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Re-inventing housing finance with blockchain. The case of Sweden (pre-print).

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Abstract

This article examines the ongoing transformation of mortgage markets induced by blockchain applications for property transactions. It argues that their adoption can reshape housing finance by re-inventing the qualities of products circulating therein. This process was evident in Sweden, where a public-private consortium pioneered the use of blockchain to orchestrate the conveyance and mortgaging of residential properties. Following the interdisciplinary cultural economy literature on marketization, and building on the analysis of 24 semi-structured interviews, this article demonstrates that by integrating technology with the legacy Land Administration System (LAS), the experiment offered a way to "fix" the Swedish mortgage market, through re-engineering conveyance workflow and supplying mortgages with a transparent audit trail. Circulating such radically new products could reconcile contradictions between Swedish mortgage market liquidity and risk-taking on the one hand and longstanding concerns about its financial safety for consumers on the other. This created unanticipated risks, however, which shaped the outcome of the experiment. This research makes two contributions. First, it re-centres the critical but overlooked LAS in shaping mortgage circulation and in materializing the connection between the urban fabric, mortgage markets, and global finance. Second, it provides a more nuanced understanding of the ongoing blockchain-induced mortgage market remaking and its socio-economic impact. It contends that at this early stage of the technology adoption, taking a step back to better understand the role of LAS in structuring housing finance opens the door to consider why the outcomes of these experiments result in little more than a reintroduction of the existing socioeconomic relations.

Keywords: Blockchain; Land Administration Systems; housing finance; marketization; Sweden.

1. Introduction

Homeownership forms the preferred asset-base for the welfare of millions of households, cities and entire jurisdictions (S. Smith, J, 2009; S. J. Smith, 2015). In advanced economies such as Sweden, homeownership is increasingly tight to the availability of and access to housing finance. Therefore, the stability of this type of finance has remained high on the political agendas since the 2008 global financial crisis (GFC) (Ashton & Christophers, 2018; Fernandez & Aalbers, 2017; Loomans & Kaika, 2021). Supporters of the technology have heralded the introduction of blockchain as a market disrupter (Baum 2017); hence, further understanding the nature, potentialities, and socio-economic implications of this technology is essential.

Blockchain is a novel data management technique that links strangers in a network, which can securely write and share tamper-proof records, in order to confirm ownership transfers or execute agreements (Christidis & Devetsikiotis, 2016; Swartz, 2018). It appeared in response to the aftermath of the 2008 GFC as a means of circumventing control of financial intermediaries and bypassing an exclusionary financial system (Henríquez, cohen, Bittan, & Tulbassiyev, 2019; Maurer, 2016; M. A. Zook & Blankenship, 2018). Recent economic geography research has begun to engage critically with the technology, shining a light on dynamics, impacts, and controversies arising from its decentralized, peer-to-peer exchange applications allegedly open to everyone who adheres to a pre-established consensus mechanism (Wójcik, 2020b; M. Zook & Grote, 2022). Within this literature, researchers often approach blockchain as a part of FinTech: a set of innovations as well as an economic sector focusing on the application of digital technologies to financial services (Wójcik, 2020a). So far, researchers have been skeptical about blockchain's capacity to "disrupt", "disintermediate", or "democratize" the financial sector (Lai & Samers, 2020, p. 726; Langley & Leyshon, 2021). They demonstrate how such innovations are designed to consolidate infrastructures recreating the existing structures and functions of the current financial sector controlled by incumbents (M. Zook & Grote, 2022). Ultimately, blockchain does little more than introduce another mode of *capitalist enterprise* for extracting value from re-intermediation (Langley & Leyshon, 2021). The adoption of blockchain applications only reinforces monopolistic positions of already powerful, mostly private actors. So far, it has resulted in little more than the reintroduction of existing socioeconomic relations and exacerbation of the inequalities they were meant to disrupt in the first place (DawnBurton, 2020; Rodima-Taylor, 2021; M. A. Zook & Blankenship, 2018).

With a handful of exceptions (DawnBurton, 2020; Proskurovska & Dörry, 2022), geographers have yet to make significant contributions to debates over blockchain applications in housing and mortgage markets. Proskurovska & Dörry (2022) shed some light on the scope and direction of the ongoing developments via an empirical investigation in the case of Sweden – the first country in the world where a government agency, the Lantmäteriet, led an experiment with blockchain to facilitate property conveyance. They showed how the proof-of-concept (PoC) developed by a public-private consortium could re-engineer the entire transactional workflow by orchestrating the interactions between the seller of a house, the buyer, their banks, the land registration authority, and other parties involved. As a result, the timeframe for conveyance and mortgaging process

reduced from many months to hours. Furthermore, adopting blockchain could re-balance powers whereby state actors could gain timely access to transactional data essential to understanding housing and mortgage market dynamics, largely at the expense of intermediaries, mainly brokers. Ultimately, the experiment did not move beyond the PoC phase despite successful testing in 2018. Instead, the banking sector adopted a non-blockchain platform called Tambur. Designed to host and facilitate interactions between the broker and the bank, the platform reintroduced and consolidated existing socioeconomic relationships and lucrative value chains. This outcome suggests that, so far, the trajectory of change triggered by blockchain in housing and mortgage markets is in line with what is happening in the financial sector. In Sweden, the industry pushback to the state-led experiment ultimately changed the basis of competition to encourage monopoly based on the monetization of transactional data aggregation and analysis. What remains elusive is why the change takes the particular form it does and what kind of socio-economic impact it creates.

To complement existing political-economy readings of blockchain-induced re-intermediation, this article will re-engage with the case of Sweden. It departs from the assumption that the Swedish experiment is yet another round of attempts to reconfigure Swedish residential mortgages. This is for pragmatic reasons as blockchain applications do not so much seek to reform or exclude particular economic actors or market institutions. Instead, they re-define types of actors (Caliskan, 2020) and to re-invent both the technical design and very nature of tradable things, be it money as a material commodity or chain of credit (Maurer, Nelms, & Swartz, 2013) or property (Arruñada, 2020; Maurer, 2016). In Sweden, conveyance - the process of transferring property - is when the lifecycle of many mortgages begins and ends (Schmid & Hertel, 2005). In the wake of the experiment, Sweden had the highest rate of housing loan penetration in the world (Badev, Beck, Vado, & Walley, 2014) and hence virtually every house sale involved the settlement of the seller's debt with the buyer's borrowed money. Swedish banks issue covered bonds – a type of security with mortgages as collateral – to finance this debt, which provides Swedish households with the lowest mortgage rates in the EU (Gaál, 2017). In other words, the Swedish mortgage market encompasses both the "primary" market where borrowers "buy" mortgages from lenders but also the "secondary" or "wholesale" market where lenders raise funds by selling packaged mortgage claims (Elliot & Lindblom, 2017; FI, 2021; SBA, 2020). As the empirical part of this paper will show, information infrastructure, which the private-public consortium refers to as the 'Land Registry'(Kairos Future, 2017), plays an essential role in sustaining mortgage circulation by materializing the connection between the urban fabric, mortgage markets, and global finance. Understanding to what extent upgrading the land registry with blockchain could change mortgages and reinvent this circulation opens the door to considering how Swedish mortgage market incumbents instrumentalized this change to reintroduce existing socio-economic relations.

The remainder of this paper proceeds as follows. The next section will clarify and re-center the role of land registries in mortgage circulation by conceptualizing the land registry as a part of the Land Administration Systems (LAS) (Zevenbergen, 2004) through using the Swedish LAS as an illustration. In doing so, it will follow scholars mobilizing marketization and Actor Network theories (ANT) and referring to such systems as *market devices* or *allocation mechanisms* (D. MacKenzie, 2016; Muniesa, Millo, & Callon, 2007). This literature demonstrates how people routinely mobilize them in order to achieve the free play of supply and demand, and how the interaction between the two intervene in the framing of markets and products, the formatting of

