Central Bank Digital Currencies and the Long-Term Advancement of Financial Stability

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Abstract

The United States financial system can be restructured by giving universal direct access to credit risk-free central bank money. In the 10 years since the financial crisis, technological advancements and regulatory tools have laid the foundation for Central Bank Digital Currencies to emerge as this economic resolution. Our paper analyzes similar economic cases and contends that introducing Central Bank Digital Currencies (CBDCs) can improve financial stability without degrading credit availability in the long term. We illustrate this by focusing on similar market shifts, namely in the U.S. student loan market and the New Zealand agribusiness sector. Our analysis showcases that by introducing CBDCs, market participants can subsequently remove certain market subsidies that promote poor risk practices and improper pricing. This subsidy to financial institutions is both explicit in the form of FDIC deposit insurance and implicit in the stipulation of taxpayer funded bailouts that materialized in 2008. We calculate the effect of introducing CBDCs by focusing on historical market examples when similar fundamental market shifts happened. Our conclusion is that CBDCs may diminish credit availability, but this effect is ameliorated as financial stability improves in subsequent years. Accordingly, we recommend a roadmap for rolling out CBDCs in the least disruptive fashion.

Introduction

Maturity transformation creates a fundamental flaw in the financial system. The capacity to borrow-short and lend-long inherently leads to instability. However, this is a tradeoff in efficiency versus fragility (Kashyap, Rajan, and Stein, 2002) in which certain financial gains can accrue by joining lending and deposit taking within one institution, but at the cost of increasing liquidity risk. Complex regulations have emerged over time to ameliorate these risks. Nevertheless, the 2008 financial crisis showed that risks from maturity transformation can never be fully eliminated and often are just shifted around the system, eventually leading to taxpayer funded bailouts when all else fails. Bank-runs follow when depositors fear that their funds have been deployed elsewhere and they will not be able to recoup their savings, an inherent component of maturity transformation. The critical question then becomes, *how can the financial system continue to provide credit to borrowers, while simultaneously providing a risk-free store of value that promotes stability?* Central banks in particular have focused on this question as regulators seek to stem financial market volatility, prevent damage to the real economy, and combat political pressure for bailouts.

The safety and soundness considerations provide an impetus for central banks to consider the implementation, over time, of *central bank digital currencies* (CBDCs). By CBDCs, we refer to direct retail access to central bank money. This differs from central bank deposits, which have largely been digitized already and are used for large-value bank settlements. CBDCs separate money and credit by providing a risk-free store of value directly to the public. This also differs from cash, which cannot be *practically* held in large quantities by depositors. Thus, we contend that a risk-free store of value without cap does not practically exist in the U.S. economy for depositors.

Central banks have conducted, and have underway, studies regarding the potential effects of adopting a CBDC. Most of the research to date has explored the impact that a shift to CBDC would have on creating new monetary policy implementation tools or the effect CBDC could have on payments systems (see *Part 1: Literature Review and Methodology*). However, less research exists regarding potential CBDC effects on lending and stability. This paper advances the discussion of those effects when deposits flow into CBDCs as a safe store of value.

We posit that the primary reason for introducing CBDC is to provide a risk-free store of value. A truly risk-free store of value is a public good. A truly risk-free store of value does not practically exist in the U.S. economy for depositors. While reserve accounts are available for the largest financial institutions, no such benefit exists for non-institutional depositors. The government is forced to intervene in the financial system to try to create this public good. The government's current and closest risk-free store of value is FDIC insured deposits held at banks. However, the problem with FDIC deposit insurance is that it is a market distortive subsidy. This is discussed in greater detail in the following section. Rather than creating a convoluted set of intermediates that require heavy oversight, government subsidy, and a potential lender of last resort, CBCDs can provide a store of a value in a less risky fashion. CBDCs thus become the public-policy good that was desired all along.

Although FDIC deposit insurance eliminates credit risk for depositors up to the stated limit, it is not risk-free in a larger sense. As we and several authors have shown (Bartholdy, Boyle and Stover, 2003; Demirguc-Kunt and Huizinga, 2004; Acharya et al, 2013), FDIC deposit insurance might reduce risk for depositors, but it actually increases bank lending risks. Accordingly, CBDCs provide an alternative to FDIC deposit insurance that reduces financial sector risk, improves lending practices, and provides a practical risk-free store of value.

We focus our paper in two ways: (1) assuming one particular CBDC structure and (2) analyzing only the lending aspects of financial stability. While financial stability has many components, our focus is on credit availability, lending, and preserving funding for productive enterprise in the real economy. For our particular structure, we first assume implementation over a long period (at least 10 years) for full CBDC for all retail deposits as a risk-free store of value, which would allow for a large reduction of deposit-insurance guarantees, namely the removal of FDIC deposit insurance. Second, we assume that all lending is still done via commercial banks and that these institutions would have to offer higher interest rates to attract deposits away from a risk-free CBDC. While this will create a reduction in available funds in the short-term, we illustrate that in the long-term there will be improved lending practices. Introduction of CBDC does not have to mean the eradication of physical cash, but instead offers a government implementation of a digital store of value.

We have also chosen to analyze a narrow segment of financial stability. While much of the post-crisis discussion has focused on systemic risk and interconnectedness, our focus is on lending. Our paper therefore discusses how CBDCs could improve lending-market discipline, thereby reducing the propensity for bubbles and furthering one tenet of financial stability.

A critical assumption for us is that given CBDCs, the United States could remove FDIC deposit insurance. We will outline this in Part 1. Given the market distortive effects of deposit insurance, we posit that not only is this subsidy not necessary in a world of CBDCs, but we also show that removing it may in fact improve lending.

The paper is organized as follows: In Part 1, we provide a survey of the current CBDC literature, including design considerations and the rationale for removing deposit-guarantee subsidies. In Part 2, we analyze the implications of CBDC on business models with a specific focus on lending in the short-term and long-term. In Part 3, we quantify how CBDCs can impact bank risk practices. In Part 4, we conclude our analysis and provide insights into future areas of research.

Our paper uses a case study methodology to conclude that two benefits will occur: (1) market discipline will improve as a result of better price discovery practices; and (2) specialty lenders will enter and expand the market, thereby softening the effects of reduced bank credit. We conclude that a gradual introduction of CBDC (to avoid credit-shock events) could have long-term financial stability benefits. We conclude that the introduction of CBDC would subsequently pave the way for the removal of certain market subsidies.

We recognize that introducing CBDCs will necessarily cause a short-term negative impact on lending, and therefore we have modeled this out. The removal of the subsidy will make bank

funding more expensive, which means that banks will have to lend at higher prices, and subsequently there will be fewer takers of these higher priced loans. To quantify the size of this effect, we use historical case examples when corporate subsidies were removed from markets to illustrate what the impact on growth and lending will be. Our analysis of the U.S. student loan market and New Zealand agribusiness suggests that once subsidies are removed, specialty lenders will enter the market and portfolio diversification will follow from improved risk practices.

