

14.462 Advanced Macroeconomics II Spring 2020

Robert M. Townsend

Syllabus

This version: 15 February 2020

Topics

Measurement, Analysis, and Design of Financial Systems - First Principles as a Foundation for Policy.

Course Logistics

Instructor: Robert M. Townsend
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Lectures:	Tu Th	1:00-2:30 pm	E51-372
Recitations:	Fr	1:00-2:30 pm	E51-376
Office hours:	Mon	10:00-11:30 am	E52-548

Course Overview

This course will cover several topics related to liquidity and financial intermediation. The focus of the course is on the design of financial contracts and markets, efficiency and policy interventions in a general equilibrium context. Special topics include innovations made possible by new technology, e-money and e-platforms.

Lecture 1: Design, Regulation, and Policy with respect to Payment Systems and Financial Infrastructure: Bitcoin and FinTech as examples of Technological Innovation, with Implications for Money and Financial Intermediation, begging issues of What is Optimal

Lecture 2: Ledgers and Data Base Management, Integrated Financial Statements, and an Application to Distributional and Regional Accounts

Lecture 3: E-money, Infrastructure and Liquidity Shortages, Financial and Trader Centrality, and Optimized Liquidity Injections as Monetary Policy

Lecture 4: Encryption and Validation Protocols for E-messages Versus Smart Contracts and Mechanism Design

Lecture 5: Vision for Optimized Design of Financial Infrastructure using Distributed Ledger Technology: Scrambling of Information and Partitioned Ledgers, Delegation to the Contract, Limiting Access to the Outside Market, Single and Multiple-Colored Tokens as Decentralized Partitioned Ledgers, Commitment to Optimized Sequential Service to Mitigate Runs

Lecture 6: Needed Financial Infrastructure: Innovations in Emerging Markets and Guidelines from Theory for Optimal Infrastructure Design

Lecture 7: Dealing with Externalities of Payments Systems and Fire Sales: Designs for Optimized Competition among Crypto Currencies and Market Structure to Remove Pecuniary Externalities

Lecture 8: Payment Systems: Problems and Issues to be Considered in Alternative Designs

Lecture 9: The Information Problem of Decentralized Monetary Exchange and of Equilibria with High-Velocity Circulating Private Debt: Regulation using Distributed Ledger Technology

Lecture 10: Money, Crypto Currency, and Public Debt as Bubbles: Implications for Indeterminacy, Fiscal Policy, Liquidity Pricing and the Interest Rate

Lecture 11: Optimal Crypto Currency Policy and Optimal Monetary Policy: Observing Transactions Patterns, Heterogeneity and Wealth Effects, and the Implications of Micro-Market Frictions

Requirements

The grade will be based on class participation (15%), two problem sets (40%) and referee report / research proposal (45%), which should discuss in detail at least one of the papers marked with \$.

The discussion should consist of a thorough critique of a paper or topic, as in a well written self-contained referee report, and ideally would give ideas about how to build on that, as in a research proposal.

The research proposal should be presented on Friday, March 13 and Tuesday, March 17. Each presentation will be allocated a 30-min slot. The time constraint will be strictly enforced. The write up should extend the discussion and be 10 to 12-page long. A write-up is due on March 29.

Required readings are marked with an asterisk (*).

LECTURE 1:

Design, Regulation, and Policy with respect to Payment Systems and Financial Infrastructure – Bitcoin and FinTech as examples of Technological Innovation, with Implications for Money and Financial Intermediation, begging issues of What is Optimal

\$ Adrian, T., & Shin, H. S. (2010). The changing nature of financial intermediation and the financial crisis of 2007–2009. *Annu. Rev. Econ.*, 2(1), 603-618.

\$ Ayyagari, M., Beck, T., & Martinez Peria, M. S. (2017). Credit growth and macroprudential policies: preliminary evidence on the firm level. *BIS Paper*, (91a).

Briglevics, Tamás and Scott Schuh (2014). U.S. consumer demand for cash in the era of low interest rates and electronic payments. Working Paper Series 1660, European Central Bank.

\$ Buchak, G., Matvos, G., Piskorski, T., & Seru, A. (2018). Fintech, regulatory arbitrage, and the rise of shadow banks. *Journal of Financial Economics*, 130(3), 453-483.