exchange mechanisms, valuation processes and economic behaviour (Berndt, 2015; Berndt & Wirth, 2019; Poon, 2007). Upgrading market devices with novel technologies prompt people to rethink their understanding of what the ideal qualities a product should have and the strategies that they use to impose contending visions to win the game of positioning (Callon, 2017; Maurer, 1999). This steers a struggle that drives the reorganization of relations between markets and market-making institutions while also altering actors competences and the way they marketize things (Ashton & Christophers, 2018; Berndt & Wirth, 2018; Caliskan, 2020; Çalışkan & Callon, 2010). Crucially, the importance of housing finance in economic growth implies that the never-ending struggle to impose a contending vision of properties or mortgages is more than a function of specific market-led processes. It is also connected to wider conjunctures such as "state strategic projects and the broader post-crisis mortgage market restructuring" (Ashton & Christophers, 2018) rather than specific events. Section 3 will situate the Swedish blockchain-experiment to broader conjunctures. It will explain how upgrading the Swedish LAS with blockchain could reconfigure mortgages and reshape Swedish housing finance, and why this potentiality instead resulted in the rise of a private platform that re-intermediates existing relations and reinforces the monopolistic market position of incumbents. The paper will conclude with a discussion of the findings arguing that at this stage of the technology's adoption, the focus on products, specific geographies of marketization, and human-non-human constellations can provide a more nuanced understanding of the ongoing blockchain-induced mortgage market remaking that better understands the socio-economic impact. The empirical results presented in this paper are built on the ANT methodological approach (Star, 1999; Wickramasinghe, Tatnall, & Bali, 2012) used to forensically identify and trace processes and networks of actors that order current and future Swedish conveyancing and mortgaging. The conventional and blockchain-based conveyance workflows where depicted as Unified Modeling Language (UML) activity diagrams that are often used in the field of software engineering to document all the relevant particiapnts and actions that take place within complex systems{Zevenbergen, 2008 #712}. These diagrams provided the basis for discussion with members of the blockchain project team as well as representatives from the Lantmäteriet, the Ministry of Finance, the Riksbank (central bank), the Swedish Bankers Association (SBA), Tambur, the Mäklarstatistik (Swedish Broker Statistics) and others helping to better understand the existing articulation underlying mortgage circulation and how this blockchain experiment could change them. The interviews took place between 2019 and 2022. The findings were triangulated with literature analysis and incorporated into the article's findings.

2. The role of LAS in mortgage circulation

Residential mortgages are both an essential means for sustaining demand in housing and act as a critical outlet for investment (Aalbers, 2008). Channeling this liquidity into housing markets requires rendering residential mortgages amenable to circulation through securitization (Ashton & Christophers, 2018). Since the value of a mortgage relies on the borrower's promise to pay (the debt instrument or promissory note) and a security interest in real property (the mortgage deed as collateral)(Gotham, 2006), both elements are inherently local and unique involving complex, data-intensive work (Ashton & Christophers, 2018; Langley, 2008; Loomans & Kaika, 2021; Poon, 2009). Ashton and Christophers (2018) explain the process mechanics, which achieve two major goals. First, the *future* ability of the borrower to pay and the value of the home as collateral must

be transformed into a standardized obligation. Second, to "lift-off" such obligations from their local grounds, they need to be commensurate. That is they need to be both comparable to and distinct from each other and from other financial assets through tagging with credit scores and pricing related to associated risks. Both processes are steered by competing actors who in their attempt to win the game of strategic positioning challenge existing product designs and thus reconfigure the market.

Equipment and infrastructure play an important role in steering the modalities of this work and influence the way people "objectify" goods which reproduces a variegated arrangement of actually existing markets (Berndt & Boeckler, 2009; Berndt & Wirth, 2019). As the introduction has already briefly mentioned, the property registry is one such device. Arruñada (2014) refer to them as the *interface* bestowing "not only obligations, on the filing users or their future contractual parties" but also rights. Their intermediation enables the claimants to acquire physical possession of the assets to recover their losses in case of a loan foreclosure. Likewise, they help protect borrowers by limiting the amount to which lenders are entitled should they be forced to sell the collateral to cover foreclosure losses. Acting as both a delegate for when investors trade mortgage claims on the secondary markets and as an investors' agent in foreclosure proceedings against delinquent owners, registries help create noteholder priority over collateral pledged by borrowers as security (Lopez-de-Silanes, 2008; Peterson, 2010).

Land administration scholars use the concept of LAS to refer to a broader socio-technical infrastructure that underpins the governance of all land related activities including the circulation of land-derived commodities like property rights or mortgages (Wallace & Williamson, 2006). The scope of LAS's components is vast and besides property registries includes institutional arrangements, legal frameworks, processes, standards, land information, technologies, and everything needed to implement land policies and support allocation, land markets, valuation, use control, and the development of interests in land (Williamson, Enemark, Wallace, & Rajabifard, 2010). The land registry and cadaster are nevertheless considered the LAS's foundational parts as both are needed to *formalize* and value properties (Lemmen, Vos, & Beentjes, 2017) and materialize ties between people and land-derived commodities (Wallace & Williamson, 2006). The former is a collection of records of titles or deeds that describe the current legal situation of units of land or buildings. Historically, private parties such as lawyers or notaries kept and updated them for a fee. Arruñada (2014) refers to such registries as "weak" because their functioning is often tied up with the interest and value chains of the third parties, compensating for more effective public arrangements. A cadaster is a methodically arranged public inventory of data that specifies the location of boundaries for objects of ownership. The latter has been used as grounds to levy taxes and is considered the pillar on which state power has developed and still rests (Kain & Baigent, 1992).

Today, the LAS integrates cadasters and land registries. The LAS is generally "run by governments" but can still rely on other public or private sector agencies (Bennett, Tambuwala, Rajabifard, Wallace, & Williamson, 2013). This explains why the LAS's components and architecture varies across geographies. Every time a transaction occurs, governments worldwide require transacting parties to register the change in ownership by submitting evidence confirming

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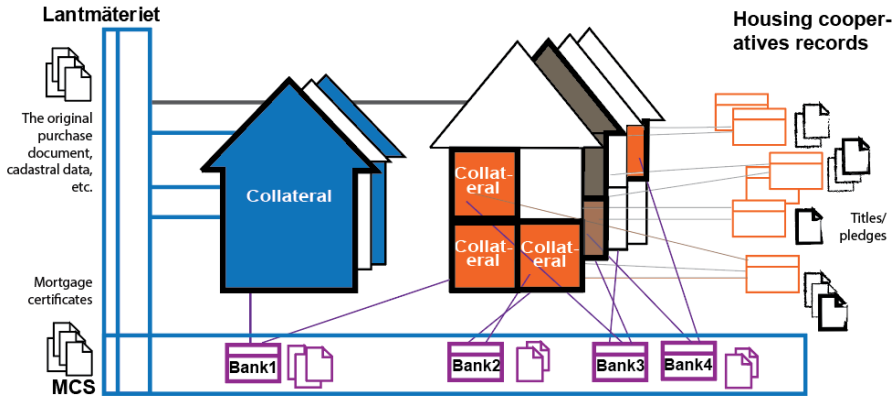
the transfer to the registration authorities. The transactional data from the contracts then serves as a basis for updating cadasters used by property and credit registries to monitor property market dynamics (Bjellerup & Majtorp, 2019), to estimate property's current and future value, or to levy taxes(Farnkvist, 2002). Private incumbents also use transactional data to objectify assets. For example, given how there is no readily available measure of real estate market risks, investors and banks feed transactional information into models that quantify residential market risks related to the value of held assets like mortgage-backed securities (Jin & Ziobrowski, 2011) and covered bonds (Elliot & Lindblom, 2017).

Yet such complex systems are far from neutral (Star, 1999). More specifically, as their components were designed to fulfill the multitude of often competing goals, their current arrangements still reflect legacy practices where legal assurances could 'favor' buyers' protection over sellers or vice versa(Arrunada & Garoupa, 2002) and as a result, reproduce a largely uneven pattern of risk distribution between borrowers and investors consuming mortgages (Arruñada, 2014). As Star (1999) aptly put it, sitting "in the middle of a work process like a rock in a stream" such systems encode and embed human work which require "workarounds, in order for the interaction to happen, leaving gaps in work processes, real-time adjustments and articulation to complete the processes". What follows is the attempt to demonstrate how the LAS intervenes in the realization of the Swedish mortgage market by formatting exchange mechanisms and valuation processes. Surfacing the socio-technical arrangements of the Swedish LAS by looking into its functioning is essential for understanding what blockchain was to change and how.

2.1. Shedding light onto the socio-technical arrangements of Swedish LAS

The Swedish LAS has developed alongside a bond-based mortgage type of housing finance that relies on public registries to ensure lenders rank as higher-tiered creditors in mortgage foreclosures (Blackwell and Kohl, 2018). Today, it underpins a booming housing market where some 50,000 houses and 100,000 apartments are sold yearly and about 85% of homeowners have mortgage debt (Eurostat, 2019). However, not all registries are public, and their management is distributed between public and private organizations (Fig.1).