Part 1 – Literature Review and Methodology: Central Bank Digital Currencies

The concept of direct access to central bank money is not a new one (Tobin, 1985). CBDC research has predominantly been dedicated to exploring monetary policy effects. The international regulatory community as well as Central Banks have contributed the vast majority to the literature on credit versus money supply, and have been doing so for years (Friedman, 1965). While the United States Federal Reserve has been fairly quiet on the CBDC front,[1],[2] the Bank of England has outlined the balance sheet implications of CBDC as well as putting forward design implications, such as keeping reserves separate from deposits (Kumhof and Noone, 2018; Border and Levin, 2017).

In this vein, researchers have also explored the impact that CBDC could have on growth. For example, Barrdear and Kumhof (2016) develop a Dynamic Stochastic General Equilibrium (DSGE) model that posits introducing CBDC in the amount of 30% of GDP could boost a nation's GDP by up to 3%.

The second major field of CBDC research has examined payments systems. The primary advantages of CBDC in this area are (a) liquidity and credit gains, which can be achieved by reducing payment-versus-delivery times (BIS, 2018; Dyson and Hodgson, 2016); (b) resiliency improvements, which can create an alternative digital payments network that reduces concentration risk (Riksbank, 2017); and (c) security and inclusivity opportunities, which help move economies towards digital solutions, with Uruguay as a prime example (Licandro, 2018).

Nevertheless, CBDC also comes with concerns, to which our paper responds. The primary arguments against CBDCs are that they could accelerate and worsen the opportunity for bank runs (Broadbent, 2016; Callesen, 2017) since financial crises induce a flight to safety. Martin, Puri, and Ufier (2018) use high-frequency data to show that regulatory bad news causes a flow *out* of uninsured deposits and that regulatory bad news often does not affect insured deposits. These deposit types remain sticky, even when a bank is highly probable to fail. Basel III indicates that "less stable" retail deposits will run-off at a rate of 10% per month during a period of severe liquidity stress. We will address these concerns by using historical examples to make inferences about how we can expect CBDCs to impact lending.

In the following section, we will discuss the primary benefit of CBDC, which is to provide a risk-free store of value. In order to evaluate the corresponding costs associated with providing this new asset class to the economy, we model out some of the expected outcomes, such as the entrance of specialty lenders into the market, an enhancement of risk practices as market distortions diminish, and an improvement in the allocation of financial resources. However, in order to explain why this change is necessary, we want to analyze the current market solution to providing a risk-free store of value for depositors: FDIC deposit insurance.

Part 1.1: Removal of FDIC Deposit Insurance

The Banking Act of 1933 established deposit insurance in the United States with the goal of establishing a risk-free place to store money. Currently, the FDIC provides a guarantee of all deposits up to $250,000 at member-bank institutions. The FDIC funds a guarantee insurance pool with premiums that banks and thrift institutions pay for deposit insurance coverage. In 2015, banks

[1] Lael Brainard, "Cryptocurrencies, Digital Currencies, and Distributed Ledger Technologies: What Are We Learning?", Decoding Digital Currency Conference, May 15, 2018

[2] Jerome Powell, "*Innovation, Technology, and the Payments System",* Blockchain: The Future of Finance and Capital Markets, The Yale Law School Center for the Study of Corporate Law, March 3, 2017

paid $8.8B to the deposit insurance fund, raising the total amount of the pool to $72.9B. Despite the full guarantee of qualifying deposits, the pool only contains sufficient funds for a small fraction of those deposits. The Dodd-Frank Act mandated that the Deposit Insurance Fund maintain a minimum designated reserve ratio of 1.35% of estimated insured deposits. In the U.S. where risk adjusted rates range from 0 to 27 bps, more than 90% of the banks qualify for the lowest rate of zero.

However, the safety that deposit insurance provides for depositors causes certain pitfalls that affect financial stability. The World Bank (Anginer, Demirguc-Kunt, and Zhu, 2013) summarizes this effect well:

> When deposits are insured, however, bank depositors lack incentives to monitor (Demirguc-Kunt and Huizinga 2004 and Ioannidou and Penas 2010). The lack of market discipline leads to excessive risk-taking culminating in banking crises. Demirguc-Kunt and Detragiache (2002), Demirguc-Kunt and Kane (2002) and Barth, Caprio and Levine (2004) find supportive evidence for this view.

The government's explicit backstop ensures that even if a bank engages in excessive risk-taking, the FDIC will ensure that depositors do not lose their money. The government's implicit backstop with respect to too-big-to-fail institutions also ensures that depositors remain secure up to a limit.

FDIC deposit insurance causes market distortions in two ways - first, it explicitly lowers the risk premium charged by banks and second, it implicitly reduces market discipline. Since Merton (1977), the effects of these market subsidies have been well documented. Bartholdy, Boyle and Stover (1994) find that on average, the deposit risk premium in OECD countries is 25 bps lower as a result of explicit deposit insurance. Demirguc-Kunt and Huizinga's findings (2004) align with this hypothesis that the subsidy provided to banks lowers their risk premium, noting that deposit insurance lowers bank interest rates by approximately 17 bps. Bartholdy, Boyle, and Stover (2003) conclude that the risk premium is on average over 40 bps higher in countries without deposit insurance than in countries with deposit insurance. They conclude that the risk premium is a nonlinear function of the deposit insurance coverage, a feature which they interpret to mean that the market recognizes that extended deposit insurance coverage makes moral hazard problems more severe. Acharya et al (2013) find that the implicit government subsidy that deposit insurance provides results in an annual funding cost advantage of nearly 28 bps on average over the 1990-2010 period, peaking at more than 120 bps in 2009. While risk-free money is the goal of deposit insurance, and a critical goal at that, there are negative repercussions for accurate risk pricing.

Second, FDIC deposit insurance reduces market discipline on bank risk taking. Calomiris and Jaremski (2016) find that in the early 20th century deposit insurance encouraged banks to increase insolvency risk. Demirguc-Kunt and Huizinga (2004) leverage cross-country differences regarding the country-specific features of deposit insurance to conclude that the existence of an explicit insurance policy lowers deposit rates, while at the same time it also reduces market discipline on bank risk taking. Thus, the mere existence of deposit insurance engenders riskier behavior. This is well documented outside of deposit insurance, as the existence of insurance, moral hazard, and principal-agent problems in many spheres tend to increase risk.

