effects of Competing with China – at Home and Abroad
Sónia Cabral | Pedro S. Martins | João Pereira dos Santos | Mariana Tavares
- 13|18 An integrated financial amplifier: The role of defaulted loans and occasionally binding constraints in output fluctuations
Paulo Júlio | José R. Maria
- 14|18 Structural Changes in the Duration of Bull Markets and Business Cycle Dynamics
João Cruz | João Nicolau | Paulo M.M. Rodrigues
- 15|18 Cross-border spillovers of monetary policy: what changes during a financial crisis?
Luciana Barbosa | Diana Bonfim | Sónia Costa | Mary Everett
- 16|18 When losses turn into loans: the cost of undercapitalized banks
Laura Blattner | Luísa Farinha | Francisca Rebelo
- 17|18 Testing the fractionally integrated hypothesis using M estimation: With an application to stock market volatility
Matei Demetrescu | Paulo M. M. Rodrigues | Antonio Rubia

- 18|18 Every cloud has a silver lining: Micro-level evidence on the cleansing effects of the Portuguese financial crisis
Daniel A. Dias | Carlos Robalo Marques
- 19|18 To ask or not to ask? Collateral versus screening in lending relationships
Hans Degryse | Artashes Karapetyan | Sudipto Karmakar
- 20|18 Thirty years of economic growth in Africa
João Amador | António R. dos Santos
- 21|18 CEO performance in severe crises: the role of newcomers
Sharmin Sazedj | João Amador | José Tavares
- 22|18 A general equilibrium theory of occupational choice under optimistic beliefs about entrepreneurial ability
Michele Dell'Era | Luca David Opromolla | Luís Santos-Pinto
- 23|18 Exploring the implications of different loan-to-value macroprudential policy designs
Rita Basto | Sandra Gomes | Diana Lima
- 24|18 Bank shocks and firm performance: new evidence from the sovereign debt crisis
Luísa Farinha | Marina-Eliza Spaliara | Serafem Tsoukas
- 25|18 Bank credit allocation and productivity: stylised facts for Portugal
Nuno Azevedo | Márcio Mateus | Álvaro Pina
- 26|18 Does domestic demand matter for firms' exports?
Paulo Soares Esteves | Miguel Portela | António Rua
- 27|18 Credit Subsidies
Isabel Correia | Fiorella De Fiore | Pedro Teles | Oreste Tristani

2019

- 1|19 The transmission of unconventional monetary policy to bank credit supply: evidence from the TLTRO
António Afonso | Joana Sousa-Leite
- 2|19 How responsive are wages to demand within the firm? Evidence from idiosyncratic export demand shocks
Andrew Garin | Filipe Silvério
- 3|19 Vocational high school graduate wage gap: the role of cognitive skills and firms
Joop Hartog | Pedro Raposo | Hugo Reis
- 4|19 What is the Impact of Increased Business Competition?
Sónia Félix | Chiara Maggi
- 5|19 Modelling the Demand for Euro Banknotes
António Rua
- 6|19 Testing for Episodic Predictability in Stock Returns
Matei Demetrescu | Iliyan Georgiev
Paulo M. M. Rodrigues | A. M. Robert Taylor
- 7|19 The new ESCB methodology for the calculation of cyclically adjusted budget balances: an application to the Portuguese case
Cláudia Braz | Maria Manuel Campos
Sharmin Sazedj
- 8|19 Into the heterogeneities in the Portuguese labour market: an empirical assessment
Fernando Martins | Domingos Seward
- 9|19 A reexamination of inflation persistence dynamics in OECD countries: A new approach
Gabriel Zsurkis | João Nicolau | Paulo M. M. Rodrigues
- 10|19 Euro area fiscal policy changes: stylised features of the past two decades
Cláudia Braz | Nicolas Carnots
- 11|19 The Neutrality of Nominal Rates: How Long is the Long Run?
João Valle e Azevedo | João Ritto | Pedro Teles
- 12|19 Testing for breaks in the cointegrating relationship: on the stability of government bond markets' equilibrium
Paulo M. M. Rodrigues | Philipp Sibbertsen
Michelle Voges
- 13|19 Monthly Forecasting of GDP with Mixed Frequency Multivariate Singular Spectrum Analysis
Hossein Hassani | António Rua | Emmanuel Sirimal Silva | Dimitrios Thomakos
- 14|19 ECB, BoE and Fed Monetary-Policy announcements: price and volume effects on European securities markets
Eurico Ferreira | Ana Paula Serra
- 15|19 The financial channels of labor rigidities: evidence from Portugal
Edoardo M. Acabbi | Ettore Panetti | Alessandro Sforza
- 16|19 Sovereign exposures in the Portuguese banking system: determinants and dynamics
Maria Manuel Campos | Ana Rita Mateus | Álvaro Pina
- 17|19 Time vs. Risk Preferences, Bank Liquidity Provision and Financial Fragility
Ettore Panetti

