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Over-indebtedness and consequences for well-being

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Over-indebtedness and consequences for well-being

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CHAPTER 1

INTRODUCTION

1.1. Research context

The 2007–08 financial crisis and the subsequent global recession has left many households in developed countries experiencing financial strain. Almost one-quarter (24%) of European households currently report having difficulty making ends meet (EU-SILC, 2018). This is due to the erosion of housing and financial wealth, severe restrictions on access to credit by financial institutions and employees experiencing job loss, low wage growth and increasingly precarious employment (French and Vigne, 2019). In addition, cuts to government spending for social welfare and protection and increases in tax are placing individuals and households under heightened financial pressure.

Financial strain has wider individual, social and political consequences. In this thesis we focus on the association between financial strain and health, which has been studied before in an array of settings (Drentea and Lavrakas, 2000; Kahn and Pearlin, 2006; Keese and Schmitz, 2014; Turunen and Hiilamo, 2014; French and McKillop, 2017; French and Vigne, 2019). There is evidence that financial strain influences psychological health (Reading and Reynolds, 2001; Wildman, 2003; Cooke et al., 2004; Jessop et al., 2005; Bridges and Disney, 2010; Selenko and Batinic, 2011; Drentea and Reynolds, 2012) however the effect on physical health is still emerging. Some studies have looked at the biological pathways through which financial strain impacts on health, specifically the role that it plays in disease pathogenesis (Ferrie et al., 2005; Georgiades et al., 2009).

We focus on subjective rather than objective measures of financial pressure such as low income or indebtedness for a number of reasons. It has been shown that subjective measures of financial strain are often more strongly correlated with measures of material hardship than objective ones (Carle et al., 2009; Heflin, 2016;

French and Vigne, 2019). In general, low income or household debt, per se, is not a sign of financial problems as many households have coping mechanisms such as accessing credit, increasing household labour hours or sourcing help from friends and family to sustain levels of consumption. Even after experiences of financial shock, for example unemployment, increasing interest rates or illness, households have methods of coping not reflected in objective measures of financial strain (Lusardi et al., 2011). Additionally, Whelan et al. (2017) note that attitudes towards debt and over-indebtedness differ across individuals, countries, time and socio-economic groups and therefore the objective level of debt does not always explain the impact on the welfare of the household (Whelan et al., 2017; French and Vigne, 2019).

Studies have found that it is the subjective experience of feeling financially strained, more so than the size or type of debt of the household, which impacts negatively on mental and physical health (Lange and Byrd, 1998; Tucker-Seeley et al., 2009; Selenko and Batinic, 2011; French and McKillop, 2017). If objectively a household is under financial pressure but not reporting trouble with managing their financial situation then it is unlikely that there will be any resulting impact on mental health (French and Vigne, 2019). This is in accordance with numerous studies which state that subjective economic stress plays an important role in the prediction of wellbeing (Drentea and Lavrakas, 2000; Wadsworth et al., 2008; Hoelzl et al., 2009).

Financial strain is often caused by unexpected circumstances beyond our control for example shocks or changes in the wider political, economic and social environments or at the household level. Households, even those that are income rich or liquidity unconstrained, can be disrupted by unexpected financial shocks subsequently leaving them experiencing financial strain. Later in this thesis we develop a theoretical model using lifetime economic decision-making models, as first proposed by French (2018), to attempt to understand the causes of financial strain. This will allow for a more complete analysis of the effects of low income, economic shocks and liquidity constraints on self-reported financial difficulties than has been undertaken previously.

1.2. Policy implications

In recent years, UK households have been under increased financial pressure due to various structural and individual level factors. The financial crisis followed by a programme of austerity measures, the recent COVID-19 pandemic and changes to the labour market accompanied by low levels of financial capability and limited provision of debt advice are some of the issues which are contributing to households feeling that they are unable to cope financially and such issues need to be addressed through appropriate government policy.

1.2.1 Structural factors

Even before the current COVID crisis, many households in developed countries were experiencing severe financial strain. The financial crisis in 2008 had been the most severe economic downturn since the Wall Street Crash of 1929 (UN, 2011). The mortgage crisis quickly resulted in the collapse of housing prices and loan defaults, leading to severe liquidity constraints on large banks worldwide and enormous government bailout packages (Mazeikaite et al., 2019). Ultimately, the crisis was succeeded by an increase in unemployment, depressed wages and decreased living standards (UN, 2011). Many Western countries faced severe budgetary pressures and the implementation of austerity measures, largely from 2010 onwards. For example, in the UK, aggregate figures suggest that overall government spending for social welfare and protection, such as unemployment, housing, tax credits and disability-related benefits contracted by 16% in real per capita terms (Figure 1: Fetzer, (2019)), reaching levels last seen in the early 2000s. The Office of Budget Responsibility (2016) estimates a total of £45.4 billion will have been cut from the welfare budget from 2010 to 2021.