Buiter, Willem H. (2009). Negative Nominal Interest Rates: Three ways to overcome the zero lower bound. NBER Working Papers 15118.

Carstens, A. (2019). Central Banking and Innovation: Partners in the Quest for Financial Inclusion. The seventeenth C.D. Deshmukh Memorial Lecture.
<https://www.rbi.org.in/Scripts/PublicationsView.aspx?id=18949>

Chicago Board of Trade (1982). "Grains, Production, Processing, Marketing."

Chodorow-Reich, G., Gopinath, G., Mishra, P., & Narayanan, A. (2020). Cash and the economy: Evidence from India's demonetization. *The Quarterly Journal of Economics*, 135(1), 57-103.

Eiger, Z. & Mandell, J. (2015). P2P Lending Basics: How it Works, Current Regulations and Considerations. Morrison Foerster. <https://media2.mofo.com/documents/150129p2plendingbasics.pdf>

Gorton, G., & Winton, A. (2003). Financial intermediation. In *Handbook of the Economics of Finance* (Vol. 1, pp. 431-552). Elsevier.

\$ Stavins, J., Schuh, S., & Greene, C. (2017). *The 2015 Survey of Consumer Payment Choice: summary results* (No. 17-3). Federal Reserve Bank of Boston. <https://www.bostonfed.org/-/media/Documents/Workingpapers/PDF/2017/rdr1703.pdf>

\$ Hildebrand, N. N. V. (2019). *The Rise of Finance: 1850-2015. Three essays in economics*. (Doctoral dissertation, Massachusetts Institute of Technology). <https://dspace.mit.edu/handle/1721.1/122104>

Lakhani, K. R., & Iansiti, M. (2017). The truth about blockchain. *Harvard Business Review*, 95, 118-127.

\$ Nakamoto, S. (2008). A peer-to-peer electronic cash system. *Bitcoin* URL: <https://bitcoin.org/bitcoin.pdf>

\$ Philippon, T. (2016). *The fintech opportunity* (No. w22476). National Bureau of Economic Research.

\$ Piketty, T., & Zucman, G. (2014). Capital is back: Wealth-income ratios in rich countries 1700–2010. *The Quarterly Journal of Economics*, 129(3), 1255-1310.

\$ Rogoff, K. S. (2017). *The curse of cash: How large-denomination bills aid crime and tax evasion and constrain monetary policy*. Princeton University Press. Schuh and Stavins 2017

* Townsend, R. (forthcoming). Design and Regulation of Financial Infrastructure and Payments Systems. MIT press

LECTURE 2: Ledgers and Data Base Management, Integrated Financial Statements, and an Application to Distributional and Regional Accounts

\$ Auten, G., & Splinter, D. (2019). Top 1 Percent Income Shares: Comparing Estimates Using Tax Data. In *AEA Papers and Proceedings* (Vol. 109, pp. 307-11).

Awuku-Budu, C., Guci, L., Lucas, C. A., & Robbins, C. A. (2013). A first look at experimental personal consumption expenditures by state. *Briefing. Bureau of Economic Analysis*.

\$ Batty, M., Bricker, J., Briggs, J., Holmquist, E., McIntosh, S., Moore, K. B., Reber, S., Shatto, M., Sweeney, T. & Henriques, A. (2019). Introducing the distributional financial accounts of the United States.

Bizer David S. and Peter M. Demarzo (1992). "Sequential Banking" *The Journal of Political Economy*, vol. 100(1) pp. 41-61.

Bond, Philip (2004). "Bank and Nonbank Financial Intermediation," *Journal of Finance*, vol. 59(6), pages 2489-2529, December.

\$ Bond, C. A., Martin, T., McIntosh, S. H., & Mead, C. I. (2007). Integrated macroeconomic accounts for the United States. *Survey of Current Business*, 87(11), 14-31.

Boyd John H. and Edward C. Prescott (1985). "Financial Intermediary Coalitions" *Journal of Economic Theory*, vol. 38(2), pp. 211-232.

Diamond, Douglas W. (1984). "Financial Intermediation and Delegated Monitoring" *The Review of Economic Studies*, vol. 51(3).

\$ Duffie, D., & Zhu, H. (2011). Does a central clearing counterparty reduce counterparty risk?. *The Review of Asset Pricing Studies*, 1(1), 74-95.