It is also important to acknowledge the benefits that FDIC insurance has allowed. This explicit guarantee provides a safe location for depositors to keep their savings, without fear that their deposits will be wiped out by exogenous forces. During the 2008 financial crisis, the U.S. government raised the insured amount per account from $100,000 to $250,000. However, the government did not ever lower the amount, even as the financial crisis abated; the higher cap was made permanent in 2010. Twenty years prior, Kennickell, Kwast, and Starr-McCluer (1996) noted that a decrease in deposit insurance from $100,000 to $25,000 per account would not be associated with a dramatic change in many non-wealthy household characteristics. Less research exists on the effects of moving deposit insurance from $250,000 back down to the previous $100,000 level

The goal of CBDCs, in turn, is to provide the same type of risk-free store of value, without the subsequent market distortions that FDIC deposit insurance causes. The obvious next question is, *how can we ensure that CBDCs do not cause market distortions that are equally unsound, if not worse?* In order to answer this question, we provide two examples. Our first example analyzes the student loan market, its historical changes, and posits that we can expect these trends to continue at

an accelerated rate once CBDCs are introduced. We come to this conclusion since CBDCs remove a similar market funding measure to one that was removed in 2010. In the student loan market, the U.S. government transitioned away from subsidizing the lending of private entities and towards, instead, providing much of that lending themselves. As discussed in Part 2, many private lenders left the industry after this shift. As such, the U.S. government now provides 92% of all U.S. student lending activity. Just as the removal of subsidies in the student loan market improved the risk and pricing models in the industry, so too will the removal of the FDIC deposit subsidy remove a second layer from this industry and continue to improve the risk and pricing models. Our second example tracks the removal of New Zealand agribusiness subsidies and the subsequent improvement in market resource allocations.

In the following section, our cases focus on the expected outcomes when CBDCS are introduced and FDIC deposit insurance becomes subsequently unnecessary and is removed. We do this by looking at two of the few examples in history when a subsidy of this size, with reliable data, provided to corporates, was removed from a developed nation's industry: this occurred in 1984 to New Zealand agribusinesses and in 2010 in the U.S. student loan market. We conclude that CBDCs can improve lending practices in the student loan market and thus ameliorate financial stability.

Part 1.2 – Methodology

Our paper uses a case study methodology for analyzing the expected effects of introducing CBDCs. We draw from two different sources – (1) The 2010 removal of guarantees in the U.S. student loan market; and (2) The 1984 removal of agro-subsidies in the New Zealand farming industry. These provide clear examples of how the CBDCs might alter the market since they illustrate how changes in funding sources and guarantees can fundamentally alter advanced economies, while still preserving critical market lending.

These examples were chosen because they are two of the few examples in history when a subsidy of this size, with reliable data, provided to corporates, was removed from a developed nation's industry. In order to evaluate an appropriate size, we determined that the industry under review should contribute more than 5% to the country's GDP at the time of the subsidy removal. We sought to find an instance of a removed direct subsidy, with a robust dataset and data for both the subsidized market and that post-removal market. This last requirement was particularly hard because most corporate subsidies (agricultural, energy, shipping, etc.) in the modern era are introduced and never removed. We did not want to use the removal of corporate tax incentives, preferring the closer example of a direct subsidy, since this would more closely track the removal of FDIC deposit insurance.

The student loan market case provides detailed data sources, highlights a market that underwent deep structural change due to the removal of subsidies, and leverages a highly concentrated private lending market such that one lender accounts for 50% of the private activity. Thus, this one firm offers insights in a broad swath of market activity. The student loan market is also currently in deep tension in the U.S., but still illustrates a generalizable argument for other markets across the world.

The New Zealand agro-subsidies case provides one of the only historical examples when subsidies have been introduced and then removed from a sector in an advanced-economy industry, where that sector is contributing more than 5% to the country's GDP at the time of removal. For context, finance and insurance contributed 7.4% to U.S. GDP in 2018.[3] Most importantly, that amount of time that has based since these changes gives insight into what longer-term benefits might look like. This paper focuses on changes in portfolio diversification, new product innovation, and improved resource allocation.

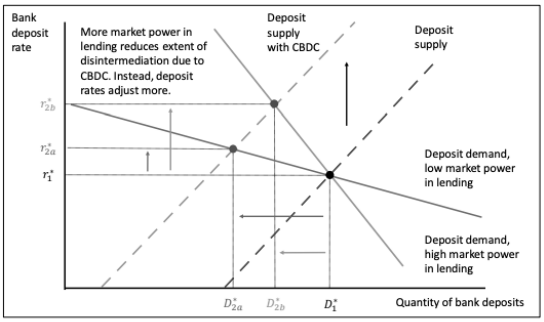
Our decision to employ this methodology is based on the forward-looking nature of CBCDs. Historical examples, coupled with nearly four decades of data to evaluate change in market functioning, provide deep insight into what economists, central bankers, and policymakers might expect when implementing this structural market shift.

[3] Bureau of Economic Analysis, 2019 First Quarter Release, April 19, 2019

Part 2 – CBDC impact on Business Models

The removal of subsidies in both the U.S. student loan market and New Zealand agribusiness fundamentally restructured the business models in each industry, thereby altering the stability and equilibrium of each market. Part 2 will begin by illustrating what the business models in each industry looked like before the change, why the change occurred, and what the effects were after the change. In both cases, the removal of subsidies increased prices in the short term, causing larger players to exit and allowing specialty lenders to enter the market and to improving lending practices. We show that the entrance of these new participants improved market functioning by offering lower rates to customers and by improving the allocation of resources. As such, this section explores the business models of lending and how those improvements in cost incentives can improve financial stability.

The charts below illustrate how initially CBDCs will reduce the supply of funding and result in higher interest rates charged by banks. However, we argue that over time the entrance of specialty lenders into the market actually reduces the cost of funding, ultimately bringing the market back towards its initial equilibrium.



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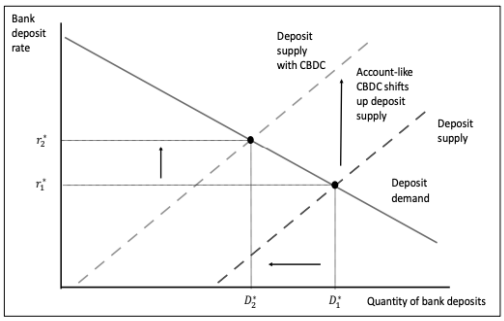

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Part 2.1 – The U.S. Student Loan Market: Specialty Lenders Enter and Improve Market Functioning

Our analysis of the student loan market indicates that specialty lenders enter the market when funding subsidies go away. As illustrated by the Federal Reserve (Kimball, 1997) these market participants have superior lending capabilities and improve market credit, thus the entrance of specialty lenders can have positive financial stability outcomes. Part 2.1 will focus on how specialty lenders changed the student loan market, whereas Part 2.2 will focus on how those market participants actually improved the allocation of credit and resources.