Figure 1: Key components of Swedish LAS



Lantmäteriet, the mapping and land registration authority, manages the centralized, public Real Property Register, which contains cadastral and legal information like the identification of real property units, ownership and encumbrances, rights, and tax information(Högberg, 2006). Following the sale of a house, the

buyer must register the original acquisition document – a sales contract – with the Lantmäteriet. By updating its records, the agency follows the logic of *prevention* where the registrar searches for possible defects first and then grants a new ownership title. To mortgage their real estate, the titleholder has to apply to the Lantmäteriet to create a mortgage certificate (*pantbrev*) - a value-bearing instrument. The owner freely chooses its value and pays a stamp tax of 2%. However, the certificate expresses no claims; to tie it to an obligation, the creditor must connect the claim and mortgage through a pledge. In other words, to grant a lien, the certificate must be "handed over" to the creditor(Jensen, 2004). When the debt is repaid, the titleholder gets it back and can re-use it. Today, the digitalized Mortgage Certificate System (MCS), managed by the Lantmäteriet, is both a register and processing system for affiliated customers such as banks and credit institutions who use it to "swap" certificates with each other (Fig.1). If the borrower goes bankrupt, the date of the claim registration in the MCS will define the creditors' priority over the collateral(Högberg, 2006). The Lantmäteriet records have a constitutive effect which is enforced by the state (Jensen, 2004).

The Lantmäteriet system, however, is not involved in apartment transfer because ownership is indirect for most apartments. Under the regime called *bostadsrätt*, the owner of multi-dwelling buildings is an economic association of tenant-owners. Private persons acquiring shares in the association receive the right to use a certain apartment as long as they remain members of the association(Granath Hansson, Ekbäck, & Paulsson, 2021). The housing association's board, not the Lantmäteriet, is responsible for registering dealings with shares. When households sell or pledge shares , no mortgage certificates are created or exchanged. It is up to the boards to create a lien by updating records in their books that ensure creditors' priority(Lidberg, 2018). To update their records, the board [3] "*should first get the [letter] from the seller's bank saying that they are releasing the collateral and they make a note in their books. And then they make a note about a new buyer and the collateral".* Thus, unlike the Lantmäteriet, they do not search for possible legal defects but follow the logic of "dispute resolution" and "compensation for damage"(Damaška, 1986).

Trade in this kind of property constitutes for two thirds of the Swedish housing market (SCB, 2021). In 2017, there were about 26,000 active housing cooperatives out of more than 32,000 registered in Sweden (Lidberg, 2018). They follow different due diligence and recordkeeping standards, and consequently, their records can be fragmented, documents lost, and pledges can remain hidden. Moreover, there is no statutory public right to information with respect to security interests in such properties. This creates information asymmetries (Donner & Kopsch, 2018) making calculations of mortgage collateral value a burdensome task. The failure to establish a consolidated view into both housing cooperative finance and the finance of its members exposes the latter to disproportionately higher risk (Lidberg, 2018).
Indeed, by acting as legal persons, a housing cooperative's board can leverage funds by mortgaging the entire multi-dwelling buildings and land of which they are the direct owners. Boards do this routinely to finance, for example, the refurbishment of common areas of the multi-dwelling building or to construct new buildings (ibid.). The [future] members of the cooperative service this debt by paying a monthly fee where the higher the level of joint debt is, the higher the monthly fees paid by the tenant-owner will be (Donner & Kopsch, 2018). The reality, however, is that Sweden has one of the highest shares of variable-interest loans and household indebtedness in

Europe (SBA, 2020). Hikes in the interest rate can, therefore, make it challenging for households to service their primary and secondary debts. Not servicing the cooperative debt results in liquidation of the cooperative and abdication of the tenant-ownership rights. The tenant-owners in this case would become renters, but households who pledged their shares and took on "secondary debt" are still bound to repay their obligation.

The crisis in the 1990s provided a vivid illustration of the consequences of such a scenario. As interest rates grew and house prices declined, corporate lending was one of the biggest shares of credit losses because many tenant-owners could not service both cooperative debt and individual loans (Englund, 2015). The state stepped in with a massive injection of liquidity and took over a vast pool of "bad" assets. While this prevented the fire sales of defaulted properties, dealing with defaulted personal loans and housing cooperatives proved difficult. [1]: "*It was a really complicated situation because without these [defaulted] associations being able to manage these buildings and land and so on, well, they didn't have a value here. So you need to start with this* [tenant-owner apartments] *to recover* this [the value of the multi-dwelling building]. *(…) And I was doing that, looking at actual registries to see if it was actually correct, and of course, it wasn't."* Key to establishing the priority of creditors and to recovering the value of cooperative housing was the synchronization of the housing cooperatives' records of pledges with those of the banks.

These events have spotlighted the deficiencies and risks deriving from the disintegrated LAS architecture and have prompted the Swedish government to look for solutions to better understand the risks and protect retail mortgage consumers. Intergovernmental commissions investigating the issue on at least two occasions have concluded that a reliable centralized tenant-owner pledge registry created and put under Lantmäteriet supervision will alleviate the issue.

This, however, did not prevent a new round of Swedish housing and mortgage market expansion. After all, in the modern world of securitization, possession techniques are rather mundane (Riles, 2011); traded commodities are mere claims and not actual ownership rights over a specific property (Maurer, 1999). Therefore, fragmented collateral knowledge has hardly been an issue for investors supplying liquidity for mortgaging, who, unlike borrowers or creditors, were never very interested in possessory claims over concrete collaterals (Ashton, 2018). Their primary interest lies instead in financial claims valued against other financial assets and the [future] value of the collateral which in the aftermath of the GFC has become indivisible from a broad apparatus of monetary, financial regulatory, and calculative techniques sustaining their futurity and desirability (ibid.).

2.2. Mobilizing elusive collateral knowledge through LAS and circulating mortgages: Swedish style.

To satisfy the Swedish household demand for liquidity, Swedish lenders routinely sell residential mortgage debt to investors in the form of covered bonds (CB). CB is an interest-bearing security collateralized by a dynamic pool of financial assets (Chesini & Giaretta, 2020). Fig 2 demonstrates the types of collaterals underlying Swedish CBs. Their sales provide for about 75% of the liquidity that finances residential mortgages (SBA, 2020). Investors consider Swedish CBs to be low risk, and its low risk is an essential condition to securing cheap liquidity. This is primarily due to Swedish CBs offering investors so-called double-recourse protection. Double-recourse means that in the case of non-respect of obligation, a bondholder has direct and preferential claims on the

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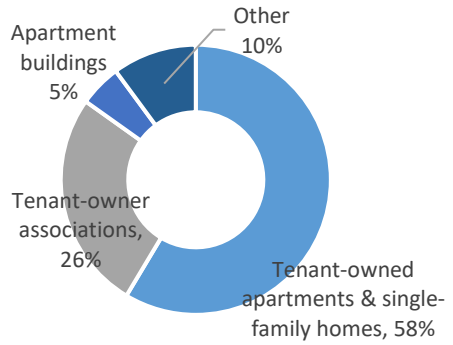
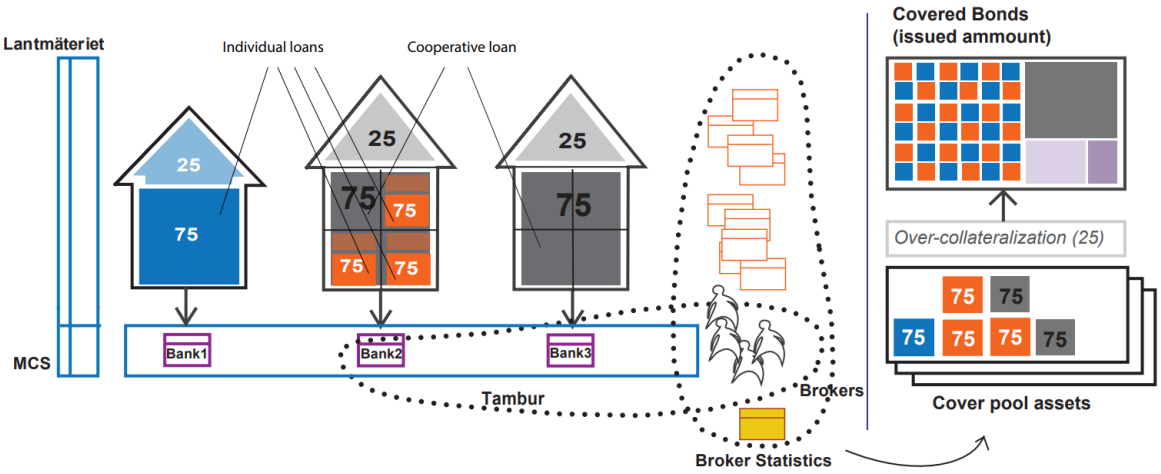
issuer's assets for any residual losses and the collateral pool (Schwarcz, 2011). Usually, credit institutions pay the interest and principal on outstanding bonds to investors from their own funds, which makes performance of the assets in the cover pool less relevant (Chesini & Tamisari, 2009). Nevertheless, the appeal of CB to investors depends on the issuer's ability to assure investors that the value of CB collateral is always higher than the debt secured on them (Elliot & Lindblom, 2017). Ultimately, this process of overcollateralization compels the issuer to replace collaterals if their loan-to-value (LTV) ratio exceeds 75%. The dynamic nature of CB cover pools indicates that the supply of cheap liquidity and hence the stability of the Swedish housing market depends on (1) the borrower's persistent desire to borrow, (2) the issuer's ability to calculate and monitor its value, and (3) the issuer's ability to enlist new claims and release settled ones promptly (Fig.3). Ensuring these conditions is important, as the investors' desire to buy such products depends on their cover pools' value "predictability"(Schwarcz, 2011). It is also a function of their trust and possibility to convert investments into liquid funds at any moment without significant price changes (Hellström, Stenbacka Köhler, & Lönnbark, 2019).