Such benefit cuts have hit already struggling deprived areas and exacerbated the experience of financial strain (Beatty and Fothergill, 2014; French, 2018).

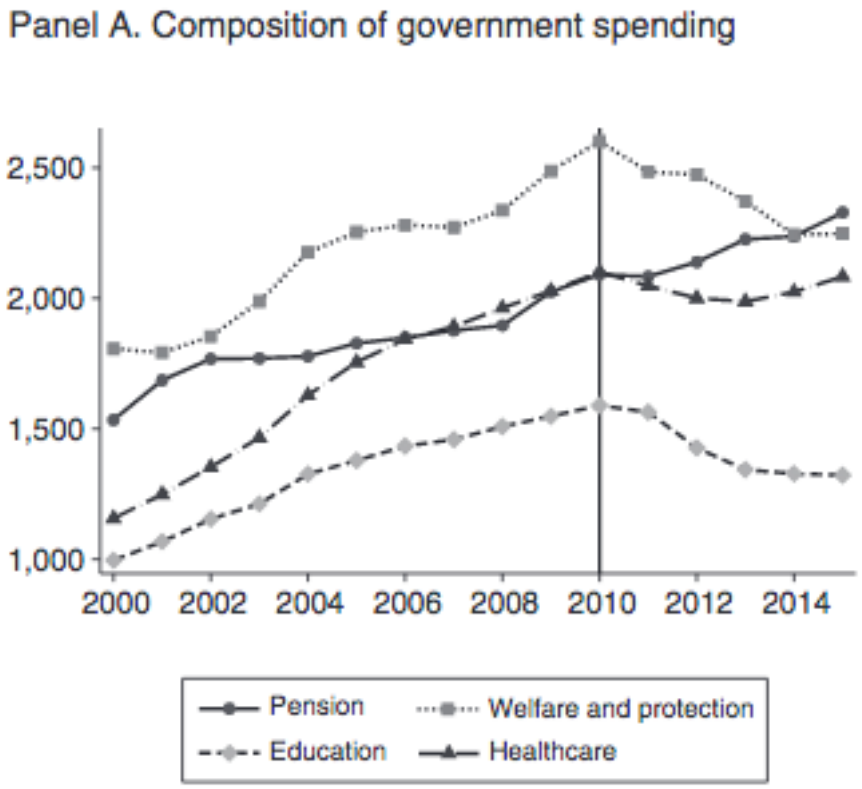


Figure 1.1. Government spending in the UK per capita. Line in 2010 represents the point when the coalition government that brought about austerity comes to power (Fetzer, 2019).

Across the rich world, the COVID-19 pandemic will increase gross government debt from 105% of GDP to 122% and this is a greater increase than in any year of the global financial crisis (IMF, 2021). Although, government intervention such as furloughing as well as the post-pandemic economic recovery should return households to pre-COVID-19 living standards, households will be paying for government pandemic borrowing for decades to come (Brewer and Patrick, 2021).

Financial difficulties have a wider social cost often unrecognised by policymakers with consequences for individual mental and physical health. Higher levels of suicide, alcohol problems, and mental illness have all been linked with increased levels of financial strain, especially in the absence of social protection (see Section 1.3) (Karanikolos et al., 2013; OECD, 2014; Frank et al., 2014). There is a smaller literature on the effects of financial difficulties on physical health, however a number

of studies have suggested that stress can lead to changes at the physiological level which impact on longevity and play a key role in disease pathogenesis (Cohen and Wills, 1985; Vitetta et al., 2005; McEwen, 2008). In particular, it has been highlighted that exposure to stress influences cardiovascular disease (Rozanski et al., 1999; Krantz and McCeney, 2002), upper respiratory infections (Miller and Cohen, 2005), autoimmune diseases (Heijnen and Kavelaars, 2005) and total mortality (Neilsen et al., 2008).

