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# Chapter 1

## Introduction

Argument in a nutshell: - Financial wellbeing is important - Emergency savings and spending behaviour are key contributors to it - Both are understudied - Behavioural science can help understand them and suggest remedies - Data and fintech are crucial enablers in performing that research and implementing its solutions on a large scale - My thesis is an attempt in that direction: use large scale txn data to understand how people save and spend money, test whether fintech apps can have effect.

### 1.1 Theoretical context

#### 1.1.1 Financial wellbeing and why it matters

Financial wellbeing is a state in which a person can make ends meet in the present, can feel comfortable about their financial future, can feel comfortable about money, and has the financial freedom to make choices that allow for the enjoyment of life. This includes having control over one's day-to-day and month-to-month finances, not having to borrow to meet ongoing obligations, being free of debt or being in control of it, having the capacity to meet unexpected expenses, and – for a working-age individual – being on track to build enough savings for retirement.<sup>1</sup>

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<sup>1</sup>The US Consumer Financial Protection Bureau defines financial wellbeing as “a state of being wherein a person can fully meet current and ongoing financial obligations, can feel secure in their financial future, and is able to make choices that allow enjoyment of life” (CFPB 2015). The UK’s Money and Pension service defines current financial wellbeing as “being able to pay the bills and feel comfortable about money” and longer-term financial security as “having the savings to deal with the expected, the unexpected and the longer-term; or having some form of loss protection such as home contents or life insurance” (MPS 2018). Both organisations also differentiate some aspects of financial wellbeing depending on whether an individual is in their working or retirement age. Throughout, this discussion, as well as in the analysis in the following chapters, I focus on working age individuals.

Financial wellbeing is important because a lack of it can have severe consequences both in the short-term and in the long-term. In the short-term, low financial wellbeing means a constant struggle to make ends meet, being overwhelmed by debt, having circumstances dictate ones of and approach to money, a higher likelihood of experiencing material hardship – which (CFPB 2017) defines as running out or worrying about running out of food, not being able to afford medical treatment or a place to live, or have utilities turned off – and the need to cut back on essentials for ones children.<sup>2</sup> All of these experiences can cause a decline in physical and mental health, a loss of productivity, and an overall deterioration in the quality of life.

In the long-term, the danger is that the situation is not only self-sustaining but leads to a vicious circle that becomes increasingly hard to escape. This can happen purely because having to borrow for regular expenses like food and bills – as, the Money and Pension service estimates, about 9 million adults in the UK do (MPS 2018) – can lead to a situation where an increasing amount has to be spent on servicing debt and thus increases monthly expenses and the borrowed amounts required to cover them. In addition, however, this could happen because of increasingly impaired decision making. A literature on mental scarcity documents that our minds tend to focus on what is scarce and neglect what is not, concentrating our mental resources where they are most needed but reducing cognitive bandwidth in other domains, which can lead to poorer decision making.<sup>3</sup> For instance, Mani et al. (2013) find that low-income shoppers in New Jersey perform worse on cognitive tasks when first prompted to think about their financial situation while the same prompts had no effect for wealthier shoppers, and sugarcane farmers in India perform worse on similar cognitive tasks shortly before the annual harvest (when money is scarce) than shortly thereafter (when money is plentiful). There is also evidence that scarcity might lower productivity in the present: Kaur et al. (2021) randomise the timing of wage payments to low-income piece-rate manufacturing workers and find that workers that receive their wages early and are thus no longer liquidity constrained make fewer mistakes and increase their output by 7 percent. Hence, if the anxiety caused by having little money to cover current expenses lowers individuals’ productivity in the present and makes it harder to engage in rational planning for the future – how to reduce spending, how to build skills that would help find a higher-paying job, how to transition to a healthier lifestyle that would help them feel and perform better physically and mentally – then low financial wellbeing in the present might beget

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<sup>2</sup>For more detailed descriptions about the consequences of financial hardship, see CFPB (2017), MPS (2018), and Step Change (2017).

<sup>3</sup>See Shah et al. (2012), Mullainathan and Shafir (2013), and Haushofer and Fehr (2014) for excellent summaries of the literature.

low financial wellbeing in the future.