Figure 2: Types of collateral underlying the loans in the CB cover pool, per cent. Source FI (2019)



Since the value of Swedish mortgage collaterals is based on the market value of a property at the time of acquisition (FI, 2016), timely access to the price paid by buyers is essential. This places the Swedish LAS at the center of mortgage circulation. Only the Lantmäteriet collects transactional data from sales contracts after the registration of the title, which sometimes takes several months (Bjellerup & Majtorp, 2019). On the other hand, the housing cooperatives are not required to register contracts at all. Swedish brokers and Swedish Brokers Statistics (SBS) compensate for these deficiencies by complementing the Swedish LAS (Fig.3).

Figure 3: Illustration of overcapitalisation of CB issues:



Brokers mediate over 90% of all housing sales. They identify transacting parties, verify and consolidate information on properties, and draft contracts (see also Proskurovska & Dörry, 2022). They engage in transactions only if the seller grants them power of attorney. This is the key that

enables brokers to access and handle private data contained in private registries including those of banks and tenant-owner associations and conduct ascending auctions[1] on behalves of the seller. Brokers also construct *Mäklarbild*[2], the broker's snapshot. The 'snapshot' is essentially a synchronized version of "truths" used by brokers to characterize properties and value them. Snapshots are invaluable for lenders as they help establish LTV, price risks, and value mortgages. In order to create snapshots and draft contracts, brokers use dedicated information management systems. As soon as a broker marks in the system that a contract has been signed (Proskurovska & Dörry, 2022), contractual data such as purchase price becomes available to SBS. SBS queries the brokers' systems every 4 hours and after analyzing the systems, the SBS provides the public with monthly updates of change in the *temperature of the market [2]*. Crucially, this human-non-human construct enables the SBS to not only gain and share insights into the sales of residential real estate months ahead of the Lantmäteriet but also to acquire perspective into the dynamics of the tenant-owner apartment market, which the Lantmäteriet cannot. Credit rating agencies such as UC and other entities like the Nasdaq OMX Valueguard-KTH Housing index utilize SBS's business model daily to access the distribution of data faster. SBS has since begun to compliment the LAS by following the consequent conversion of all unsecured securities into CB as this constant state of conversion requires consistent knowledge about the market value of tenant-owner apartments.

Since 2018, the Tambur platform complements this assemblage (Fig.3). As explained by its providers, they designed Tambur to structure broker-bank interactions by leveraging the brokers' power of attorney to compensate for private and unreliable records. Apart from uncovering and preventing unlawful dealings with tenant-owner apartments, such as double-mortgaging, Tambur facilitates lenders' access to brokers' "snapshots", contracting and settlement processes (UC, 2019). Importantly, by linking payments to a property transfer, Tambur created a mechanism that forces noteholders to release mortgage deeds and delist them from balance sheets promptly. Synchronizing these operations facilitates compliance with overcollateralization requirements but can be problematic; the buyer's bank can wait for the seller's bank to "release" mortgage deeds for up to 6 months (Kairos Future, 2017). To use Tambur, parties agree *[3] to do certain things within certain time limits (…) because if they don't, then they breach our contract, and we can sue them."*

3. Placing blockchain experiments in context: post-crisis mortgage market remaking and blockchain

When the public-private consortium started its blockchain experiment, Tambur did not exist. Meanwhile, the share of tenant-owner apartments in the outstanding mortgage loan portfolio expanded from a few percent in 1995 to almost a third in 2016, and Sweden became the fifth-largest covered bond market in Europe (SBA, 2020). Domestic investors such as insurance corporations, pension funds, and investment companies held about two-thirds of Swedish CB's outstanding stock (Statistics Sweden, 2016), and foreign investors owned the rest (SBA, 2018). By 2013, the average mortgage repayment period was more than 140 years (EC, 2013). Notably, amortization requirements were not regulated until 2016; nothing prevented Swedish credit institutions from gradually switching from mortgage contracts based on annuity principles to interest-only loans (Andersen & Kauko, 1996). This effectively meant that borrowers were

[1] Ascending auction is a preferred mechanism to establish the sales price of a residential property in Sweden.
[2] https://bostadslexikon.se/maklarbild/.

"renting" their homes from lenders, and many home sales involved creating a new mortgage while also repaying the old mortgage in order to perform the swap of certificates.

Over time, the abundance of cheap funds channeled into the housing market, combined with tax incentives, booming equity extraction activities[3], amortization-free loans, and a persistent shortage of rental housing drove house prices up and created a bubble (Gaál, 2017). Growing household indebtedness made households more sensitive to changes in interest rates; this is to say that the value of collaterals became a function of the CB investors' persistent demands. The risk of borrower defaults had become systemic. The absence of a central tenant-owner credit register that could reveal the number and monetary amount of pledges made on tenant-owner apartments meant that there was no clear picture of dynamics in the Swedish housing market (Bjellerup & Majtorp, 2019). Given the predominantly domestic base of CB investors in this situation covered by double recourse (Lundholm, 2021), the government had few choices in the event that CB investors hesitate in investing. It is, therefore, hardly surprising that since 2008, when Lehman Brothers collapsed and investors began to sell their CB back to Swedish banks, the state and the Swedish Central Bank supported banks experiencing difficulties in finding new investors (cf. Sandström, Forsman, Stenkula von Rosen, & Wettergren, 2013). The omnipresence of guarantee schemes (Engbith & Kiernan, 2020) suggests that the Swedish mortgage "market" has effectively ceased to function as a commercial market as the state socializes risks.

Several supranational and national institutions criticized this situation in pointing to the growing housing market bubble (Gaál, 2017) and numerous policy gaps that exists (Lidberg, 2018; Riksbank, 2011; Sandström et al., 2013). They urged the Swedish government to adjust policies and improve market dynamics monitoring with the IMF (2016: 33) going so far to suggest the establishment of an automated market surveillance system in order to improve data availability and quality. At the time, a comprehensive database covering the Swedish mortgage market, the CB market, and bank mortgage rates was altogether missing (Elliot & Lindblom, 2017).

Inspired by the aspiration to emulate the US where capital markets have a stronger position in the overall financial structure, the European Commission's (EC) post-crisis regulations and policies have created additional impetus to address these issues (Fernandez & Aalbers, 2017). As demonstrated by Ashton and Christophers (2018), the underlying objective of US reforms was to reconfigure residential mortgages and address issues of solvency and risk in order to create a nationally liquid market that does not require an active role for state institutions. In their attempt to replicate not only post-crisis fixes but also a US-style market-based financial system, the EC also sought to curb overreliance on bank lending and shift towards market lending instead (Engelen & Glasmacher, 2018). Thus, the transformation of EU mortgage securitization into an alternative, safe, and efficient channel for credit intermediation foresaw a profound harmonization and standardization of EU member states' legal frameworks, procedures, and information infrastructures regulating mortgage circulation (Alvarez León, 2018; Fernandez & Aalbers, 2017; Loomans & Kaika, 2021). Chesini & Giaretta (2020) identify the publication of a report on EU CB frameworks and capital treatment (EBA, 2014), as the starting point for this pan-European mortgage-harmonization effort. Branded as a response to organizational failures, malfeasance of national financial systems, and mounting purchase programs, its recommendations found their way into the EU CB Legislative Framework. Not only did it clearly define the core characteristics of

[3] where one releases cash by taking on more mortgage debt

eligible cover assets, cover pool features, and modalities in monitoring and valuation, it also specified information requirements that could help investors "assess the profile and risks" of collateral pools. It stipulated that compliant CB would comprise of mortgage debt secured on physical properties with their ownership, attribution of encumbrances, and claims recorded on the public register (Chesini & Giaretta, 2020) (Chesini & Giaretta 2020). (Stöcker, 2021) notes that this requirement was "one of the main points of contention" because in many EU countries, such registries do not exist. As a result, the final text of the EU Directive 2019/2162 permitted Member States to provide an alternative if the protection were comparable to that of public registries and allowed interested third-parties to access required information.