While many pathways that link economic crisis to changes in health have been proposed, the relative contributions of different factors are largely unknown and appropriate policy responses are lacking (Mazeikaite et al., 2019). Hence, examining the drivers of the observed health changes may provide evidence for future policy responses aimed at safeguarding population health in times of economic uncertainty (Mazeikaite et al., 2019). This research is especially relevant at a time of further social, economic and political change in the UK with the unfolding of Brexit and the more recent global COVID-19 pandemic. It is likely that both will bring long-term systemic changes to the UK economy, politics and society and vulnerable groups will be increasingly affected. In particular, although household income has not deteriorated in aggregate groups such as younger workers, those on insecure contracts, those in leisure and hospitality, and the self-employed have benefitted from government support to a much lesser extent (Brewer and Patrick, 2021). Once the job retention scheme ends in 2021-22, unemployment is expected to increase by 900,000 which along with the end of the uplift in Universal Credit will move 1.2 million people into relative poverty.

It is already evident that the financial uncertainty posed by the COVID-19 pandemic is pervasive and could affect mental and physical health both now and in the future. A recently published ONS survey shows around 45% of working-age households in Britain expect their financial position to get worse over the next 12 months as a result of COVID-19 (ONS, 2020). Particularly those with insecure jobs, with fewer rights and employee benefits, are less likely to have savings to cover additional unplanned costs or gaps in income with knock on effects for psychological welfare (Hepburn, 2020).

Similar research has emerged elsewhere from Europe and the US. In a European consumer payment report on the effects of Covid-19 on the financial wellbeing of respondents from across 24 countries in Europe, results show increased financial stress among consumers. Approximately half of survey respondents said their financial wellbeing had declined compared with six months ago, and a third expected it to decrease further in the next six months. The report stated millennials in particular were vulnerable to the economic upheavals of the Covid-19 crisis due to less secure jobs with lower earning power, partly a legacy of the structural economic problems arising from the 2008-09 debt crisis (Intrum, 2020). Meanwhile a study by the Commonwealth Fund found that more than 30% of U.S. adults reported that they've been faced with negative economic effects from the coronavirus pandemic, and 56% of those U.S. adults who reported experiencing any negative economic consequences of the pandemic also reported having mental health distress (Commonwealth Fund, 2020).

1.2.2 Evolution of the labour market

The labour market in the UK has been radically transformed with a boom in low quality precarious employment. Workers are moving from full-time permanent employment to zero-hour or temporary contracts, and they are increasingly taking up self-employment or gig work (Balaram and Wallace-Stephens, 2018; Hiilamo, 2018). This is not just the case in the UK alone, but also in the US and other European countries (Kalleberg, 2011; Prosser, 2016; ICF and Radar Europe, 2018; Howell and Kalleberg, 2019). In a longitudinal study of the changes of precarious employment in the US it was found that long-term decreases in employment quality were widespread, with large increases among men, college graduates and higher-income individuals observed (Oddo et al., 2021). Meanwhile, the Dutch labour market is characterised by a high degree of flexibility with a relatively high and increasing proportion of employees in temporary work and solo self-employment. The use of flexible contracts is particularly common among young people (between 15 and 34 years old) and low educated workers, whilst highly educated workers are overrepresented in the group of solo self-employment (ICF and Radar Europe, 2018).

Standing (2011) has popularised the notion of precariousness, describing the unpredictable conditions faced by different people in contemporary market economies. His account describes how socio-economic conditions are becoming ever increasingly insecure and unpredictable.

In the UK, there are now nearly a million people on zero-hour contracts and 1.7 million are in temporary work. A record 4.8 million are in self-employment, while there are an estimated 1.1 million people in the UK's gig economy (ONS, 2017). This rise in atypical work is concerning in that the labour market is fragmenting into low paying, poorly protected jobs and undermining the financial security of workers, resulting in worsening feelings of financial strain. In a Royal Society for the encouragement of Arts, Manufactures and Commerce (RSA) report on economic security and modern work in the UK (Balaram and Wallace-Stephens, 2018), it was found that many workers are experiencing various strands of financial strain with over a quarter of workers not feeling like they earn enough to maintain a decent standard of living. One in five workers sometimes have trouble making ends meet because of income volatility and nearly half (43%) of workers do not have anyone in their household whom they could depend on to support them financially in the event of hardship. Furthermore, many workers lack the necessary savings to withstand financial shock – 32% have less than £500 in savings and 41% hold less than £1,000. A further 40% do not expect to have enough in savings to maintain a decent standard of living in retirement. Overall, a third (34%) of the workforce would consider themselves to be 'just about managing').