\$ Duffie, D. (2014). Financial Market Infrastructure: Too Important To Fail. *Across the Great Divide: New Perspectives on the Financial Crisis*, 652, 251.

Green, Daniel, and Ernest Liu, 2015. "Credit Markets without Commitment," Working Paper.

Hughes, Joseph P. and Loretta J. Mester (2011). "Who Said Large Banks Don't Experience Scale Economies? Evidence From a Risk-Return-Driven Cost Function," Working Paper No. 11-27, Federal Reserve Bank of Philadelphia.

\$ Mallett, J. (2009). Limits on the Communication of Knowledge in Human Organisations. *Studies in Emergent Order* 2: 1-18.

* Paweenawat, A. & Townsend, R. (2019). The Impact of Isolationist Policy: Disentangling Real and Financial Factors Through the Lens of Integrated Regional Financial Accounts. Working Paper. revised Jan 2019.

\$ Piketty, T., Saez, E., & Zucman, G. (2018). Distributional national accounts: methods and estimates for the United States. *The Quarterly Journal of Economics*, 133(2), 553-609.

* Samphantharak, K., Schuh, S., & Townsend, R. M. (2018). Integrated household surveys: An assessment of US methods and an innovation. *Economic inquiry*, 56(1), 50-80.

Samphantharak, K., & Townsend, R. M. (2010). *Households as corporate firms: an analysis of household finance using integrated household surveys and corporate financial accounting* (No. 46). Cambridge University Press.

\$ Smith, M., Yagan, D., Zidar, O., & Zwick, E. (2019). Capitalists in the Twenty-first Century. *The Quarterly Journal of Economics*, 134(4), 1675-1745.

\$ Smith, M., Zidar, O., & Zwick, E. (2019). Top wealth in the united states: New estimates and implications for taxing the rich. *Unpublished manuscript*. <http://www.ericzwick.com/wealth/wealth.pdf>

Townsend, R. (1978). "Intermediation with Costly Bilateral Exchange." *Review of Economic Studies* 45 (3): 417-425.

US Department of Commerce. Bureau of Economic Analysis. 1985. "An Introduction to National Economic Accounting." Methodology Paper Series MP-1. Washington, DC: GPO.

LECTURE 3: E-money, Infrastructure and Liquidity Shortages, Financial and Trader Centrality, and Optimized Liquidity Injections as Monetary Policy

Allen, Franklin and Douglas Gale (2000). "Financial Contagion," *Journal of Political Economy*, vol. 108(1), pp. 1–33

Alvarez, F., & Lippi, F. (2009). Financial innovation and the transactions demand for cash. *Econometrica*, 77(2), 363-402.

* Alvarez, F., Pawasutipaisit, A., & Townsend, R. M. (2018). *Cash Management in Village Thailand: Positive and Normative Implications*. MIT Working Paper.

Bech, Moren L. and Enghin Atalay (2010). "The Topology of the Federal Funds Market," *Physica A: Statistical Mechanics and its Applications*, vol. 389(22), pp. 5223-5246.

Boss, Michael, Helmut Elsinger, Martin Summer and Stefan Thurner (2003). "The Network Topology of the Interbank Market," *Quantative Finance*, vol. 4(6), pp. 677-684.

* Chandrasekhar, A. G., Townsend, R., & Xandri, J. P. (2018). *Financial Centrality and Liquidity Provision* (No. w24406). National Bureau of Economic Research.

\$ Cocco, João F., Francisco J. Gomes and Nuno C. Martins (2009). "Lending relationships in the interbank market," *Journal of Financial Intermediation*, vol. 18(1), pp. 24-48.

\$ Duffie, D., Gârleanu, N., & Pedersen, L. H. (2005). Over-the-counter markets. *Econometrica*, 73(6), 1815-1847.

\$ Freeman, Scott. 1996. "The Payments System, Liquidity, and Rediscounting." *American Economic Review* 86 (December): 1,126–38.

\$ Green, Edward J. 1999. "Money and Debt in the Structure of Payments." *Federal Reserve Bank of Minneapolis Quarterly Review* 23 (Spring): 13–29

\$ Hendershott, T. & Madhavan, A. (2015). "Click or Call? Auction versus Search in the Over-the-Counter Market," *Journal of Finance*, vol. 70(1), pp. 419-447, 02.