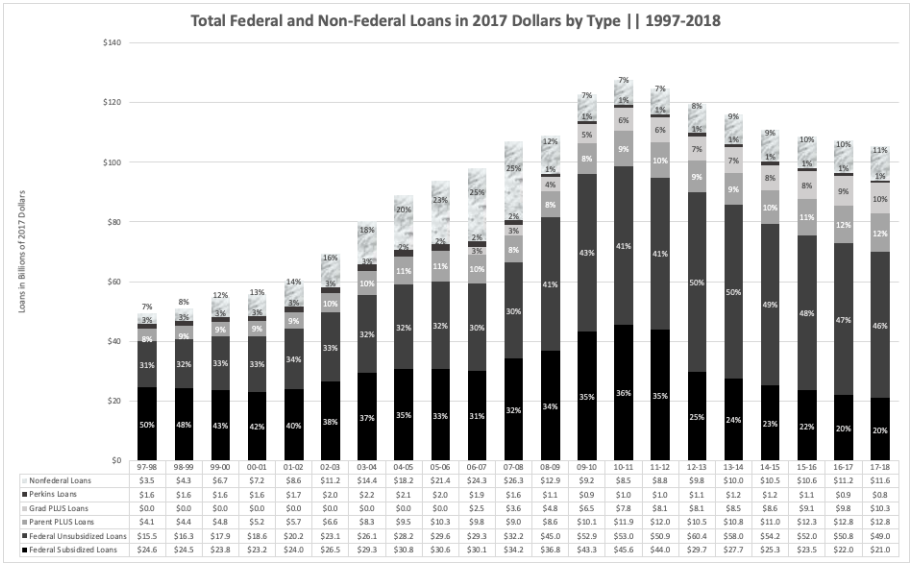
We have chosen to analyze the student loan market with respect to CBDCs for several reasons. We sought to find an instance of a removed direct subsidy, with a robust dataset and data for both the subsidized market and that post-removal market. This last requirement was particularly hard because most corporate subsidies in the modern era are introduced and never removed. The student loan market experienced the removal of government subsidy in 2010, moving towards direct government access to services. Moreover, the student loan market is the largest market for unsecured consumer debt in the United States (in contrast to the mortgage debt market, which is secured).

Over the past 20 years, the U.S. government has removed two major subsidies from this lending market. As the government removed subsidies to lenders, two new market structures emerged. First, many existing lenders exited and specialty lenders entered the market; and second, one major player emerged to dominate the private lending market. This section provides context for the student loan market so that readers can evaluate how changes to this market mirror changes that can be expected by introducing CBDCs.

In 1965 federal legislation provided for U.S. government guarantees of all student loans. The Federal Family Education Loan "FFEL" program (or "FFELP") was a system in which all private loans made by banks were subsidized by the government and also guaranteed against default. This created a classic "principal-agent" problem in which the agent (the student loan servicers) had

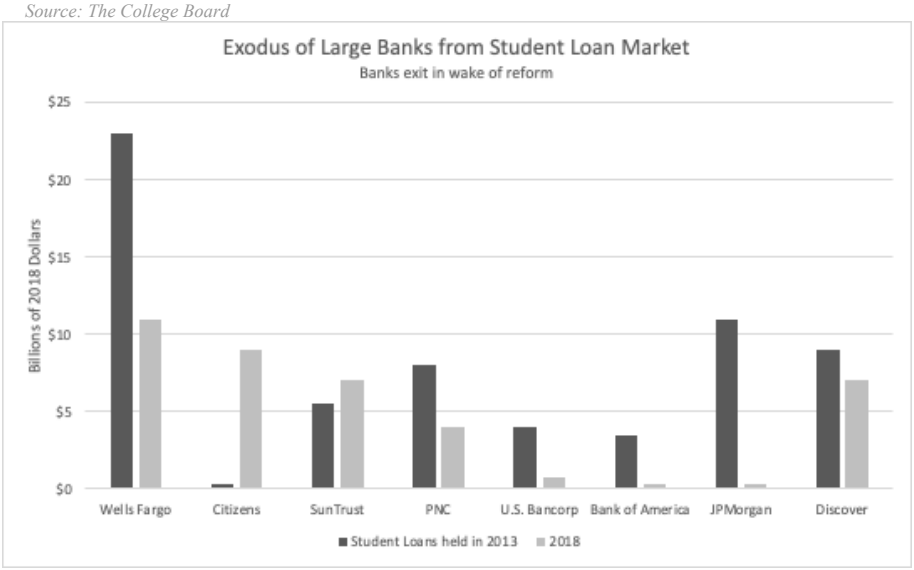
little incentive to act in the best interests of the principal (the federal government) while student loan servicers similarly did not have much incentive to prevent borrowers from defaulting.[4]

In 2010, the U.S. government undertook a complete overhaul of its guarantee system such that guarantees ended for new loans, without any phase-out. After 2010, the U.S. Department of Education became the direct lender for all new U.S. government funded student loans. Large U.S. banks that had a substantial part of the U.S. student-loan originations market completely exited the market as the guarantees against default were eliminated.[5] After the U.S. government changed from a loan-guarantee structure to direct lending in 2010, large banks exited from the student-loan origination market. U.S. Bancorp left in 2012, and J.P. Morgan Chase followed in 2014.[6] As of 2016, the U.S. government backed approximately $1.26 trillion or 92.5 percent of outstanding student loans. The remaining 7.5 percent of the higher education student loan market is made up of about $102 billion of private student loans.[7] Our paper focuses on the private student loan market.



	97-98	98-99	99-00	00-01	01-02	02-03	03-04	04-05	05-06	06-07	07-08	08-09	09-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18
Nonfederal Loans	$3.5	$4.3	$6.7	$7.2	$8.6	$11.2	$14.4	$18.2	$21.4	$24.3	$26.3	$12.9	$9.2	$8.5	$8.8	$9.8	$10.0	$10.5	$10.6	$11.2	$11.6
Perkins Loans	$1.6	$1.6	$1.6	$1.6	$1.7	$2.0	$2.2	$2.1	$2.0	$1.9	$1.6	$1.1	$0.9	$1.0	$1.0	$1.1	$1.2	$1.2	$1.1	$0.9	$0.8
Grad PLUS Loans	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$2.5	$3.6	$4.8	$6.5	$7.8	$8.1	$8.1	$8.5	$8.6	$9.1	$9.8	$10.3
Parent PLUS Loans	$4.1	$4.4	$4.8	$5.2	$5.7	$6.6	$8.3	$9.5	$10.3	$9.8	$9.0	$8.6	$10.1	$11.9	$12.0	$10.5	$10.8	$11.0	$12.3	$12.8	$12.8
Federal Unsubsidized Loans	$15.5	$16.3	$17.9	$18.6	$20.2	$23.1	$26.1	$28.2	$29.6	$29.3	$32.2	$45.0	$52.9	$53.0	$50.9	$60.4	$58.0	$54.2	$52.0	$50.8	$49.0
Federal Subsidized Loans	$24.6	$24.5	$23.8	$23.2	$24.0	$26.5	$29.3	$30.8	$30.6	$30.1	$34.2	$36.8	$43.3	$45.6	$44.0	$29.7	$27.7	$25.3	$23.5	$22.0	$21.0