Research suggests that this type of atypical work could continue to grow in the coming years and there is a need for greater awareness among policymakers, commentators and the public of the vulnerability of this fast growing sector and, in particular, the impact it is having on the financial situation of households (Balaram et al., 2017).

In Theresa May's first speech as Prime Minister (May, 2016), she recognised that there were a contingent of workers who were "just about managing", despite the fact that employment rates were high. Subsequently the government commissioned The Taylor Review of Modern Working Practices to examine issues such as agency

workers, employment status, the enforcement of employment rights, maternity discrimination and zero-hours contracts. Following the recommendations of the Taylor Review published in 2017 (Taylor et al., 2017), the government introduced a package of reforms under the Good Work Plan (HM Government, 2018) to protect the rights of workers such as guaranteeing workers the ability to request a stable contract after six months of work, larger fines for employers who violate the law, and giving workers information about their rights from day one in their job (Varghese, 2018). A number of sources have recently called for further reforms such as portable benefits and government advice services to support precarious workers (Balaram et al., 2017; Varghese, 2018; Glover et al., 2019).

In the increasing environment of precarious work and welfare, Universal Basic Income, a monthly payment to all adult citizens (Wright, 2006), has gained attention in the policy agenda, with growing levels of public awareness and support (Martinelli, 2017). Standing (2014) and others (e.g. Torry, 2013) have been influential in bringing the notion of UBI to the fore. It is a potential solution to the financial insecurity faced by individuals in that it guarantees the basic income previously promised by work and the welfare state (Skidelsky, 2016). In a Finnish study of the scheme, it was found that UBI improved participant's mental wellbeing, confidence and life satisfaction (De Wispelaere et al., 2018). Similarly, two pilot studies of basic income were conducted in India in 2011 by the Self Employed Women's Association (SEWA). The results showed many positive implications, notably, an improvement in living conditions, increased food sufficiency, reduction in seasonal illnesses, greater involvement of women in household economic decision making and debt reductions (Standing, 2013). Sources highlight that the public-health case for UBI is under-explored (Forget, 2011; Johnson and Johnson, 2018; Johnston et al., 2019; Haagh and Rohregger, 2019).

1.2.3 Individual factors

Economic stress is a result of a combination of causes arising from both structural and individual factors. Focusing on the individual level, financial strain can be a product of often underestimated and unexpected events such as relationship breakdown, poor mental health, family illness and unforeseen large expenses. A

more thorough understanding of the dynamic processes is needed and this could help in the design of appropriate policy interventions (French and Vigne, 2019). Households, even those that are income rich or with access to as much credit as future income permits, can still be disrupted by these unexpected financial shocks leaving them experiencing financial strain (Wadsworth et al., 2008; Santiago et al., 2011; French, 2018).

In addition, more research is needed to understand this apparent financial fragility of households which makes them vulnerable to shocks at both the structural and individual level. In particular, more research is required on issues facing households such as the lack of precautionary saving; the role of overspending; attitudes to risk; and lack of financial capability, particularly among those in younger age groups.

1.2.4 Financial capability

A growing body of evidence suggests that financial capability is among the most important determinants of financial wellbeing (Panos and Wilson, 2020). Evidence indicates that those with greater financial competence tend to enjoy greater psychological wellbeing (Melhuish et al., 2008; Taylor et al., 2011), more stable financial behaviour (Hilgert et al., 2003; Lusardi and Mitchell, 2007) and achieve more favourable economic outcomes (Lusardi and Mitchell, 2014; Winstanley et al., 2018). On the other hand there is evidence that individuals with poor financial capability are more likely to make financial mistakes (Benjamin et al., 2013) such as borrowing at higher interest rates (Stango and Zinman, 2009), they are less likely to have savings (Smith et al., 2010), and are more likely to default on mortgage payments (Gerardi et al., 2013; Cuesta et al., 2015). Therefore, earlier intervention is needed to improve financial capability and build financial resilience, enabling individuals to avoid rather than respond to financial difficulties, particularly as strain has been found to have links with various health outcomes.

According to the Organisation for Economic Cooperation and Development (OECD), the need for financial education and literacy is now universally recognised and is a core component of financial empowerment for individuals and the stability of the financial system (OECD, 2020). In 2016, the leaders of the G20 endorsed the

National Strategies for Financial Education, developed by the OECD and International Gateway for Financial Education. In response, the vast majority of G20 countries have a national strategy in place to tackle these issues (Fincap, 2021).