The determinants of financial wellbeing are a combination of circumstantial and external factors as well as the capabilities, beliefs, and behaviours of the individual. MPS (2018) provides a useful categorisation that sees financial wellbeing as a function of four broad factors: external factors that include economic conditions, demographics, and other external factors such as a person's social environment; enablers that include financial confidence and numeracy, a sense of control, one's spending and savings mindset, and one's engagement with money, advice, and technology; day-to-day behaviours like managing the use of credit, avoiding to borrow for everyday spends, active saving, keeping track of and making adjustments to one's spending, and shopping around; and, finally, planning ahead behaviours like building financial resilience through saving and planning for retirement.<sup>4</sup>

While no one factor is deterministic for financial wellbeing, research from the US (CFPB 2017) and the UK MPS (2018) agrees that, as expected, external economic factors such as access to education and higher paying jobs are important. In the UK, for instance, individuals with an annual income of £20,000 or below account for 41 percent of the working age population but for 69 percent of those with less than £100 of savings. Similarly, 50 percent of people who borrow to cover everyday expenses earn less than £17,000. So, clearly, a search for and support of effective economic and social policy measures should be an important part of any effort to improve societal financial wellbeing. But the same research also shows that higher incomes are not sufficient. In the UK, 18 percent of individuals with less than £100 in savings have a household income of £30,000 or higher, and 20 percent of those who borrow to cover everyday expenses have an income of £50,000 or higher. In the US, too, there is a large variation in the characteristics of individuals at each level of financial wellbeing; the financial wellbeing of the top quarter of people with a high-school degree, for instance, is higher than that of the bottom half of those with graduate degrees.

In both countries, research shows that the level of savings is a key contributor to financial wellbeing. In the US, it is the one factor that discriminates between different levels of financial wellbeing better than any other examined factor (CFPB 2017). In the UK, it is, together with behaviour towards credit, the strongest predictor of financial wellbeing (MPS 2018). In fact, research by a UK charity suggests that having £1,000 in liquid savings could reduce the probability of being in debt by almost half. In particular, having a habit of saving regularly – even more so than the amounts saved – has been found to be a key

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<sup>4</sup>The US Consumer Financial Protection Bureau uses a similar classification in its definition of financial wellbeing (CFPB 2015).

determinant. Other factors that are positively associated with higher financial wellbeing are confidence in one's ability to achieve one's financial goals, not using debt to cover everyday expenses, paying one's bills on time, staying within one's budget and spending plan, paying credit card balances in full, and checking bank statements for errors.<sup>5</sup>

But many people struggle with these behaviours. For instance, in the UK, 21 percent of the working-age population (10.7 million adults) report to rarely or never save, and 22 percent of the population have less than £100 in savings, with those holding that amount in a formal savings account being even lower. Unsurprisingly, then, one in four adults could not pay an unexpected bill of £300 from their own money. In the US, the situation is similar, with 30 percent of adults saying they would be unable to cover a bill of \$400. This is problematic because many households do face unexpected financial shocks over the course of a year. Also, many households experience high income volatility: in the US between 2013 and 2018, the median month-to-month change in household income was 36 percent, with low-income households experiencing more frequent and larger income dips (Chase 2019). The same research finds that while families need roughly six weeks of take-home income in liquid assets to weather a simultaneous income dip and expenditure shock, 65 percent of households lack such a buffer. In line with these findings, Roll and Despard (2020) find that during the coronavirus pandemic, households with liquid assets of above \$2,000 had significantly lower risk to experience financial distress (indicators like skipping essential bills, being behind on credit card debt, being in overdraft) than households with lower savings.

Managing debt is similarly challenging for many. 9 million people in the UK also borrow to cover expenses for food and bills (MPS 2018), and many struggle to stay on top of their credit card debt: 2 million cards were in arrears or default, another 2 million carried persistent debt, and for another 1.6 million cards, owners were persistently making minimum payments only. Altogether, the study found that 5 million accounts (9 percent of the total) that were active in January 2015 would, under their current repayment pattern and without further borrowing, take 10 years to repay their balance (FCA 2016). In addition to holding high and persistent balances, a large body of research also indicates that individuals make other mistakes in debt management, especially in dealing with credit cards: they choose suboptimal credit card contracts (Agarwal, Chomsisengphet, Liu, et al. 2015), sometimes because they are overly susceptible to temporarily low teaser rates (Shui and Ausubel 2004, Ausubel 1991); they borrow on payday loans before

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<sup>5</sup>For details on contributors to financial wellbeing see (CFPB 2017) for the US and MPS (2018) for the UK.

while being far from having exhausted their credit card limits (Agarwal, Skiba, et al. 2009), their repayment amount is overly influenced by stated minimum payments (Sakaguchi et al. 2022), they pay down debt across different cards proportionally to outstanding balances instead of prioritising high-interest cards (Gathergood, Mahoney, et al. 2019), and they sometimes hold credit card debt and liquid assets at the same time (Gross and Souleles 2002, Gathergood and Olafsson 2020).<sup>6</sup>