In the wake of the experiment, the idea that the "safe" circulation of mortgages requires an abundance of transparent, reliable, and comparable data to reduce uncertainties and facilitate prediction gained momentum at both national and supranational levels (Haldane, 2018; Latimer & Maume, 2015; A. Mackenzie, 2015). Achieving this also meant fixing faulty lines in disintegrated and siloed information infrastructures that support payments, debt collection, risk management (Bernards & Campbell-Verduyn, 2019; DawnBurton, 2020), and spatial data flows (Alvarez León, 2018). Although these EU-wide regulatory changes in banking and financial regulation were reproducing global models supported by widespread financial logics of business groups and networks, the relations created by these networks also revealed and reflected local particularities (Faria, 2021). As the next chapter will demonstrate, this was also the case in Sweden – a country at the fore of investigating the potential for cryptographically secured, algorithmically regulated store-of-records for property conveyance and mortgaging.

3.1. Understanding blockchain-induced transformation of housing finance: the Swedish experiment

The Swedish blockchain experiment begun in 2016, two years after the EBA report publication. The public-private consortium led by the Lantmäteriet aimed to investigate whether blockchain technology could facilitate conveyance by digitalizing the mortgaging and sale of residential real estate (Kairos Future, 2017). At the time, scores of private start-ups had already proved that blockchain could create a permanent, immutable, timestamped, and distributed record of evidence about every transfer of ownership of digitally represented assets or other types of on- chain agreements (see alsoM. A. Zook & Blankenship, 2018). A control algorithm made the final call on whether they should add an existing chain of evidence (Khan, Loukil, Ghedira-Guegan, Benkhelifa, & Bani-Hani, 2021). The Swedish consortium sought to go beyond securing transactional records with blockchain and explore the use of Smart Contract (SC). SC is essentially a code representing "a set of promises, specified in a digital form, including protocols within which the parties perform on these promises"(Szabo, 1997). SC takes input from incoming blockchain transactions, processes it according to deterministic algorithms, and generates an output indicating either a state change in the smart contract or a new blockchain transaction. As one interviewee put it, SC [4] "*is a state machine (…) [that] defines what state the contract can be and what transition can be done between the states, and each transition must be the signed message with correct information (…) almost like a board game".*

Explained in detail in Proskurovska and Dörry (2022), the Swedish SC orchestrated the entire conveyance and mortgaging process of a directly-owned home. It ran on a *permissioned* blockchain, meaning only identified and authorized parties could initiate, participate in, or validate

transactions. When accessing the marketplace, participants had to select the role of seller, buyer, bank or others, which would provide them with power to perform actions as specified in the SC. In other words, the SC script governed what parties had to do and when they had to do it (Kairos Future, 2017). Furthermore, upon fulfilment of specific conditions such as the bank granting the loan or transferring funds, the SC triggered automatic execution of consecutive actions and propelled the conveyance towards the end. Conversely, in the absence of either a required input or consensus on validity, the transaction would not progress. In practical terms stakeholders could finalize conveyance and mortgaging within hours due to automation. The Lantmäteriet could access the resulting transactional data immediately and the rest of the transaction participants would be promptly updated about the agreement's results.

Importantly, the use of such mechanisms in the system where transacting parties interacting directly would create a reality in which the acquisition and synchronization of knowledge about past events would no longer require the engagement of trusted third parties or the creation of snapshots. Indeed, blockchain preserved participants' privacy as the system stored signed messages and added only *verification records* - uniquely identifiable 'fingerprints' of actual files - to the immutable record. It also allowed for encrypting contractual data so that only authorized parties with the correct key could decrypt the contract content. However, the transaction outcome would still be discoverable via a blockchain-enabled mechanism known as *zero-knowledge proof* (ZKF). ZKF is a cryptographic technique for verifying private data without revealing it (Meralli, 2020). In other words, interested parties can acquire insight into different property by making simple yes/no queries about the encrypted content. For example, yes/no queries can establish the total number and monetary amount of loans secured on a given property, the LTV of one or many mortgages, and even if an entire collateral pool exceeds a certain parameter.

This functionality gave the experiment a serious spin. Since the process of conveyance for tenant-owner apartments is similar, "*the architecture of the application could be reconfigured to support the sales of the tenant-owner apartments"* [4]. Forcing all 26,000 housing association boards *[5]: "to enter into a system where the verifications are controlled (...), you get an identity* [of a party providing the evidence]*, (...)* [the information describing the] *property, and then you have events. So if you are a bank, you can 'ask' the owner of the sequence of events (...)* [ensuring that] *nothing is in conflict with your interest in that sequence. And that can be kept publicly accessible"*. This effectively meant that the synchronization of "truth" about ownership, the attribution of encumbrances and claims scattered across scores of public and private registries, and the sharing of this knowledge, no longer required intermediaries with power of attorney. Although the PoC did not exclude brokers from the workflow, conveyancing and mortgaging tenant-owner apartments via application could offer an alternative solution to the deficiencies of the disintegrated Swedish LAS. [7]: *"(...) for the apartment sector, I guess a blockchain would be probably easy to implement there because we don't have the legacy which we do have in immovable property. (...) if you start from scratch (...) then you can regulate this, of course, and build up the infrastructure from the start with the use of blockchain technology"*. With blockchain, Swedish mortgages would get a "secure, permanent, immutable electronic audit trail" (Maurer, 2016) regardless of the type of the collateral.

The rise and circulation of such mortgages would provide lenders and CB issuers with many opportunities. For example, by leveraging instant property- and mortgage-valuations (A. Mackenzie, 2015), lenders could benefit from reductions in risk premiums or create new riskier

products that expand the base of foreign investors. However, since the Lantmäteriet had the master key – that is the cryptographic feature used to encrypt all other keys on the system – the agency would become the obligatory passage point in ZKF. That is, not only lenders but also tax authorities, regulators, and the Central Bank could tap into "real-time maps" depicting financial and activity flows "in much the same way as is already done for flows of traffic or information or weather"(Haldane, 2018) but for housing finance. Arguably, this could improve the regulatory and supervisory capacity of state actors by reducing faulty inferences and permitting potentially serious mistakes in policies. Coupled with the consistent flow of cheap liquidity from secondary capital market, this new position presents state actors with a chance to devise dynamic and intricately calibrated policies that address growing indebtedness and the extreme exposure of Swedish households to credit risk by stabilizing the Swedish mortgage market and potentially wean it off state guarantees. After all, the management of risk in securitization has never been a problem as long as risk is known (Allen & Yago, 2010; Goldstein & Yang, 2017). A workshop uniting [5]:.. *some 15 stakeholders, like the Central Bank, the Debt Office, Tax agency, the Association of Swedish Bankers (SBA), (…)*" was organized to present the application's capability to fix issues related to the private records of housing associations *[5]: "and no one had said that there exists any better solution".*

Blockchain, however, is only as good as its underlying data (Lemieux, 2017; Spielman, 2016), and building a record from scratch takes time and requires coordination with the private incumbents that constitute the Swedish LAS. Furthermore, were the application to be used exclusively for the sales of directly-owned residences, radically different mortgages would have to circulate alongside traditional ones, so only a part of the mortgage market could be re-risked. What are the chances that investors would still desire to buy or hold products secured on conventional residential mortgages, alongside those underlined by a pool of debt with a transparent electronic audit trail and not short-sale their holdings? In light of this major uncertainty, the emergence of the Tambur platform only months before the live-testing of the PoC can hardly be interpreted as mere industry pushback and resistance to the change. Indeed, besides extracting value from the intermediation of broker-bank interactions, its providers also offered a quick fix to the deficiencies of the distributed Swedish LAS: an alternative platform that protected interested third parties and allowed them to acquire the required information from a multitude of private registries in line with new EU regulations. Ultimately, its consistent use by brokers and banks would gradually synchronize distributed records, phase out discrepancies, and prepare the ground for the rise of radically safe and liquid mortgages that avoid the cliffhangers caused by hikes in the investors' moods. Surely, in the meantime, its increased use would see growth in the monopolistic position of the platform provider. As one of the government officials noted, to implement blockchain for conveyance, "*the banks would also become a part of the system"* [7] which would effectively provide them with new opportunities to extract value. Whilst the application remains a prototype awaiting a missing piece of legislation that legalizes the use of digital signatures for real estate conveyance, a consortium of seven mortgage banks is expected to take over Tambur in April 2023[4].