Jack, W., Suri, T., & Townsend, R. M. (2010). Monetary theory and electronic money: Reflections on the kenyan experience. *FRB Richmond Economic Quarterly*, 96(1), 83-122.

Jaramillo et al. (2012), An Empirical Study of the Mexican Banking System Network and Its Implications for Systemetic Risk

Kiyotaki, Nobuhiro and Randall Wright (1989). "On Money as a Medium of Exchange," *Journal of Political Economy*, vol. 97(4), pp. 927-954.

Lagos, R., & Wright, R. (2005). A unified framework for monetary theory and policy analysis. *Journal of political Economy*, 113(3), 463-484.

\$ Lagos, R., & Zhang, S. (2019). *On money as a medium of exchange in near-cashless credit economies* (No. w25803). National Bureau of Economic Research.

\$ Longstaff, F. A. (2004). The Flight-to-Liquidity Premium in US Treasury Bond Prices. *Journal of Business*, 77(3).

Miller, M. H., & Orr, D. (1966). A Model of the Demand for Money by Firms. *The Quarterly journal of economics*, 80(3), 413-435.

\$ Summer, M. (2013). Financial Contagion and Network Analysis, *Annual Reviews of Financial Economics*, 5, 1–38.

Upper, Christian and Andreas Worms (2004). "Estimating bilateral exposures in the German interbank market: Is there a danger of contagion?" *European Economic Review*, vol. 48(4), pp. 827-849.

\$ Weill, P. O. (2007). Leaning against the wind. *The Review of Economic Studies*, 74(4), 1329-1354.

LECTURE 4: Encryption and Validation Protocols for E-messages Versus Smart Contracts and Mechanism Design

\$ Berlin, M., & Mester, L. J. (1999). Deposits and relationship lending. *The Review of Financial Studies*, 12(3), 579-607.

Budish, E. (2018). *The economic limits of bitcoin and the blockchain* (No. w24717). National Bureau of Economic Research.

\$ Coles, P. A., & Shorrer, R. (2012). Correlation in the multiplayer electronic mail game. *The BE Journal of Theoretical Economics*, 12(1).

\$ Chwe, M. S. Y. (1995). Strategic reliability of communication networks.
<http://www.chwe.net/michael/p.pdf>

\$ De Jaegher, K.J.M.. (2015). "Beneficial Long Communication in the Multi-Player Electronic Mail Game". Working Papers 15-09, Utrecht School of Economics. <<https://ideas.repec.org/p/use/tkiwps/1509.html>>

\$ Green, E. J., & Oh, S. N. (1991). Contracts, constraints and consumption. *The Review of Economic Studies*, 58(5), 883-899.

Halpern, J. Y., & Moses, Y. (1990). Knowledge and common knowledge in a distributed environment. *Journal of the ACM (JACM)*, 37(3), 549-587.

* Harris, M., & Townsend, R. M. (1981). Resource allocation under asymmetric information. *Econometrica: Journal of the Econometric Society*, 33-64.

Kocherlakota, N. R. (1996). Implications of efficient risk sharing without commitment. *The Review of Economic Studies*, 63(4), 595-609.

\$ Narayanan, A., Bonneau, J., Felten, E., Miller, A., & Goldfeder, S. (2016). *Bitcoin and cryptocurrency technologies: a comprehensive introduction*. Princeton University Press.

* Morris, S., & Shin, H. S. (1997). Approximate common knowledge and coordination: Recent lessons from game theory. *Journal of Logic, Language and Information*, 6(2), 171-190.

\$ Prescott, Edward. (2003). "Communication in Models with Private Information: Theory and Computation." *The Geneva Papers on Risk and Insurance Theory*, 28 : 105- 130.

* Townsend, R. M. (1982). Optimal multiperiod contracts and the gain from enduring relationships under private information. *Journal of political Economy*, 90(6), 1166-1186.

LECTURE 5:

Vision for Optimized Design of Financial Infrastructure using Distributed Ledger Technology: Scrambling of Information and Partitioned Ledgers, Delegation to the Contract, Limiting Access to the Outside Market, Single and Multiple-Colored Tokens as Decentralized Partitioned Ledgers, Commitment to Optimized Sequential Service to Mitigate Runs

Bertolai, J. D., Cavalcanti, R. D. O., & Monteiro, P. K. (2014). Run theorems for low returns and large banks. *Economic Theory*, 57(2), 223-252.