### 1.1.2 Role of behavioural science

- Retirement planning: among working age, 14 pct report to have done substantial amount of retirement planning, 44 pct at least a good amount. Among those between 45-65, this is 47 percent. 20 pct of that latter group have no plan at all.
- agarwal2017shapes 2.3 for review

Behavioural science can contribute to higher financial wellbeing in three ways. First, as a discipline it has learned a fair amount about the psychological factors that drive financial decisions and accumulated a large body of knowledge about the effectiveness of different solutions that can make it easier for people to avoid mistakes and achieve their own goals. Second, a large body of research has used a subset of these insights and solutions to help people save more for retirement, and it has learned important lessons from that endeavour, at least some of which translate to other financial behaviours. Third, behavioural science might be able to help understand and – ultimately – circumvent the barriers that stand in the way of economic and social policies that shape the financial wellbeing of many people to a large degree but is largely outside of their control.

Researchers have documented a large number of factors that influence financial decision making: cognitive limitations and financial literacy (Agarwal, Driscoll, et al. 2009, Agarwal and Mazumder 2013, Korniotis and Kumar 2011, Agarwal, Amromin, et al. 2010, Fernandes et al. 2014, Jørring 2020); time-preferences and self-control (Frederick et al. 2002, Read et al. 2018, Ericson and Laibson 2019, Cohen et al. 2020); attitude towards money and spending (Rick, Cryder, et al. 2008, Rick, Small, et al. 2011); ones perceived locus of control (Perry and Morris 2005), degree of optimism (Puri and D. T. Robinson 2007), ability to frame decisions broadly rather than narrowly (Kumar and S. S. Lim 2008), and propensity to gamble (Kumar 2009); ones social network (Bailey et al. 2018, Kuchler and Stroebe 2021); the degree of financial planning (Ameriks et al. 2003); and habits (Blumenstock et al. 2018, Schaner 2018, De Mel et al. 2013).<sup>7</sup>

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<sup>6</sup>See Agarwal, Chomsisengphet, and C. Lim (2017) for a more complete review of a large body of research documenting consumer choice inefficiencies and suboptimal financial behaviour.

<sup>7</sup>For two thorough reviews, see Agarwal, Chomsisengphet, and C. Lim (2017) and Greenberg

Researchers have also developed and tested a large number of approaches aimed to help people make better decisions. One main area of research here aims to address limited self-control – the difficulty most of us face at least occasionally to act, moment-by-moment, in our own best interest and according to our own goals. I briefly discuss three such approaches that have the potential to help people make the financial choices they themselves would like to make.<sup>8</sup> One extensively studied approach are commitment devices, whereby an individual restricts their future choice set in order to avoid choosing a self-defeating action. While not everybody makes use of such devices when offered the opportunity (Bryan et al. 2010), and while they do not work in all contexts (Laibson 2015, C. D. Robinson et al. 2018), they have been found to help individuals increase their savings rates (Ashraf et al. 2006), quit smoking (Giné et al. 2010), make healthier food choices (Schwartz et al. 2014), and exercise more regularly (Royer et al. 2015).

Another approach are implementation intentions, a particular type of planning for the achievement of one's goals that involves “if-then” intentions, such as “if I get paid, then I transfer 10 percent of it into my savings account” (P. M. Gollwitzer and Sheeran 2006, Rogers, Milkman, et al. 2015). Such intentions have been found to support perseverance in pursuing one's goals (Oettingen and P. Gollwitzer 2010) and to increase overall goal attainment across different age groups, life domains, and types of obstacles (P. M. Gollwitzer and Sheeran 2006).

A third intervention that has the potential to alter financial behaviour is social norms messaging, whereby people are informed about how their own behaviour compares with that of a relevant peer group. Such information can be especially useful for domains where such information is usually not available, as is the case with spending and saving, and has been successful inducing high energy use households to lower their energy use without inducing low-use households to increase theirs (Schultz et al. 2007, Allcott 2011, Allcott and Rogers 2014, Brandon et al. 2017). However, the information can also backfire and has been found to lower participation in pension savings plans (Beshears, Choi, et al. 2015) and completion rates of an online course (Rogers and Feller 2016), making it important to test messages before deploying them on a large scale and to avoid unintended consequences.

These approaches, together with many others, have the potential to make it easier for individuals to manage their money and to spend and save in line with their own goals. To realise that potential, however, we need to be able to test these approaches on a large scale and at low cost to gather reliable results

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and Herschfield (2019).

<sup>8</sup>For an extensive review of a large number of behavioural interventions aimed to address self-control problems, see Duckworth et al. (2018).

and to have the ability to tweak and refine them, and we need to be able to deploy approaches that work on a large scale. The advent of online and mobile banking and the large amount of data they create enable researchers and financial institutions to do just that.