Locally in the UK, improving financial capability among the population has been highlighted as a Government priority in the Financial Capability Strategy for the UK (Money Advice Service, 2015). Under the new Money and Pensions service (MaPS)[1], the UK Strategy for Financial Wellbeing[2] was launched in 2020 with the aim of improving financial wellbeing across the UK over a ten year period through five key areas: (1) Delivering effective and meaningful financial education; (2) Making it easy for people to develop a savings habit; (3) Improving access to affordable credit plus better tools for managing it; (4) Delivering high-quality debt advice when it's needed; and (5) Empowering consumers to make informed decisions for their future (Money and Pensions Service, 2020).

As in the UK, some steps have also been taken to improve financial capability in the US. The US National Strategy for Financial Literacy 2020 prioritizes financial education as a key pathway to economic wellbeing for all. The Financial Literacy and Education Commission lists five priority areas in its strategy including basic financial capability, saving for retirement and investor education, housing counselling, the military, and post-secondary education (U.S. Financial Literacy and Education Commission, 2020).

In the Netherlands, there is the Money Wise Strategic Action Plan which has the main objective of putting financial literacy on the national core projects. For example, the National Money Week, where primary school students learn how to deal with money; and the Pension3Days, a national three-day event designed to bring awareness on raising pension. This action plan counts with the support of over 40 partners from the financial sector, the government and consumer organisations that are part of the Money Wise Platform. By joining forces, the platform goes in depth on three core components of responsible financial behaviours including financial planning, monetary management and selecting the right financial products (Money Wise, 2019).

[1]The Money and Pensions Service (MaPS) brings together three respected financial guidance bodies: the Money Advice
[2]The strategy builds on the previous Financial Capability Strategy for the UK published in 2015.

Delivering on national financial strategies and a subsequent improvement in financial wellbeing will benefit individuals, communities, businesses, the economy and wider society (Money and Pensions Service, 2020). For example, tackling financial strain and its knock on effects for mental and physical health, would reduce the costs to hospitals and other services of adverse health episodes. Individuals who enjoy good financial wellbeing are more productive at work. Businesses have healthier profits and cash flow, and benefit from individuals who have financial wellbeing and spend in sustainable ways. Additionally, the wider economy benefits from a population who enjoy financial wellbeing.

1.2.5 Debt advice

Funding of financial counselling services in the UK in particular has been significantly reduced in recent years (see French and McKillop, 2017). Consequently, there is currently a preventative advice gap with people being unable to access the advice they need at the key moments (Citizens Advice Bureau, 2016). This is in part due to a lack of financial advice services in the first place, as well as a lack of awareness of what advice is available and where to access it and in part due to unhelpful beliefs about the types of people who need help managing their finances (Money Advice Service, 2015). Greater access to financial advice for households experiencing financial strain could serve to prevent the associated negative health and well-being consequences as well as improve long-term financial capability.

Credit unions have been identified as key tools in the improvement of household finances. In the UK, credit unions are being recommended as an alternative to payday lenders in socially disadvantaged areas (French and McKillop, 2016). Financial education of members and promoting thrift and wise use of credit are some of the core functions of credit unions. However, according to French and McKillop (2016) and Byrne et al. (2010), despite the fact that credit unions are engaged in some form of financial education in the community, the majority are low-commitment activities with marginal impact. Credit unions could play a bigger role in financial capability.

Elsewhere in the Netherlands, politicians and policy makers are giving more

attention to the debt problem, however assistance offered is compartmentalised, partially due to increasing governmental decentralisation (Money Wise, 2019). The different approaches between municipalities and private parties has been found to create significant challenges such as individuals being unable to find their way to get help and also making it difficult to collaborate, measure effectiveness and scale debt advice initiatives, with efforts often overlapping (Deloitte and SchuldenlabNL, 2020).

Additionally, financial technology (FinTech) has the potential to enhance financial capability. Panos and Wilson (2019) assess whether smartphone apps can be utilised to improve desirable financial capability. Individuals were more likely to keep track of their income and expenditure and proved to be more resilient when faced with a financial shock. In a randomised control trial, French et al. (2020) find significant improvements in 'financial knowledge, understanding and basic skills' and 'attitudes and motivations' for a group of individuals that use a smartphone app intended at improving financial capability. Similarly, a US study by Servon and Kaestner (2008) assessed whether access to an online financial demonstration programme, combined with financial literacy training could help low- and moderate-income individuals in inner-city neighbourhoods be more effective financial actors. It was found that there were a small number of qualitative improvements among individuals.