Source: The College Board



Source: Bloomberg

[4] Susan Dynarski, "An Economist's Perspective on Student Loans in the United States", Economic Studies Working Papers at Brookings, September 2014

[5] The College Board, "Trends in Higher Education: Total Federal and Non-Federal Loans over Time" accessed from https://bit.ly/2I6Jz0M

[6] Brandon Kochkodin, "Here's How the Student Loan Landscape has Changed since 2013", Bloomberg News, December 6, 2018

[7] Office of the Inspector General, U.S. Department of Treasury, "Safety and Soundness: Financial Institutions' Private Student Lending Activities", OIG-17-008, November 14, 2016

This private-loan portion of the market consists primarily of specialty finance companies and smaller banks. Even in the face of direct government lending, private student loans total $115 billion in outstanding amount; about 7.5% of the overall market. These are amounts that originating lenders continued to keep off their own balance sheets, not securitizing them.

Our position is that the same effects that were observed when the loan guarantees were removed will be observed when CBDCs are introduced. As deposits run out of banks and into CBDCs, this causes a similar loss in funding benefits. Just as the loan guarantee helped student lenders finance their loans, so too do deposits for banks. CBDCs, and the removal of the loan guarantee, provide a new funding reality for banks. Our goal is to explain what this new reality looked like following the 2010 subsidy removal, and what we can expect a CBDC market to look like in the future, given these insights from student lending.

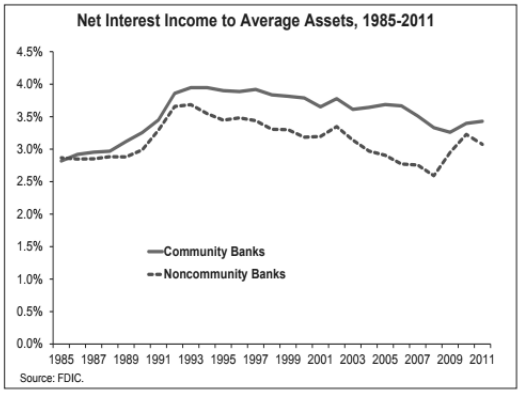
As deposits move to CBDCs, as FDIC insurance diminishes, and as the subsidy to large banks abates, we expect specialized lenders to enter the student loan market and thus improve credit risk standards. Specialty lenders differ from traditional banks in that they target narrower customer segments and leverage industry expertise in this one specific field. The Federal Reserve examined whether specialized lenders make superior credit decisions and concluded that due to specialization, such lenders have superior lending expertise (Kimball, 1997). In today's lending market in which specialty lenders compete with subsidized-cost-of-capital banks, specialty lenders use that knowledge and experience advantage because they have historically had to make loans in the riskier part of the market (Carey, Post and Sharpe 1996).

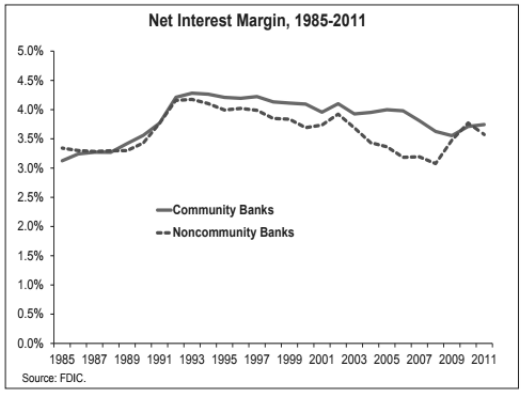
The student loan market's evolution before and after the 2010 guarantee removal illustrate this position. Before 2010, the quality of issued loans did not impact banks' balance sheets because of the government guarantee. With the removal of the guarantee, credit analysis became crucial within the student loan market while securitization became less attractive since loans were no longer guaranteed. Thus, a bank with a choice to leave a lesser-subsidized market would do so. Banks that were focused more on consumer lending, like Wells Fargo, remained in the market, as well as specialty lenders since they were able to leverage their comparative advantage. Community banks also entered the student loan market, and often sourced underwriting and servicing practices to specialty lenders and student-loan-knowledgeable service providers.

Other forms of consumer and small business finance have also seen a shift from bank lending to specialty lenders with market costs of capital. For example, specialized consumer lending increased 200% from 2014 to 2016. This lending encompasses both consumer lending (71% as of 2018) and small-business lending (21% of the specialty lending market). This demonstrates that specialty lenders can step in to fund productive enterprise at the ground-floor level of small business loans. Such growth has happened over a medium-term period, in the 8-10 years since the 2008 financial crisis. There is no reason to think that specialty lenders could not similarly step in during a long adjustment period of CBDC implementation.

That said, it may be difficult to quantify the benefit of specialty lenders in a space. Nevertheless, we sought to obtain a quantitative estimate by comparing Wells Fargo's balance sheet, the only remaining big bank in this sector, against that of community banks, who have the practical ability to deploy significant capital into this market on a specialized basis because the economics of outsourcing work for them.

High level data suggests that specialized student loan issuers would perform better. A 2012 FDIC study concluded that historically, community banks have been more successful than larger banks in generating net interest income. Over the entire study period, the ratio of net interest income to total assets has been higher at community banks in all but one year. The net interest margin of Wells Fargo is 2.6-2.8%. This may have been lower due to a one-time charge in connection with certain large government fines, but, for comparison, the net interest margin of the five largest U.S. bank is 3.1%. The top 10 community banks participating in the student loan market have an average net interest margin of 3.3%.





As specialty lenders entered the market, credit standards improve, as highlighted by the Federal Reserve, and some banks leave the market as the loss of subsidy no longer makes financial sense. These specialty lenders have superior credit lending capabilities thereby improving lending in the long-term and ensuring that institutions are not improperly propped up. However, this paper did not analyze a possible loss of access to certain communities as a result of some banks existing and specialty lenders entering. It is our hope that other researchers go beyond the financial stability implications, but also highlight the community access implications of CBDCs.

Part 2.2 – New Zealand Agribusiness: Improved Resource Allocation

In order to check our observations and conclusions, we examined another historical case study involving the removal of a large corporate subsidy in a developed nation. Our requirements listed in Part 1.2 pointed us towards another analogous case: The 1984 removal of agricultural subsidies in New Zealand. In the 1970s and early 1980s, New Zealand's government provided direct income support to agribusiness corporations. If agricultural commodity prices fell below the target price, public funds paid large corporations as a supplement to their market revenue. In 1983, 75% of income support to New Zealand pastoral agriculture came in the form of these subsidies. With such high subsidy levels, there was both an explicit guarantee of income as well as an implicit guarantee against failure of large farming enterprises. In 1984 New Zealand's budget deficit was 9% of GDP, with nearly 40% of that budget deficit coming from agricultural subsidies. Ultimately, a political impetus for fiscal responsibility led New Zealand to remove the subsidies.