4. Conclusion

If the takeover of Tambur by banks materializes, they will become an integral component of the Swedish LAS. As shown in this article, LAS can be understood as a *critical public infrastructure*

[4] https://www.swedishbankers.se/repository/bankfokus/bankfokus-2022/banker-tar-oever-tilltraedesportalen-tambur/

(Bennett et al., 2013) as apart from providing a basis for the enforcement of people-land relationship, it also takes an active role in enabling and reproducing the mortgage market in defining a pattern of risk distribution between market participants. Notably, by structuring social relations and making them durable, the LAS affects the understanding of the ideal product's qualities and the particular ways in which the national mortgage market emerge and evolve. Thus, the collaborative effort of humans and nonhumans comprising the Swedish LAS sustains the co-existence of two different logics, which is prevention and compensation from damage, used to create liens. Its legacy arrangements define the way transactional data is supplied at what time and to whom formatting how properties and mortgages are valued. As a result, today, neither the first lien holder nor investors know the exact combined LTV of the mortgages secured on cooperative housing, or, correspondingly, the actual composition of the pool of securities traded on secondary markets. Meanwhile, borrowers' exposure pledging tenant-owners' apartments as collaterals to risk remains disproportianlly higher than that of the rest of the market's participants.

Yet, understanding the anatomy of the Swedish mortgage market and the role of LAS as an allocation mechanism was not the primary goal of this investigation. It has been a necessary means to an end for explaining why despite the apparent potential for blockchain application to disintermediate national housing finance, the experiment outcome has been little more than a re-intermediation and re-combination of the legacy system where platform elements of Tambur lock in mortgage retail consumers, investors, and the state agencies. Shading light into the black box of the Swedish LAS's socio-technical arrangements makes it clear that the adoption of the blockchain conveyance application would overhaul the existing pattern of transactional data distribution between public and private actors, providing the former with an improved view into market dynamics and expanding the logic of prevention to all kinds of property dealings. Furthermore, imposing this new order on market participants would give birth to liquid mortgages with a transparent audit trail regardless of the type of collateral. However, both adopting the solution and enhancing state control over housing finance would take time. This meant that for a while, Swedish mortgages would be incommensurate with each other and other financial assets, potentially affecting current CB holders' moods. The predominantly domestic base of Swedish CB investors leaves the state with few choices to avoid major disruptions by supplying additional liquidity in the form of guarantee schemes, protecting over-indebted borrowers and safeguarding the stability of the economy from hikes in interest rates. If the cost of having debt rises, many tenant-owners effectively "renting" homes from lenders could no longer service their primary and secondary obligations. This would mean their right to live in tenant-owner apartments could disappear along with the value of such homes. Given the risk distribution, the price of a drastic shift in investors' preferences and appetite could be too high for over-indebted households and disrupt the entire economy - a risk that no state can take.

In light of this, the standstill in PoC-adoption in Sweden and other highly leveraged mortgage markets and the crystallization of incumbents' positions that takes place instead can hardly be explained solely by regulatory obstacles (cf. Bennett et al., 2021), by industry push-back, or by the strategic consolidation of the infrastructure to extract more value. Arguably, the strategic importance of housing finance for advanced economies implies that the outcomes of such innovating endeavors, in this instance being re-intermediation, do not merely arise as a function of specific market-led processes where state actors have lost the struggle to impose their vision of ideal mortgages to the mortgage industry incumbents. The state-led experiments with blockchain and their results are connected to state projects, modes, and strategies of crisis-management, just as the outcomes of post-crisis regulatory restructuring of mortgage markets have been (cf. Ashton

& Christophers, 2018). The resulting reorganization of relations between market-making institutions could therefore be interpreted as a co-designing activity; the adoption of Tambur was simply more aligned with the common understanding of the ideal qualities mortgages should have, existing technics of mortgage marketization, and current state-led modes of crisis management. After all, it did enable the immediate creation of knowledge about the value of mortgages secured on cooperative housing while also enhancing compliance with EU regulations. Tambur designers have capitalized on these conjunctures and existing arrangements of the LAS in seizing the opportunity to re-intermediate the Swedish mortgage market and become an obligatory passage point in the valuation of mortgages secured on tenant-owner apartments.

Overall, this research contends that at this early stage of blockchain adoption shifting the focus from the change in power relations between market-making institutions towards market devices, emerging products, and the markets in which they circulate allows for better understanding of the dynamics shaping this ongoing technological transformation and its scope. This conceptual move, however, requires taking time to trace legacy socio-technical systems arrangements, their distributed agency, and articulation work. Doing this is frequently mundane, "to the point of boredom" (Star, 1999), but essential to better understanding such radical innovations and why they do little more than introduce yet another mode of capitalist enterprise. Effectively, as blockchain applications gain prominence worldwide and prompts economic actors interacting with the technology to question organizations and the methods conventionally used to produce, own, trade, and finance land and the built environment, experiments with blockchain trigger a struggle. This struggle in turn renders peculiar, geographically specific, centuries-old socio-technical infrastructures visible and highlights their role in reproducing unequal social relations as they connect local housing markets to global finance. The visibility of these effects opens the door to consider how attempts to introduce novel technologies align with contending objectives of various economic actors as they struggle to re-invent existing product design and win the strategic game of positioning. Whilst the full extent of the socio-economic impact on concrete post-crisis housing and mortgage markets thus produced is yet to materialize, the results from this empirical investigation suggest that the political implications are challenging. The circulation of more liquid and safe mortgages as a means of producing the future, for investors, citizens, and states alike, could hardly offer any kind of counter-politics to debt as what (García-Lamarca & Kaika, 2016) call a punitive technology for both residential mortgage consumers and the entire society. Ironically, the full extent of the socio-economic implications tend to become visible only after products with radically different designs become commensurate with and are seamlessly melded into the very same systems that they were made to disrupt (M. A. Zook & Blankenship, 2018). Further empirical research in such experiments is essential to better understand whether technology innovation creating novel product designs can disrupt such circulation or on the contrary, intensify its uneven effects.

References

Aalbers, M. B. (2008). The Financialization of Home and the Mortgage Market Crisis. *Competition & Change, 12*(2), 148-166. doi:10.1179/102452908X289802

Allen, F., & Yago, G. (2010). *Financing the Future: Market-Based Innovations for Growth*. Upper Saddle River: Wharton School Publishing.

Alvarez León, L. F. (2018). A blueprint for market construction? Spatial data infrastructure(s), interoperability, and the EU Digital Single Market. *Geoforum, 92*, 45-57. doi:https://doi.org/10.1016/j.geoforum.2018.03.013

Andersen, K., & Kauko, K. (1996). A Cross-Country Study of Market-Based Housing Finance. *Bank of Finland, Research Discussion Papers*.

Arruñada, B. (2014). Registries. *Man and the Economy, 1*(2), 209-230. doi:https://doi.org/10.1515/me-2014-0016

Arruñada, B. (2020). Prospects of Blockchain in Contract and Property. In A. Lehavi & R. Levine-Schnur (Eds.), *Disruptive Technology, Legal Innovation, and the Future of Real Estate* (pp. 35-55): Springer.

Arrunada, B., & Garoupa, N. M. (2002). The Choice of Titling System in Land. *SSRN Electronic Journal*. doi:10.2139/ssrn.311586

Ashton, P. (2018). Circulation, futurity, and risk: Re-situating property's geopolitics. *Dialogues in Human Geography, 8*(2), 232-235. doi:10.1177/2043820617736621

Ashton, P., & Christophers, B. (2018). Remaking Mortgage Markets by Remaking Mortgages: U.S. Housing Finance after the Crisis. *Economic Geography, 94*(3), 238-258. doi:10.1080/00130095.2016.1229125

Badev, A., Beck, T., Vado, L., & Walley, S. (2014). *Housing Finance across Countries: New Data and Analysis* (WPS6756). Retrieved from Washington, DC: http://documents.worldbank.org/curated/en/697351468165251669/pdf/WPS6756.pdf

Bennett, R., Tambuwala, N., Rajabifard, A., Wallace, J., & Williamson, I. (2013). On recognizing land administration as critical, public good infrastructure. *Land Use Policy, 30*(1), 84-93. doi:https://doi.org/10.1016/j.landusepol.2012.02.004

Bernards, N., & Campbell-Verduyn, M. (2019). Understanding technological change in global finance through infrastructures. *Review of International Political Economy, 26*(5), 773-789. doi:10.1080/09692290.2019.1625420

Berndt, C. (2015). Behavioural economics, experimentalism and the marketization of development. *Economy and Society, 44*(4), 567-591. doi:10.1080/03085147.2015.1043794

Berndt, C., & Boeckler, M. (2009). Geographies of circulation and exchange: constructions of markets. *Progress in Human Geography, 33*(4), 535-551. doi:10.1177/0309132509104805