1.2.6 Poverty and wellbeing strategies

In the UK, the devolved administrations exercise considerable autonomy in regard to poverty related issues. Hence, the lack of a central UK government anti-poverty strategy can sometimes mean that policies are introduced without consideration of their impact on those experiencing economic difficulties.

At the local level, it has been claimed that Northern Ireland anti-poverty strategies lack political commitment (French and McKillop, 2017). There are various programmes and interventions that address poverty, social exclusion and deprivation patterns however action is disjointed and does not have a coordinated long-term plan (French and McKillop, 2017). It is also argued that the current strategy, 'Lifetime

Opportunities', focuses excessively on child poverty and highlights economic policy solutions over social policy (Tinson and McInnes, 2016).

Similar to poverty-related issues, health is also a devolved matter in the UK. It is worth noting that the Northern Ireland Executive has highlighted the importance of social and economic determinants of health in its ten-year strategic framework for public health, 'Making Life Better' (2013/2023) (Department of Health, Social Services and Public Safety, 2014). The framework builds on the Investing for Health Strategy (2002/12) (Department of Health, Social Services and Public Safety, 2012). Actions proposed include ensuring appropriate family-based financial support to children, providing young people with an awareness of budget management and encouraging long-term financial independence (Department of Health, Social Services and Public Safety, 2014). This approach reinforces the importance of these initiatives for health as they will encourage sound financial decision-making and help individuals avoid financial difficulties and the associated repercussions for health.

1.3. Review of the literature

1.3.1 Effects of strain on mental health

To date, existing research on the health consequences of financial strain has focused largely on psychological health. The relationship between financial wellbeing and mental wellbeing has been investigated in a number of studies in a variety of settings with individuals' perceptions of their financial circumstances in particular found to be a significant contributor to psychological health (Wildman, 2003; Cooke et al., 2004; Jessop et al., 2005; Kahn and Pearlin, 2006; Selenko and Batinic, 2011; Drentea and Reynolds, 2012; Turunen and Hillamo, 2014; Richardson et al., 2017; Holgrem et al., 2019: Frankham et al., 2020).

Several studies highlight the importance of using subjective measures. Butterworth et al. (2012) found that the risk of psychological disorder was statistically stronger for financial hardship than other measures of income and SES such as occupation.

Similarly, in a study on the effects of credit card debt on wellbeing, the subjective appraisal of the economic situation was identified as the most important predictor of physical impairment and mental health, while the objective amount of debt was of minor importance (Drentea and Lavrakas, 2000). Further reinforcing the need to focus on subjective measures to understand the effects on health, Dew (2007) claims that the relationship between debt and in particular, depression is ambiguous. Debts are only detrimental to mental health when they exacerbate economic pressures however households may also use debt to consume at levels equal to their reference group and hence gain a sense of well-being from 'keeping up with the Joneses' (French and Vigne, 2019).

Self-reports of financial strain or concern have been consistently linked to common mental health problems such as depression and anxiety (Reading and Reynolds, 2001; Mirowsky and Ross, 2003; Bridges and Disney, 2010; Stein et al., 2013; Frank et al., 2014; Dijkstra Kersten, et al., 2015). Reading and Reynolds (2001) found that among women with objective financial difficulties suffering from postnatal depression, worries about debt accounted for the largest amount of variance of depression, beyond the objective amount of debt and other health related factors. In a Whitehall study of future uncertainty and socioeconomic inequalities in health, Ferrie et al. (2003) found that differences in self-reported financial insecurity across socio-economic groups were a major determinant of differences in the incidence of depression. In a study of a group of young adults, Stein et al. (2013) found a direct relationship between perceived economic pressure and psychological well-being. Individuals who reported having to make more economic adjustments as a result of the US economic crisis also reported higher levels of anxiety and low mood. Furthermore, in a longitudinal study of adults in two communities in rural Ontario where significant job losses recently occurred, financial strain was positively related to symptoms of anxiety and depression (Frank et al., 2014).

Financial strain has also been found to have links with self-harm behaviours and suicide (Meltzer et al., 2011; Barnes et al., 2016; Korhonen et al., 2016; Fountoulakis, 2020). In the first UK study of self-harm among people experiencing economic or austerity-related difficulties, it was proven that economic hardships resulting from the recession and austerity measures accumulated to trigger self-harm

behaviours in a small group of participants from two undisclosed UK cities (Barnes et al., 2016). A Finnish paper investigating changes in the severity of economic hardship and long-run trends in suicide found that any reduction in levels of an individual's normal or habitual consumption patterns due to adverse economic conditions resulted in a greater risk of suicide (Korhonen et al., 2016).

