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Payment prioritisation and liquidity risk in collateralised interbank payment systems

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ABSTRACT

Participants in interbank payment systems manage a stream of payment requests of varying priority to minimise their total costs. However, individually optimal strategies may conflict with system-wide optimality and can lead to inefficient equilibria, where banks cannot meet obligations in a timely manner. We construct a model of a collateralised payment system and demonstrate that socially optimal states exist in which banks should delay a proportion of non-priority payments in an internal queue, but banks' strategising behaviour leads to liquidity hoarding and increased systemic cost. We discuss how this behaviour can be reduced using measures available to a regulator.

1. Introduction

Providing payment services to allow banking institutions to settle their obligations is one of the key functions of the financial system, and hence it is vitally important that the interbank payment systems are well designed and regulated. The importance of this point becomes even more apparent when considering the exceptionally large payment volumes that have to be processed on a daily basis. The US Fedwire system settles around $2.4 trillion of transactions every day (Federal Reserve Board, 2014), while the UK interbank systems, CHAPS[1] and CREST,[2] settle around £ 575 billion in the same period, which is roughly equivalent to UK annual GDP every three days (Dent and Dison, 2012).

One of the reasons for these incredibly high volumes has been the move to gross settlement. In the past, most payment systems operated on a net settlement basis, but this entailed banks running tremendous counterparty exposures throughout the day. Furthermore, the potential cost of late settlement failure was shown by many studies to lead to heavy systemic risks (Humphrey, 1986; Angelini et al., 1996; Chakravorti, 2000). In order to alleviate this problem, many systems now operate a mechanism of real time gross settlement (**"RTGS"**), ensuring that all obligations are settled with finality, in real-time, via a transfer of funds from the account of the creditor to the account of the debtor at the central bank.

The increased liquidity demand posed by gross settlement means that intraday liquidity is the lifeblood of these RTGS systems. Ideally this liquidity would be provided free of charge on an intraday basis by the central bank operating as

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[1] Clearing house automated payment system.
[2] CREST is a securities settlement system.

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settlement agent for the system, but this would require them to take on an unacceptable level of credit risk. Therefore the central bank must implement a pricing policy to both mitigate this risk but also allow the smooth functioning of the system (Furfine and Stehm, 1998; Freixas et al., 2000). The first policy option is to charge an overdraft fee for any period of negative balance on a participant bank account, as used in the US Fedwire system (Coleman, 2002). The second approach is to demand high-quality collateral on an intraday basis up to the value of liquidity required by the participant. Both CHAPS and the European TARGET2[3] system utilise the latter approach.

In a collateral-based system, the central bank typically provides intraday liquidity to the participant banks at the start of the day. Banks will source liquidity dependent on their projected payment flows, with each balancing a trade-off between the opportunity cost of using that collateral elsewhere and the costs that it will incur due to expected payment delays throughout the day. In a low opportunity cost environment these systems operate efficiently due to a high volume of liquidity being present, but there is a systemic risk if those costs increase. The system incentivises member banks to minimise their own total costs, so that individually optimal strategies, such as free-riding on the liquidity provision of others, may be at odds with the most beneficial behaviour for overall system performance (Afonso and Shin, 2011). Notably, insufficient liquidity sourcing or poor recycling of liquidity within the system can cause cascades of payment failures, leading to delays and system-wide inefficiencies (Angelini, 1998).

For these reasons, intraday liquidity risk is currently receiving a high level of scrutiny. The Basel Committee on Banking Supervision (2012) recently released a paper, detailing a number of measures which banks must report that assess their intraday liquidity requirements under various stress scenarios. However these measures focus on the individual banks themselves and do not fully capture the system-wide effects that a stress situation would cause. An analysis of the equilibrium behaviour of collateralised payment systems under differing conditions is a first step towards understanding these systemic risks. In this paper, we focus on providing such an analysis for CHAPS, but the principal results are applicable to any collateral-based system.

The CHAPS system was until recently very effective in terms of liquidity provision. It had settled into a comfortable equilibrium where banks posted more collateral than they needed to at the start of the day, and all payments were made smoothly with minimal delays. It was also simple for banks to make their decisions on a day-to-day basis as their collateral postings tended not to change, so banks were fully informed as to how others would act. However, these low liquidity sourcing costs were due to the practice of double duty, whereby collateral that banks were forced to hold as part of their prudential asset buffer could still be used on an intraday basis for posting in a collateral-based RTGS system (Ball et al., 2011). This effectively meant that many banks incurred costs significantly lower than the true opportunity cost of the collateral[4] (James and Willison, 2004). Under the new regulations, banks are forced to hold an additional intraday liquidity buffer (Ball et al., 2011). This implies a significantly larger opportunity cost to banks and hence the incentives for actors in the CHAPS "*liquidity game*" have changed.

Modelling payment flows in these systems is far from trivial, as bank interactions lead to a complex dynamic of queues and cascades. State-of-the-art models in the field such as that of Galbiati and Soramäki (2011) use a combination of multi-agent simulation and game-theoretic analysis to understand the relationship between bank decisions and delay costs. However, they do not yet explore realistic queueing protocols within banks and treat all incoming payments as identical. One important aspect in real payment systems is prioritisation, whereby banks will internally delay certain payments and prioritise others due to both internal and external factors (Becher et al., 2008). In this paper we extend earlier work (Galbiati and Soramäki, 2011) by introducing a novel framework to model this prioritisation behaviour in a multi-agent setting. We then consider a game-theoretic model in which banks optimise both their liquidity sourcing and their internal queueing strategy with the aim of minimising total expected costs. We discuss the equilibrium behaviours that evolve in this system and how inefficiencies may be reduced by utilising measures that are available to the Bank of England, specifically liquidity-saving mechanisms and throughput requirements.

2. Related literature

Models of interbank payment systems have traditionally taken one of two forms. The first form is simulation based on empirical data, attempting to capture as much detail as possible about the mechanics of the settlement process using a simulator such as the Bank of Finland's BoF-PSS2 (2015). Leinonen (2005) provides a comprehensive overview of such papers, studying liquidity requirements, liquidity shocks and various liquidity saving mechanisms. Similarly, the optimal timing of intraday payments is studied by Angelini (2000), who compares a simulated optimisation model to empirical data from the Italian interbank market. However a major shortcoming of these studies is that bank behaviour is parameterised using rules based on historical data. Such an approach makes it difficult to capture changes in strategic behaviour in the face of unprecedented scenarios. A change in the behaviour of actors is one major source of systemic risk that needs to be investigated when considering new regulation. This is particularly true of the recent paper by McLafferty and Denbee (2013), which simulates the effect of introducing a liquidity saving mechanism to CHAPS. They predict that up to 30% less liquidity

[3] Trans-European automated real-time gross express transfer 2.
[4] The difference between the unsecured interbank rate and the secure-lending repo rate.