Berndt, C., & Wirth, M. (2018). Market, metrics, morals: The Social Impact Bond as an emerging social policy instrument. *Geoforum, 90*, 27-35. doi:10.1016/j.geoforum.2018.01.019

Berndt, C., & Wirth, M. (2019). Struggling for the Moral Market: Economic Knowledge, Diverse Markets, and Market Borders. *Economic Geography, 95*(3), 288-309. doi:10.1080/00130095.2018.1521699

Bjellerup, M., & Majtorp, L. (2019). *The Development of Swedish Housing Prices*. Stockholm: Swedish National Debt Office Retrieved from https://www.riksgalden.se/contentassets/b450c141e8c840c8899d301ec55ba2d6/2019-11-15-focus-report-the-development-of-housing-prices.pdf

Caliskan, K. (2020). Data money: The socio-technical infrastructure of cryptocurrency blockchains. *Economy and Society, 49*(4), 540-561. doi:10.1080/03085147.2020.1774258

Çalışkan, K., & Callon, M. (2010). Economization, part 2: a research programme for the study of markets. *Economy and Society, 39*(1), 1-32. doi:10.1080/03085140903424519

Callon, M. (2017). Markets, marketization and innovation. In H. Bathelt, P. Cohendet, S. Henn, & L. Simon (Eds.), *The Elgar Companion to Innovation and Knowledge Creation*.

Chesini, G., & Giaretta, E. (2020). Recent Innovation in the Regulation of Covered Bonds in Europe: Who Will Benefit from the New Legislative Framework? In (pp. 49-73).

Chesini, G., & Tamisari, M. (2009). The Regulatory and Market Developments of Covered Bonds in Europe. In *Financial Innovation in Retail and Corporate Banking*: Edward Elgar Publishing.

Christidis, K., & Devetsikiotis, M. (2016). Blockchains and Smart Contracts for the Internet of Things. *IEEE Access, 4*, 2292-2303. doi:10.1109/ACCESS.2016.2566339

Damaška, M. R. (1986). *The Faces of Justice and State Authority*

A Comparative Approach to the Legal Process: Yale University Press.

DawnBurton. (2020). Digital Debt Collection and Ecologies of Consumer Overindebtedness. *Economic Geography, 96*(3), 244-265. doi:10.1080/00130095.2020.1762486

Donner, H., & Kopsch, F. (2018). Housing Tenure and Informational Asymmetries. *Journal of Real Estate Research, 40*(2), 155-178. doi:10.1080/10835547.2018.12091496

EBA. (2014). *Report on EU covered bond frameworks and capital treatment*. Retrieved from on-line: https://www.eba.europa.eu/documents/10180/534414/EBA+Report+on+EU+Covered+Bond+Frameworks+and+Capital+Treatment.pdf

EC. (2013). *In-depth review for Sweden in accordance with Article 5 of Regulation (EU) No 1176/2011 on the prevention and correction of macroeconomic imbalances*. (52013SC0124). European Commission Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52013SC0124&from=SV

Elliot, V., & Lindblom, T. (2017). The Swedish Mortgage Market: Bank Funding, Margins, and Risk Shifting. In G. Chesini, E. Giaretta, & A. Paltrinieri (Eds.), *The Business of Banking: Models, Risk and Regulation* (pp. 35-53). Cham: Springer International Publishing.

Engbith, L. S., & Kiernan, K. (2020). Sweden's Guarantee Scheme (Sweden GFC). *Journal of Financial Crises, 2*(3), 911-926. Retrieved from https://elischolar.library.yale.edu/journal-of-financial-crises/vol2/iss3/47/

Engelen, E., & Glasmacher, A. (2018). The waiting game: How securitization became the solution for the growth problem of the Eurozone. *Competition & Change, 22*(2), 165-183. doi:10.1177/1024529418758579

Englund, P. (2015). *The Swedish 1990s banking crisis. A revisit in the light of recent experience*. Paper presented at the The Riksbank Macroprudential Conference, Stockholm.

Faria, I. (2021). The market, the regulator, and the government: Making a blockchain ecosystem in the Netherlands. *Finance and Society, 7*(1), 40-56.

Farnkvist, O. (2002, 27-28 June). *Property taxes and mass valuation in Sweden.* Paper presented at the UN ECE Working Party on Land Administration Workshop On Mass Valuation Systems of Land Moscow.

Fernandez, R., & Aalbers, M. B. (2017). Capital Market Union and residential capitalism in Europe: Rescaling the housing-centred model of financialization. *Finance and Society, 3*(1), 32-50.

FI. (2016). *Regulations regarding mortgage amortisation requirement* (FI Ref. 14-16628). Stockholm: Finansinspektionen Retrieved from https://www.fi.se/contentassets/690c9d8430bd4961b6073dedf4f9105f/memo_amortisation_2016-16.pdf

FI. (2021). *The Swedish Mortgage Market* (21-4799). Retrieved from https://www.swedishbankers.se/media/5084/1407-sbf-rapport-bolaanemarknad-2021_en02.pdf

Gaál, N. (2017). *Nordic Heat Wave: Recent Housing Market Developments in Denmark and Sweden* (31). Retrieved from Brussels: https://ec.europa.eu/info/sites/info/files/economy-finance/eb031_en_nordic_heat.pdf

García-Lamarca, M., & Kaika, M. (2016). 'Mortgaged lives': the biopolitics of debt and housing financialisation. *Transactions (Institute of British Geographers : 1965), 41*(3), 313-327. doi:10.1111/tran.12126

Goldstein, I., & Yang, L. (2017). Information Disclosure in Financial Markets. *Annual Review of Financial Economics, 9*(1), 101-125. doi:10.1146/annurev-financial-110716-032355

Gotham, K. F. (2006). The Secondary Circuit of Capital Reconsidered: Globalization and the U.S. Real Estate Sector. *American Journal of Sociology, 112*(1), 231-275. doi:10.1086/502695

Granath Hansson, A., Ekbäck, P., & Paulsson, J. (2021). The Sliding Scale between Usufruct and Ownership: The Example of Swedish Multi-Family Housing. *Land, 10*(3). doi:10.3390/land10030311

Haldane, A. G. (2018). [Will Big Data Keep Its Promise?].

Hellström, S., Stenbacka Köhler, H., & Lönnbark, C. (2019). *How do covered bonds*

function? Retrieved from on-line:

Henríquez, R., cohen, i., Bittan, N., & Tulbassiyev, K. (2019). Blockchain and Business Model Innovation: Designing a P2P Mortgage Lending System. *Information Systems & Economics eJournal*.

Högberg, M. (2006, October 8-13, 2006). *Selling Property and Mortgaging in Sweden – A Simple Matter.* Paper presented at the XXIII International FIG Congress. Shaping the Change, Munich, Germany.

Jensen, U. (2004). *Swedish Conveyancing Law*. Retrieved from https://www.eui.eu/Documents/DepartmentsCentres/Law/ResearchTeaching/ResearchThemes/EuropeanPrivateLaw/RealPropertyProject/GeneralReport.pdf

Jin, C., & Ziobrowski, A. J. (2011). Using Value-at-Risk to Estimate Downside Residential Market Risk. *The Journal of Real Estate Research, 33*(3), 389-414. Retrieved from http://www.jstor.org.proxy.bnl.lu/stable/24888381

Kain, R. J. P., & Baigent, E. (1992). *The cadastral map in the service of the state : a history of property mapping*. Chicago: Univ. of Chicago Press.

Kairos Future. (2017). *The Land Registry in the blockchain - testbed*. Retrieved from Stockholm:

Khan, S. N., Loukil, F., Ghedira-Guegan, C., Benkhelifa, E., & Bani-Hani, A. (2021). Blockchain smart contracts: Applications, challenges, and future trends. *Peer-to-Peer Networking and Applications, 14*(5), 2901-2925. doi:10.1007/s12083-021-01127-0

Lai, K. P. Y., & Samers, M. (2020). Towards an economic geography of FinTech. *Progress in Human Geography, 45*(4), 720-739. doi:10.1177/0309132520938461

Langley, P. (2008). Sub-prime mortgage lending: a cultural economy. *Economy and Society, 37*(4), 469-494. doi:10.1080/03085140802357893

Langley, P., & Leyshon, A. (2021). The Platform Political Economy of FinTech: Reintermediation, Consolidation and Capitalisation. *New Political Economy, 26*(3), 376-388. doi:10.1080/13563467.2020.1766432

Latimer, P., & Maume, P. (2015). *Promoting information in the marketplace for financial services: Financial market regulation and international standards*.