There are a number of excellent systematic review papers such as Fitch et al. (2011) and Turunen and Hiilamo (2014) who investigate the relationship between debt/indebtedness and mental health and conclude that financial troubles are linked to various mental disorders.

Bridges and Disney (2010) and Gathergood (2012) note a problem with individuals reporting economic difficulties and poor mental health simultaneously, arguing that it may be an individual tendency to report having difficulties in both domains. Bridges and Disney (2010) state that it is likely that respondents who are depressed or anxious may perceive a given set of financial circumstances as more difficult than respondents who are not depressed or anxious. Similarly Gathergood (2012) states that an individual with poor psychological health might be more, or less, inclined to subjectively report they are struggling with debts compared to an individual with good psychological health in the same financial situation. However French and Vigne (2019) argue that this issue is overstated as several longitudinal studies (Latif, 2015; French, 2018) document a positive relationship between financial strain and mental health, even when controlling for individual effects.

Individuals vary in their response to financial problems and it has been indicated that financial strain has less of an effect on mental health if the individual is able to cope and adapt to the financial difficulties (Frankham, 2020). Selenko and Batinic (2011) found that financial strain had less effect on mental health if the individual had strong self-efficacy beliefs, a belief in his or her own competence, a belief in his or her ability to cope, and greater access to some sort of collective purpose. However, having more access to social contacts was related to better mental health only if the perceived financial strain was low. Additionally, Frankham et al. (2020) found that psychological flexibility (Renner et al., 2015), resilience (Heilemann et al., 2002), or possessing adaptive problem-solving skills (Nelson, 1989; Chou and Chi, 2002;

Meyer and Lobao, 2003; Chen et al., 2006) were protective of mental health and made challenging economic conditions easier to tolerate. Individuals also report lower levels of worrying about debt where a partner has assumed financial responsibility for the household thus taking on the psychological burden (Goode, 2012).

The greater the number of coping mechanisms employed by households to adjust to shocks the greater the psychic cost and hence drain on mental well-being. Aytaç et al. (2015) show that the number of coping adjustments that Turkish households employed during the recent economic crisis was positively associated with higher depression levels and greater physical health problems. Similarly, Stein (2013) reported that young adults who had to make more economic adjustments as a result of the financial crisis suffered higher levels of both anxiety and depressed mood.

While medication costs are not an issue in the UK, it is worth highlighting that individuals using strategies to cope with the financial burden of prescription medication have poorer psychological wellbeing. In a US study, Martin et al. (2012) found that those using the cost-coping strategy of borrowing money to cover the cost of prescription medication had worse psychosocial health. Individuals with accumulating credit card debt reported poorer physical functioning, self-rated health and feelings of helplessness. Additionally the cost-coping strategy of medication underuse was associated with worse psychological health, greater disability and depressive symptoms (Turunen and Hiilamo, 2014). Such findings highlight the need to further explore the relationship between mental health and the adjustments households make in response to financial strain.

1.3.2 Effects of strain on physical health

Financial difficulties not only negatively affect mental health but also worsen self-reported health and increase physical impairment (Drentea and Lavrakas, 2000). Financial strain leads to poorer self-care, difficulties performing usual activities and pain problems (French and McKillop, 2017); unemployment causes worse reports of self-assessed health (Urbanos-Garrido and Lopez-Valcarcel, 2015); and overindebtedness is associated with worse subjective health and sub-optimal health-

related behaviours (Turunen and Hiilamo, 2014). According to Burgard et al. (2013) recessions in the USA tend to have a bigger impact on health than in other advanced economies due to its weaker welfare state (French and Vigne, 2019).

The response to financial strain and its subsequent impact on physical health can act both through behavioural and biological pathways, however a broader understanding and greater quantification of the relative importance of these mediating pathways is required. Studies have suggested that economic strain can lead to changes at the physiological level through the dysregulation of multiple biological systems which impact on longevity and play a key role in disease pathogenesis (Cohen and Wills, 1985; Lipowicz et al., 2016). Release of hormones such as adrenalin in response to stressful events can interfere with control of physiological systems such as anti-inflammatory responses; metabolism of carbohydrates, fats, and proteins; gluconeogenesis as well as regulation of cardiovascular, pulmonary, hepatic, skeletal, muscle, and immune systems resulting in increased disease risk (Cohen et al., 2007). The consequences of stress for health include increased risk of cardiovascular disease (Rozanski et al., 1999; Richardson et al., 2012), faster progression of HIV/AIDS (Remor et al., 2007), delayed wound healing response (Broadbent et al., 2012), upper respiratory infections (Miller and Cohen, 2005; Pedersen et al., 2010) and autoimmune diseases (Porcelli et al., 2016).