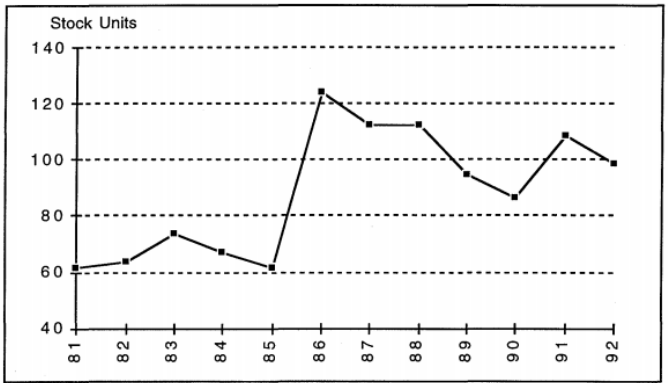
FDIC deposit insurance is a subsidy that causes both explicit and implicit benefits to private *lenders*, whereas New Zealand farm subsidies provide both explicit and implicit benefits to private *enterprise*. The New Zealand case allows for a more concrete measurement of subsidy removal because a full retail CBDC would remove explicit and implicit subsidies for funding productive enterprise, Our quantitative examples gather data from the New Zealand Meat and Wool Boards' Economic Service, Sheep and Beef Farm Survey and the New Zealand Department of Statistics, specifically for data for the 5 years prior to the subsidy removal plus 10 years after the removal. The goal of the following section is thus to quantify both the explicit and implicit removal of subsidies and the subsequent market shifts that emerge in new market funding regimes.

Over the long term, New Zealand saw three benefits when subsidies were removed: (1) better allocation of resources both within firms and across the industry; (2) growth of product innovation; and (3) improved diversification within farm product portfolios.

After removal of New Zealand subsidies, productivity remained relatively flat but the allocation of resources dramatically improved. Specifically, fertilizer usage per unit of livestock became far more efficient. Stock units of sheep (the second largest export product of New Zealand) per ton of fertilizer used doubled in the five years after subsidy removal, indicating improved efficiency as the stock of sheep remained stable. This was a major positive effect because fertilizer accounted for 75% of farmers' expenditures in 1983, the year before the subsidy removal.

Nevertheless, there was a marked decline after the initial ascent following the subsidy removal (see chart below), though the average stock units per ton of fertilizer still remained consistently higher than pre-subsidy levels. This is likely due to the fact that there were initial large efficiency gains to be made, but these slowed and leveled off over time.

Stock units per ton of fertilizer used on sheep farms, New Zealand, 1981-92

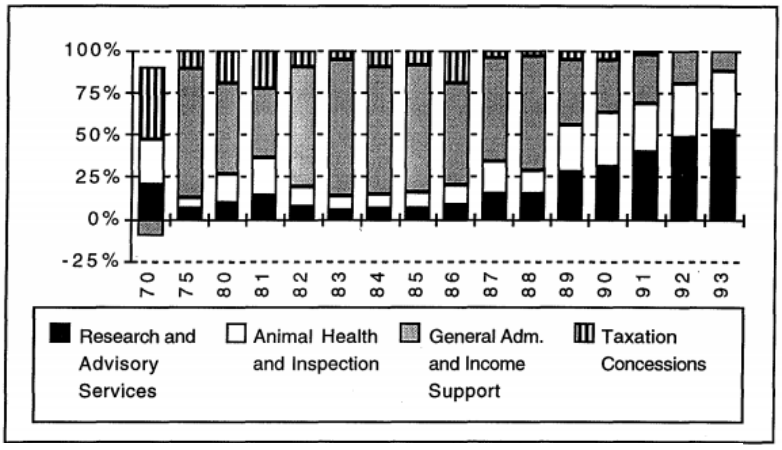


Source: Agribusiness & Economics Research Unit, New Zealand

The New Zealand government was also able to redirect some pure subsidy funds into forward-looking development in the agriculture industry. Rather than providing millions in subsidies, the New Zealand government redirected funds towards research and development (R&D) in the agricultural sector.

This provides an interesting precedent for a CBDC subsidy removal. In this area, a concern of Central Banks is to what extent a CBDC's effect on lending could reduce the growth of productive enterprise. The New Zealand example demonstrates that there can be a redeployment of subsidy resources to a different type of long-term growth enhancing program, such as R&D. Similarly, removal of a government subsidy to banks could allow a redeployment away from the financial sector into R&D for productive, nonfinancial portions of the economy. In New Zealand's case, the misallocation of resources due to the subsidy was a drag on the real-economy by propping up firms. Japanese "zombie companies" in the country's Lost Decade(s) provide a salient example as well. In the chart below, we can see the sustained growth in R&D investments at the same time as the costs associated with income support (i.e. the agro-subsidy) is reduced.

Breakdown of Total Assistance to Pastoral Agriculture by Category, New Zealand, 1970-93



Source: Agribusiness & Economics Research Unit, New Zealand

Part 3 – CBDC Impact on Risk Practices

As deposits flow out of banks and into retail CBDC accounts at the central bank, financial institutions will need to respond to this increase in liquidity risk. Deposits have historically acted as a sticky, secure asset for banks. Nevertheless, bank runs occur when deposits no longer believe their funds are safe and would rather hold the cash themselves, believing that the institution is no longer credible. Central banks do not suffer from this challenge. As long as there is trust in the continuation of the state, there will be trust in the central bank.

Our analysis indicates that there will be two market changes in response to change in risk practices: first, lenders will persist despite increased costs associated with new risk pricing; and second, we expect banks to further diversify their portfolios. We again use the removal of subsidies in the U.S. student loan market and New Zealand agribusiness to illustrate these points.

Part 3.1 – The Student Loan Market: The Persistence of Lenders

Central Bank Digital Currencies will alter the student loan market by decreasing the amount of deposits held at lenders, nevertheless, given similar changes that this market has already experienced, we expect lenders to persist. The student loan market has a unique benefit that no other market of this size has: one single company is responsible for 50% of the private loan market. Sallie Mae thus provides important data and insight into market functioning, risk practices, and lending.

The 1960s federal involvement in the student loan market led to the 1973 chartering of Sallie Mae so it could serve as a major servicer of student loans. As a "government sponsored enterprise" (GSE), Sallie Mae benefitted from an implicit government guarantee. Prior to 1997, Sallie Mae also enjoyed a $1 billion special line of credit from the U.S. Treasury, exemption from state and local taxes, and very low capital requirements, often lower than that of banks. Enjoying both the GSE and government guarantee benefit, Sallie Mae became the largest originating lender of student loans in the United States. However, from 1997 through 2004, Sallie Mae underwent full privatization as the government wound down its government guarantee program. Sallie Mae now accounts for 50% of lending in the private student loan market.