Lemieux, V. L. (2017). Evaluating the Use of Blockchain in Land Transactions: An Archival Science Perspective. *European Property Law Journal, 6*(3), 392-440. doi:doi:10.1515/eplj-2017-0019

Lemmen, C., Vos, J., & Beentjes, B. (2017). Ongoing Development of Land Administration Standards. *Blockchain in Transaction Management, 6*(3), 478-502. doi:doi:10.1515/eplj-2017-0016

Lidberg, A. (2018) The finances of housing cooperatives and financial stability In, *Economic Commentaries: Vol. 4*. On line: Sveriges Riksbank.

Loomans, D., & Kaika, M. (2021). Mortgage regulation as a quick fix for the financial crisis: standardised lending and risky borrowing in Canada and the Netherlands. *International Journal of Housing Policy*, 1-23. doi:10.1080/19491247.2021.1946639

Lopez-de-Silanes, F. (2008). Turning the key to credit: credit access and credit institutions. In F. Dahan & J. Simpson (Eds.), *Secured transactions reform and access to credit* (pp. 283). Cheltenham, UK ; Northampton, MA: Edward Elgar.

Lundholm, M. (2021). Compensation and Socio-Economic Status of Borrowers in Foreclosure: Evidence from Swedish Micro-data. *Journal of Consumer Policy, 44*(1), 95-116. doi:10.1007/s10603-020-09474-w

Mackenzie, A. (2015). The production of prediction: What does machine learning want? *European Journal of Cultural Studies, 18*(4-5), 429-445. doi:10.1177/1367549415577384

MacKenzie, D. (2016). A material political economy: Automated Trading Desk and price prediction in high-frequency trading. *Social Studies of Science, 47*(2), 172-194. doi:10.1177/0306312716676900

Maurer, B. (1999). Forget Locke? From Proprietor to Risk-Bearer in New Logics of Finance. *Public Culture, 11*(2), 365-385. doi:10.1215/08992363-11-2-365

Maurer, B. (2016). Re-risking in Realtime. On Possible Futures for Finance after the Blockchain. *Behemoth : a Journal on Civilisation, 9*, 82-96.

Maurer, B., Nelms, T. C., & Swartz, L. (2013). "When perhaps the real problem is money itself!": the practical materiality of Bitcoin. *Social Semiotics, 23*(2), 261-277. doi:10.1080/10350330.2013.777594

Meralli, S. (2020). Privacy-preserving analytics for the securitization market: a zero-knowledge distributed ledger technology application. *Financial Innovation, 6*(1), 7. doi:10.1186/s40854-020-0172-y

Muniesa, F., Millo, Y., & Callon, M. (2007). An Introduction to Market Devices. *The Sociological Review, 55*(2_suppl), 1-12. doi:10.1111/j.1467-954X.2007.00727.x

Peterson, C. L. (2010). Foreclosure, subprime mortgage lending, and the mortgage electronic registration system. *University of Cincinnati Law Review, 78*(4), 1359 -1407.

Poon, M. (2007). Scorecards as Devices for Consumer Credit: The Case of Fair, Isaac & Company Incorporated. *The Sociological Review, 55*(2_suppl), 284-306. doi:10.1111/j.1467-954X.2007.00740.x

Poon, M. (2009). From New Deal Institutions to Capital Markets: Commercial Consumer Risk Scores and the Making of Subprime Mortgage Finance. *Accounting, Organizations and Society, 34*, 654-674. doi:10.1016/j.aos.2009.02.003

Proskurovska, A., & Dörry, S. (2022). The blockchain challenge for Sweden's housing and mortgage markets. *Environment and Planning A: Economy and Space*. doi:DOI: 10.1177/0308518X221116896

Riksbank, S. (2011). *The Riksbank's inquiry into the risks in the Swedish housing market*. Retrieved from Stockholm:

Riles, A. (2011). *Collateral Knowledge: Legal Reasoning in the Global Financial Markets*. Chicago: University of Chicago Press.

Rodima-Taylor, D. (2021). Digitalizing land administration: The geographies and temporalities of infrastructural promise. *Geoforum, 122*, 140-151. doi:https://doi.org/10.1016/j.geoforum.2021.04.003

Sandström, M., Forsman, D., Stenkula von Rosen, J., & Wettergren, J. F. (2013). *The Swedish covered bond market and links to financial stability*. Retrieved from http://archive.riksbank.se/Documents/Rapporter/POV/2013/2013_2/rap_pov_artikel_2_130918_eng.pdf

SBA. (2018). *The Mortgage Market in Sweden November 2018*. Retrieved from https://bf-swedishbankers.azurewebsites.net/media/3906/1809_bolaanemarknad-2018_en.pdf

SBA. (2020). *The Mortgage Market in Sweden*. Retrieved from on line: https://www.swedishbankers.se/media/4747/appendix-bolaanemarknad-2020.xlsx

SCB. (2021). Real estate prices and registrations of title. Retrieved from https://www.statistikdatabasen.scb.se/pxweb/en/ssd/START__BO__BO0501/. Retrieved 2/22/2023, from SCB https://www.statistikdatabasen.scb.se/pxweb/en/ssd/START__BO__BO0501/

Schmid, C. U., & Hertel, C. (2005). *Real Property Law and Procedure in the European Union*. Retrieved from on-line: https://www.eui.eu/Documents/DepartmentsCentres/Law/ResearchTeaching/ResearchThemes/EuropeanPrivateLaw/RealPropertyProject/GeneralReport.pdf

Schwarcz, S. L. (2011). The Conundrum of Covered Bonds. *The Business Lawyer, 66*(3), 561-586. Retrieved from http://www.jstor.org/stable/41348271

Smith, S., J. (2009). Managing financial risk: the strange case of housing. In G. L. Clark, A. D. Dixon, & A. H. B. Monk (Eds.), *Managing Financial Risks: From Global to Local* (pp. 233-253). Oxford University Press.

Smith, S. J. (2015). Owner occupation: at home in a spatial, financial paradox. *International Journal of Housing Policy, 15*(1), 61-83. doi:10.1080/14616718.2014.997432

Spielman. (2016). *Blockchain: Digitally Rebuilding the Real Estate Industry.*

Star, S. L. (1999). The Ethnography of Infrastructure. *American Behavioral Scientist, 43*(3), 377-391. doi:10.1177/00027649921955326

Stöcker, O. (2021). EU harmonisation of covered bonds. *Economy & finance, 8*, 27-56. doi:10.33908/EF.2021.1.2

Swartz, L. (2018). What was Bitcoin, what will it be? The techno-economic imaginaries of a new money technology. *Cultural Studies, 32*(4), 623-650. doi:10.1080/09502386.2017.1416420

Szabo, N. (1997). Formalizing and Securing Relationships on Public Networks. *First Monday, 2*(9). doi:10.5210/fm.v2i9.548

UC. (2019). *Tambur Användarmanual*. Retrieved from on line: https://www.uc.se/globalassets/pdfer/tambur/tambur_anvandarmanual.pdf

Wallace, J., & Williamson, I. (2006). Building land markets. *Land Use Policy, 23*(2), 123-135. doi:https://doi.org/10.1016/j.landusepol.2004.07.003

Wickramasinghe, N., Tatnall, A., & Bali, R. K. (2012). Using Actor-Network Theory to Facilitate a Superior Understanding of Knowledge Creation and Knowledge Transfer. In A. Tatnall (Ed.), *Social Influences on Information and Communication Technology Innovations* (pp. 205-218). Hershey, PA, USA: IGI Global.

Williamson, I., Enemark, S., Wallace, J., & Rajabifard, A. (2010). *Land administration for sustainable development* (I. P. Williamson Ed. 1st ed ed.). United States: ESRI Press

Wójcik, D. (2020a). Financial Geography I: Exploring FinTech – Maps and concepts. *Progress in Human Geography, 45*(3), 566-576. doi:10.1177/0309132520952865

Wójcik, D. (2020b). Financial geography II: The impacts of FinTech – Financial sector and centres, regulation and stability, inclusion and governance. *Progress in Human Geography, 45*(4), 878-889. doi:10.1177/0309132520959825

Zevenbergen, J. (2004). A Systems Approach to Land Registration and Cadastre. *Nordic Journal of Surveying and Real Estate Research 1*, 11-24.

Zook, M., & Grote, M. H. (2022). Blockchain financial geographies: Disrupting space, agency and scale. *Geoforum*. doi:https://doi.org/10.1016/j.geoforum.2022.08.001

Zook, M. A., & Blankenship, J. (2018). New spaces of disruption? The failures of Bitcoin and the rhetorical power of algorithmic governance. *Geoforum, 96*, 248-255. doi:https://doi.org/10.1016/j.geoforum.2018.08.023