Budish, E., Cramton, P., & Shim, J. (2015). The high-frequency trading arms race: Frequent batch auctions as a market design response. *The Quarterly Journal of Economics*, 130(4), 1547-1621.

Diamond, D. W., & Dybvig, P. H. (1983). Bank runs, deposit insurance, and liquidity. *Journal of political economy*, 91(3), 401-419.

* Doepke, M., & Townsend, R. M. (2006). Dynamic mechanism design with hidden income and hidden actions. *Journal of Economic Theory*, 126(1), 235-285.

Ennis, H. M. & Keister, T. (2008). "Run equilibria in a model of financial intermediation," Staff Reports 312, Federal Reserve Bank of New York.

\$ Green, E. J., & Lin, P. (2003). Implementing efficient allocations in a model of financial intermediation. *Journal of Economic Theory*, 109(1), 1-23.

Jacklin, Charles J. (1987). "Demand deposits, trading restrictions, and risk sharing," Contractual Arrangements in Intertemporal Trade.

Malinowski, Bronislaw (1922). "Argonauts of the Western Pacific: An Account of Native Enterprise and Adventure in the Archipelagos of Melanesian New Guinea". London: Routledge & Kegan Paul.

\$ Narayanan, A., Bonneau, J., Felten, E., Miller, A., & Goldfeder, S. (2016). *Bitcoin and cryptocurrency technologies: a comprehensive introduction*. Princeton University Press.

* Townsend, R. M. (1987). Economic organization with limited communication. *The American Economic Review*, 954-971.

* Townsend, R. M. (1988). Information constrained insurance: the revelation principle extended. *Journal of Monetary Economics*, 21(2-3), 411-450.

\$ Zhu, Haoxiang (2013). "Do dark pools harm price discovery?," Review of Financial Studies, vol. 27(3), pp. 747-789.

LECTURE 6:

Needed Financial Infrastructure: Innovations in Emerging Markets and Guidelines from Theory for Optimal Infrastructure Design

Acemoglu, Daron, & Zilibotti, Fabrizio (1997). "Was Prometheus Unbound by Chance? Risk, Diversification, and Growth" *The Journal of Political Economy*, vol. 105(4) pp. 709-751

\$ Allen, Franklin & Gale, Douglas (2004). "Financial intermediaries and markets," *Econometrica*, vol. 72(4), pp.1023-1061.

Bisin, A. (1998). General equilibrium with endogenously incomplete financial markets. *Journal of Economic Theory*, 82(1), 19-45.

Kinnan, C., Samphantharak, K., Townsend, R. M., & Vera-Cossio, D. (2018). Networks and Risk Sharing in Village Economies. Working paper, MIT.

\$ Pesendorfer, W. (1995). Financial innovation in a general equilibrium model. *Journal of Economic Theory*, 65(1), 79-116.

* Prescott, E. C., & Townsend, R. M. (1984). General competitive analysis in an economy with private information. *International Economic Review*, 1-20.

Prescott, E. C., & Townsend, R. M. (1984). Pareto optima and competitive equilibria with adverse selection and moral hazard. *Econometrica: Journal of the Econometric Society*, 21-45.

Ru, Hong, & Townsend, R.M. (2019). Enhanced Informal Networks: Costly State Verification and Village Fund Intervention. Working paper, MIT.

Samphantharak, Krislert, & Townsend, Robert M. (2018). Risk and Return in Village Economies. *American Economic Journal-Microeconomics* 10 (1): 1–40.

* Townsend, R, & Xandri, J.P. (2019). Regulation and the Optimal Design of Financial Markets. Working Papers

Vera-Cossio, Diego A. (2018). Targeting Credit through Community Members. Working paper, University of California, San Diego.

LECTURE 7: : Dealing with Externalities of Payments Systems and Fire Sales : Designs for Optimized Competition among Crypto Currencies and Market Structure to Remove Pecuniary Externalities

\$ Acharya, V., & Bisin, A. (2014). Counterparty risk externality: Centralized versus over-the-counter markets. *Journal of Economic Theory*, 149, 153-182. Alvarez, Fernando & Jermann, Urban. (2000). "Efficiency, Equilibrium, and Asset Pricing with Risk of Default," *Econometrica*, vol. 68(4), pp. 775-798.