Sallie Mae allows us to examine subsidy removal effects because it has always been the largest lending entity in the private student loan market. This market concentration allows us to examine, on a case-study basis, how removal of subsidies have affected the student loan market.

Most importantly, Sallie Mae provides a clear example of two benefits that occur when government guarantees are removed: specialty lenders enter, and market funding persists. In our analysis of financial stability, we want to ensure that credit is still available and that financial institutions in the market are exhibiting safe and sound practices. Markets often consider companies associated with governments to have an implicit guarantee against failure -- that the government will bailout creditors and stockholders in the case of company failure. This is an indirect subsidy, because such companies can take excessive risks by exporting the risks onto the government.

Two U.S. government agencies analyzed the effect of the subsidy to Sallie Mae and the following impact of its removal. In 1985, before the privatization and before privatization considerations were even on the table, a Congressional Budget Office study concluded that Sallie Mae benefited from a subsidy of 30 bps. This GSE subsidy, which several studies have similarly modeled for too-big-to-fail banks, indicates that Sallie Mae, and in turn a huge percentage of the private student loan market, was experiencing pricing benefits that were market distortive. A U.S. Treasury study after completion of the privatization in 2004 concluded: "Congress provided the wind-down period to allow time for the safe and sound transfer of Sallie Mae operations and assets and to give the private company time to develop alternative financing sources to fund these transfers." The removal of Sallie Mae's GSE implicit subsidy, and its U.S. Treasury credit facility, required Sallie Mae to reset the liability side of its balance sheet and subsequently its cost of funding.

However, after 2004 Sallie Mae became fully privatized and thus was no longer able to enjoy these market funding benefits, shedding light on how we can expect CBDCs to similarly change the market. Just as Sallie Mae had to reevaluate its risk models with its 30 bps subsidy from GSE benefits, so too will CBDCs alter bank funding schemes.

First, Sallie Mae was able to secure new funding sources. For example, in 2002 during the privatization process, Sallie Mae was able to issue private debt for the first time. At that same time, Sallie Mae was able to undertake its first market-rate securitization of non-guaranteed student loans. In addition, Sallie Mae sought a banking license so that it could use deposit funding. The government rejected that application. Sallie Mae nevertheless continued to grow. It was able to obtain $4 billion of bond capital at its parent company. In conclusion, the loss of Sallie Mae's subsidy, the firm was still able to operate with a market rate of funding. The well-conceived medium-term transition of Sallie Mae away from its implicit subsidy could have lessons for CBDC implementation and the removal of a deposit-guarantee subsidy.

As such, Sallie Mae illustrates that even without government support, lenders adapt to the new risk practices. Even without implicit backstops, lenders learn to re-price their risk and continue to compete with new specialty lenders. In the following section, we analyze the specific mechanisms by which lenders can compensate for the loss of certain risk benefits (i.e. government supported) by focusing on portfolio diversification and new product innovation.

Part 3.2 – Portfolio Diversification in New Zealand Agribusiness

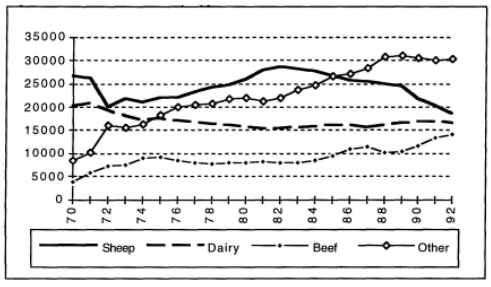
Portfolio diversification will increase as banks need to consider different product offerings. Formerly cheap and risk-free loans for banks will start to diminish from their balance sheets. As such, banks will need to acquire other safe assets to continue to hedge their positions. Student loans are particularly interesting in this respect since students cannot declare bankruptcy and in turn the credit risk is even more nuanced. Therefore, we can expect bank balance sheets to change as the degree of risk that they are now taking on shifts further out. In turn, Treasuries might see an uptick as well as banks cover liquidity and credit risk.

As part of portfolio diversification, New Zealand also illustrates that new product innovations will come to market. It is beyond the scope of this paper to posit what new product innovations in the student loan market will look like, since surely the New Zealand government at the time did not know that so many new dairy products or different types of fertilizer utilization were possible. What we can observe is that in the student loan market and the New Zealand agriculture market, businesses did adapt to having market-rate costs and non-subsidized revenues.

Nevertheless, it remains entirely possible that as new risk practices engender new prices, certain students may be priced out of the industry. The removal of the 2010 loan guarantee did change the industry in the short-term as major firms exited, the longer-term gains have been better risk practices. A fundamentally new market structure that focuses on risk, diversification, and innovation over the long-term rather than the short-term will portend benefits to the consumer.

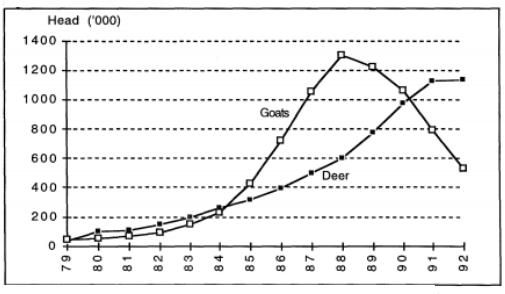
As beef and sheep prices fell after New Zealand subsidies were removed, farmers diversified land use to include deer and goat farming. Sheep was one of the most highly subsidized sectors and without government support, this product was no longer profitable for farmers and therefore this sector saw a production decline. Sheep and beef land-use dropped 16% from 1984 to 1994 to make room for deer and goat farming. The subsidies encouraged farming corporates to concentrate their business models to maximize the benefits that the subsidies provided. However, once the subsidies were removed, the farmers had to reconsider their asset allocations not only to meet true market demands, but also to hedge against portfolio risk.

Number of Farms by Type of Production, New Zealand, 1970-92



Source: Agribusiness & Economics Research Unit, New Zealand

Number of Deer and Goats, New Zealand, 1979-92



Source: Agribusiness & Economics Research Unit, New Zealand

The conclusion that we can draw here is that while total agricultural output did not markedly increase or decrease for the period, the *diversification* for different products changed significantly.

In 1983, New Zealand dairy farms produced 35 different commodities from milk, but by 2017 these companies were producing over 2,200 different dairy products. While this 63x new product innovation is coupled with a larger global industry trend towards development of new products, the pace of New Zealand's innovation is exceptional. This growth occurred even while much of the farming industry in the developed world received significant subsidies as many farming countries retrenched and rolled out protectionist policies. The period after subsidy removal saw New Zealand agribusiness able to compete because of innovation and efficiency gains.