### 1.1.3 Large scale data and fintech

- buyalskaya2021golden for opportunities of new data for social research
  - stachl2020predicting show that using sensor and log data from smartphones to predict peoples' Big Five personality traits is about as accurate as using social media footprints.
  - montjoye2013predicting also predict personality (big five) from mobile log data and find predictions to be considerably better than random.
  - industry uses: Adaptation in financial sector (boe2019machine)
  - baker2021household
  - Current applications: simpler dashboards (Monzo, Money Dashboard). link to lit in levi2020mind on improved information display and lowering cost of information acquisition - potential for info display: McKenzie and Liersch (2011) find that people systematically underestimate the exponential growth, and that showing them difference in long term outcome from regular savings left to compound makes them more motivated to save more for retirement. This is something fintech apps can easily help with by showing projections - or offering to show them
  - what is my wealth if I save x, or y, or z.
    - robo advising (philippon2019fintech, dacunto2021frontiers)
    - Challenges: what is good advise (sabat2019rules)
    - Soman and Cheema (2011) find that earmarking part of salary as savings increases savings rates. Fintech apps could suggest automatically transferring fixed amount into labelled savings pot. - could even be default option - duckworth2018beyond for default lit
    - Gargano and Rossi (2021) show that setting savings goals in a fintech app (a soft commitment device (Beshears, Milkman, et al. 2016)) increases savings.
- Guttman-Kenney et al. (2021) - Aggregator apps an prove particularly useful to study effect of intervention because we can see complete financial picture, avoiding semblance of success results.
  - De Montjoye et al. (2015) find that it's easy to reidentify users based on credit card metadata.

Exception: Philipps et al. (2021) - Automatic payroll deduction seems to be valued by employees and has helped people from the squeezed and struggling segments



This is why I'm focusing on it... Discuss in next section.  
Savings understudied. Exceptions: beshears2022borrowin

## 1.2 Objectives and research questions

- I use a single dataset, provided by Money Dashboard, for all three papers.
- The data presented a number of challenges.
- Handling data of this size.
- Secure storage with easy remote access (AWS).
- Consistent and efficient preprocessing (my process).
- Open science contribution: all work available on Github, code available for preprocessing from beginning to end.

**Motivation:** My experience as a researcher in well-known academic and private-sector institutions has made clear to me over the years that careful, reliable, and replicable data preprocessing is undervalued in many settings.

The result are plain data errors that overturn results (Reinhard and Rogoff) and replication issues (see Ariely controversies). Given my experience, I'd think that all we know is the tip of the iceberg.

In the vast majority of empirical research projects there is no good reason to not make the code public, even when the data is proprietary. And yet, for the vast majority of papers, there is no code available to replicate findings and check precise implementation details, which often matter but are not described in papers.

All of this harms science - the quality of it and the trust in it.

I have dedicated a lot of time during my PhD to ensure that I can rectify at least some of those issues.

The code for all my projects is available online and includes scripts that can be used to easily run the entire analysis.

## 1.3 Chapter summaries

There is a lot more work to be done in characterising spending profiles. From entropy paper: There are a number of alternative ways to characterise spend profiles. We could calculate profiles based on the distribution of transaction values rather than counts. We could also calculate profiles based on inter-temporal

rather than intra-temporal distributions, focusing on consistency of purchasing behaviour over time rather than on predictability at any given time (Krumme et al. 2013). Further, we could focus on time-based rather than category-based measures, focusing, for instance, on whether purchases of the same type tend to occur on the same day of the week (Guidotti et al. 2015). Finally, one could also create composite measures based on principal component analysis, an approach used in Eagle et al. (2010). We leave these extensions for future research.

## 1.4 Contribution

## 1.5 Limitations and directions for further research

Data - Sample representativeness

- Can often only use small fraction of users for study because of incomplete data for many. One reason: mps2018building points out that many people use budgeting tools to achieve short term goals. Hence, no intention of long-term use.

# Chapter 2

## Conclusion

This thesis consists of three independent research studies on ...

In the first part of this conclusion, I will summarise the three chapters, before discussing challenges...

### 2.1 Summary

The two applied studies presented in Chapters 1 and 2 are purely exploratory. A natural next step to exploring their generalisability is a pre-registered replication on new data (Van den Akker et al., 2019). We did not pre-register any studies presented here since many analysis decisions were taken conditional on the data observed. It is a well-known problem that such data-dependent decisions can affect the conclusions drawn from the research (Simmons, Nelson, and Simonsohn, 2011; Gelman and Loken, 2014). The studies are thus a useful first step in exploring the questions of ethnic bias and domestic abuse and will require further, pre-registered analyses.

### 2.2 Discussion

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