Beviá, C., Corchón, L. C., & Wilkie, S. (2003). Implementation of the Walrasian correspondence by market games. *Review of Economic Design*, 7(4), 429-442.

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\$ DeMarzo, Peter M. (2005). "The Pooling and Tranching of Securities: A Model of Informed Intermediation," *Review of Financial Studies*, vol. 18(1), pp. 1-35.

Du, S., & Zhu, H. (2017). What is the optimal trading frequency in financial markets?. *The Review of Economic Studies*, 84(4), 1606-1651.

Dubey, P., & Sondermann, D. (2009). Perfect competition in an oligopoly (including bilateral monopoly). *Games and economic behavior*, 65(1), 124-141.

* Jain, A., & Townsend, R. M. (2018). *The economics of platforms in a Walrasian framework*. Working paper, Massachusetts of Technology.

* Kilenthong, W. T., & Townsend, R. M. (2020). *A market based solution for fire sales and other pecuniary externalities*. Working paper, Massachusetts of Technology.

\$ Netzer, Nick and Florian Scheuer (2014). "A game theoretic foundation of competitive equilibria with adverse selection," *International Economic Review*, 55(2), pp. 399-422.

\$ Newman, N., Bergquist, L. F., Immorlica, N., Leyton-Brown, K., Lucier, B., McIntosh, C., ... & Ssekibuule, R. (2018, June). Designing and evolving an electronic agricultural marketplace in Uganda. In *Proceedings of the 1st ACM SIGCAS Conference on Computing and Sustainable Societies* (pp. 1-11).

\$ O'Hara, M., & Ye, M. (2011). Is market fragmentation harming market quality?. *Journal of Financial Economics*, 100(3), 459-474.

Prescott, Edward C. & Townsend, Robert M. (2006). "Firms as Clubs in Walrasian Markets with Private Information," *Journal of Political Economy*, vol. 114(4), pp. 644-671.

Rothschild, Michael & Stiglitz, Joseph E. (1976). "Equilibrium in Competitive Insurance Markets: An Essay on the Economics of Imperfect Information," *The Quarterly Journal of Economics*, 90(4), pp.629-649.

\$ Rustichini, A., Satterthwaite, M. A., & Williams, S. R. (1994). Convergence to efficiency in a simple market with incomplete information. *Econometrica: Journal of the Econometric Society*, 1041-1063.

Spence, Michael (1973). "Job Market Signaling," *The Quarterly Journal of Economics*, vol. 87(3), pp. 355-374.

Stiglitz, Joseph E. and Andrew Weiss, A (1981). "Credit rationing in markets with imperfect information," *The American economic Review*, vol. 71(3), pp.393-410.

\$ Townsend, R. M. (1983, January). Theories of intermediated structures. In *Carnegie-Rochester Conference Series on Public Policy* (Vol. 18, pp. 221-272). North-Holland.

Vulkan, N., Roth, A. E., & Neeman, Z. (Eds.). (2013). *The handbook of market design*. OUP Oxford.

\$ Wilson, R. (1978). Competitive exchange. *Econometrica: Journal of the Econometric Society*, 577-585.

LECTURE 8: Payment Systems: Problems and Issues to be Considered in Alternative Designs

\$ Afonso, G., & Shin, H. S. (2011). Precautionary demand and liquidity in payment systems. *Journal of Money, Credit and Banking*, 43, 589-619.

Bank of Canada, Bank of England, & Monetary Authority of Singapore. (2018). "Cross-border interbank payments and settlements". <https://www.mas.gov.sg/-/media/MAS/ProjectUbin/Cross-Border-Interbank-Payments-and-Settlements.pdf>

\$ Bech, Morten & Garratt, Rodney. (2017). Central Bank Cryptocurrencies. *BIS Quarterly Review* (Sept. 2017): 55–70. Accessed October 22, 2018: https://www.bis.org/publ/qtrpdf/r_qt1709f.pdf

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\$ Dandekar, P., Goel, A., Govindan, R. & Post, I. (2012). Liquidity in Credit Networks: A Little Trust Goes a Long Way. Working paper, Stanford University.

De Roover, Raymond (1948). "Money, Banking and Credit in Mediaeval Bruges," Medieval Academy of America.