Our conclusions indicate two factors that policymakers will need to track. First banks may actually begin to hold safer assets as regulatory requirements mandate that as deposits leave, they will need to substitute new assets onto their balance sheets instead. Regulators have spent years building the Liquidity Coverage Ratio and the High Quality Liquid Asset ratios, which provide a detailed ranking of the safest assets banks may need. Second bank risk practices will likely improve due to portfolio diversification and new product innovation.

Part 4 Conclusion

We posit that the primary reason for introducing CBDC is to provide a risk-free store of value. A truly risk-free store of value is a public good. Nevertheless, a truly risk-free store of value does not practically exist in the U.S. economy for depositors. The closest risk-free store of value is FDIC insured deposits held at banks, however, this only applies up to a stated-limit and also generates market distortive effects such as improper risk pricing. CBCDs thus emerge as a truly risk-free store of a value that avoids the convoluted intermediaries and complex regulations. CBDCs are the ultimate economic public-policy good.

Part 4.1 Assumed CBDC Structure

Our conclusion is that CBDCs diminish credit availability within one-year, but this effect is ameliorated as financial stability improves in subsequent years. Our analysis assumes a particular CBDC implementation model – full retail implementation in which individual and business customers can take any current bank deposits, without cap, and place them instead in a deposit account directly at the central bank. Given CBDCs, which provide a risk-free store of value, we assume a complete reduction of FDIC deposit insurance. We illustrate that FDIC deposit insurance is less effective at providing a safe haven for assets due to its market distortive effects. We also assume a gradual implementation of CBDC over an extended period of time, likely in congruence with the FDIC deposit insurance removal. We leverage the student loan market and the New Zealand agribusiness sector to illustrate that while markets may contract in the short-term as liquidity shifts to CBDCS, these cases illustrate that as new market structure experience, the economy will experience greater financial stability in the long-term.

Our proposal is to remove FDIC deposit insurance in a stepwise fashion from its $250,000 threshold down to zero over the course of 5 years after the implementation of CBDCs. This timeline is based off of BIS best-practices and the timeline taken for full implementation of the Basel III Common Equity Tier 1 ratio. Every year an additional 20% will be removed from the deposit insurance until 100% of the subsidy has been eliminated.

Part 4.2 – Synthesis and Future Work

We conclude that the introduction of CBDC, in the long term, could improve financial stability by improving lending practices in a certain market segment. We specifically look at the likely substantial reduction of deposit insurance as a subsidy since a retail CBDC will provide the zero-risk safe-haven for capital. We find that after the removal of similar implicit subsidies from the U.S. student loan market, lenders dependent on the market stayed. We acknowledge that there could

be several channels driving these improvements. For instance, market funding may have required better credit decisions, which in turn made space for specialty lenders to improve credit quality.

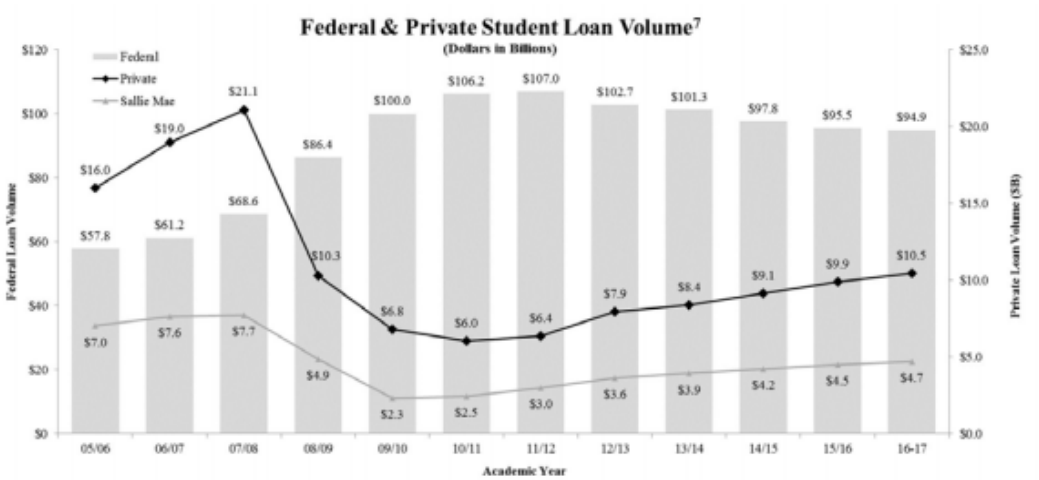
There is one final comparison between our two historical examples that could benefit central bank consideration of CBDC policy issues. Both the New Zealand subsidy removal and the U.S. 2010 subsidy removal occurred in a single cutoff, though with significant forward guidance, creating suboptimal short term effects including declines in production and credit availability. In the U.S. case, the government had to step in as a direct lender. In contrast, the organized, multi-year privatization of Sallie Mae can provide an example of planning for and implementation of subsidy removal that was smooth, ahead of schedule, and avoided the same kind of ill-fated short-term effects. These differences could provide guidance around CBDC implementation.

We also recognize instances where CBDCs might behave quite differently from our selected cases. For example, the short-term reduction in credit could price out smaller lenders while entrenching incumbents. As the market picks up, our historical examples indicate that specialty lenders will enter, but it is possible that the larger incumbents, saddled with regulatory approvals and market position, might make this more difficult. In addition, technological considerations might alter post-CBDC market functioning. Retail CBDCs can be hugely accessible and provide near-instant verification, whereas agribusiness changes require multiple seasons to manifest and student loan repayments can take years to pay off. While our timeline thus indicates a short-term limited credit followed by longer-term sustained growth, these timelines might be more rapid than expected. Lastly, the wide-spread access to CBDC would have a much larger economic impact, whereas the other two examples were more market specific.

It is our hope that these historical examples of subsidy withdrawal can provide illustrative analogies to frame and spur additional research and analysis. Each central bank has to consider its own specific banking funding and lending system. There may be country-specific examples of subsidy removals inside or outside the banking sector that can be leveraged for policymaking discussions. We think that the U.S. student loan market has a broad range of lenders, and therefore the method of analysis might provide a foundation for country-specific CBDC implementations that reduce financial market subsidies. Similarly, the New Zealand experience adds another perspective of major-business subsidy removal in a developed country.

The financial crisis of 2008-09 caused many regulatory, economic, and social changes to the financial system. Nevertheless, fractures still exist that pose risks to financial stability. As the global economy becomes increasingly interconnected and as taxpayers continue to stand at risk of funding bailouts for large banks, CBDCs emerge as a method of fundamentally reshaping the financial system and promoting long-term financial stability.

Appendix



Source: https://www.salliemae.com/assets/investors/shareholder/annual-reports/SLM_Corp_2017_Form_10-K_2.23.18.pdf

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