* Dubey, P. (1982). Price-quantity strategic market games. *Econometrica: Journal of the Econometric Society*, 111-126.

\$ Dubey, P., Geanakoplos, J., & Shubik, M. (2005). Default and punishment in general equilibrium 1. *Econometrica*, 73(1), 1-37.

\$ Fleming, M. & Garbade, K. (2005). "Explaining settlement fails," Current Issues in Economics and Finance, Federal Reserve Bank of New York, vol. 11, September 2005.

Garbade, K. D., Keane, F. M., Logan, L., Stokes, A. & Wolgemuth, J. (2010). "The introduction of the TMPG fails charge for U.S. Treasury securities," Economic Policy Review, Federal Reserve Bank of New York, October, pp. 45-71.

\$ Garbade, Kenneth D., & Silber, William L. (1979). "The Payment System and Domestic Exchange Rates: Technological versus Institutional Change" *Journal of Monetary Economics*, vol. 5 (1), pp. 1-22.

\$ Garratt, Rod, Antoine Martin, McAndrews, James J. & Nosal, Ed. (2015). "Segregated balance accounts," Staff Reports 730, Federal Reserve Bank of New York.

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\$ Güntzer, M., Jungnickel, D & Leclerc, M. (1998). Efficient Algorithms for the Clearing of Interbank Payments. *European Journal of Operational Research* 106 (1): 212–219.

\$ Jurgilas, M., & Martin, A. (2013). Liquidity-saving mechanisms in collateral-based RTGS payment systems. *Annals of Finance*, 9(1), 29-60.

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\$ Kuussaari, Harri. (1996). Systemic Risk in the Finnish Payment System: An Empirical Investigation. Bank of Finland Discussion Paper No. 3/96.

\$ Martin, Antoine & McAndrews, James J. (2008). "An economic analysis of liquidity saving mechanisms", Economic Policy Review, Federal Reserve Bank of New York, September, pp. 25-39.

\$ Morris, S., & Shin, H. S. (2018). *Distributed ledger technology and large value payments: a global game approach*. mimeo, Princeton University, November.

\$ Payments Canada. (2017). Project Jasper: A Canadian Experiment with Distributed Ledger Technology for Domestic Interbank Payments Settlement. White paper prepared by Payments Canada, Bank of Canada and R3, September 29, 2017. Accessed on October 19, 2018.
https://www.payments.ca/sites/default/files/29-Sep-17/jasper_report_eng.pdf

\$ Piazzesi, M., & Schneider, M. (2018). Payments, credit and asset prices.

LECTURE 9: The Information Problem of Decentralized Monetary Exchange and of Equilibria with High-Velocity Circulating Private Debt: Regulation using Distributed Ledger Technology

Bagehot, Walter (1873). "Lombard Street: A Description of the Money Market". Wiley Investment Classics, April 1999.

\$ Infante, S., Press, C., & Strauss, J. (2018). The Ins and Outs of Collateral Re-use. FEDS Notes. <https://www.federalreserve.gov/econres/notes/feds-notes/ins-and-outs-of-collateral-re-use-20181221.htm>

* Ostroy, J. M., & Starr, R. M. (1974). Money and the Decentralization of Exchange. *Econometrica: Journal of the Econometric Society*, 1093-1113.

Prescott, Edward S & Townsend, Robert M. (2006). "Private Information and Intertemporal Job Assignments". *Review of Economic Studies*, vol. 73(2), pp. 531-548.

Schelling, T. (1960). *The Strategy of Conflict*. Harvard University Press.

Spector, M. & Townsend, R.M. (2020). Notes on Townsend Wallace coordination problem. Working paper.

* Townsend, R. M., & Wallace, N. (1987). Circulating Private Debt: An Example with a Coordination Problem. In *Contractual Arrangements for Intertemporal Trade*, Edward C. Prescott and Neil Wallace (eds.), Minneapolis: University of Minnesota Press.

LECTURE 10: Money, Crypto Currency, and Public Debt as Bubbles: Implications for Indeterminacy, Fiscal Policy, Liquidity Pricing and the Interest Rate

\$ Abel, A. B., Mankiw, N. G., Summers, L. H., & Zeckhauser, R. J. (1989). Assessing dynamic efficiency: Theory and evidence. *The Review of Economic Studies*, 56(1), 1-19.

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