The term, allostatic load which refers to the effects of chronic and acute stress and is the process of wear-and-tear on the body and brain (Sterling and Eyer, 1988; McEwen and Stellar, 1993; McEwen, 1998, 2006; McEwen and Gianaros, 2010), is a useful conceptual framework through which to capture the physiological dysregulation related to stress (McEwen and Lasley, 2003). However, extensive work on how stress "gets under the skin" has yet to be carried out (Prentice et al., 2017; Patel, 2019).

Stress can manifest as alterations not only to physical health and physiology, but also behaviour, affect and cognitions, which can influence susceptibility to disease and its course (Fields et al., 2014). Adopting unhealthy behaviours is one of the coping strategies used to relieve the burden felt by financial strain (Bennett et al., 2009; Shim et al., 2009; Jones et al., 2010; Nakao, 2010) and it has been found that stress is

a significant correlate of snacking or emotional eating (van Strien et al., 1986), higher levels of smoking and reduced probability of smoking cessation (Steptoe et al. 1996; Adams et al., 2007; Grafova, 2007; Nelson et al. 2008; Umberson et al., 2008), drinking (Steptoe et al. 1998) substance use (Gerber and Pühse, 2009; Guo, 2013) and foregoing medical care (Barcellos and Jacobson, 2015). The most relevant research connects smoking, drinking, non-nutritional food, and sedentary activities to morbidity and mortality through the onset of cardiovascular diseases, diabetes, hypertension, and cancers (Adler et al., 1994).

The tendency of those struggling financially to adopt impulsive unhealthy behaviours despite the monetary costs is a puzzle which has not been addressed in a comprehensive way and is an area which requires more work (Pampel et al., 2010; French and Vigne, 2019). One behavioural attribute that may explain this relationship is time discounting. Discount rates have been found to change under situations of stress (Fields et al., 2014; Haushofer et al., 2015), causing individuals to become more present biased and engage in impulsive and risky health behaviours (Fields et al., 2014). Higher rates of intertemporal discounting have been correlated with cigarette smoking (Bickel et al., 1999; Mitchell, 1999; Reynolds et al., 2004; Adams, 2009), frequent alcohol consumption (Vuchinich and Simpson, 1998; MacKillop and Kahler, 2009), obesity (Komlos et al. 2004; Ikeda et al., 2010), illicit drug use (Madden et al., 1997; Coffey et al., 2003; Kirby and Petry, 2004), lack of physical exercise (Leonard et al., 2013) and mortality (Boyle et al., 2013).

There is a need to further understand the mix of financial strain causing impulsivity and worse health behaviours versus a reduction in the ability to afford unhealthy consumption due to lower spending power.

1.4. Current research and research gaps

Although the studies mentioned in Section 1.3 have made the association between financial difficulties and both biological and non-biological pathways to illness, no study to date has quantified the relative importance of each of these pathways. Current research would indicate that causality has largely been established but the

potential mediating and moderating variables are still not well understood. This is critical for identifying interventions to mitigate the health consequences of economic downturns as well as austerity programmes.

Literature has indicated that both impulsivity and stress are risk factors for negative health behaviours and subsequent ill health however there has been little work on understanding the causal mechanism from stress to time discounting to worse health-related behaviour. Particularly it is not clear as to the extent to which financial stress is different from other forms of stress. Do all forms of stress affect health behaviours such as smoking, drinking and fast food consumption in an equal manner? Subsequently, how can we understand the mix of financial strain causing impulsivity and suboptimal health behaviours versus a reduction in the ability to afford unhealthy consumption due to lower spending power?

It is not clear as to which mediating pathway from financial strain to worse health is most important. There is a need to compare both the behavioural pathway and biological pathway of financial strain to health by investigating the effects of financial strain on health as mediated by health behaviours versus the effects of financial strain on health as mediated by higher allostatic load.

There has been little research into potential moderators of the strain-health pathway (Sinclair et al., 2010); an area that would be beneficial for policy makers and health practitioners to identify which factors enable individuals to cope better with financial strain and which factors make individuals vulnerable to stress related illnesses. For example sexes differ in their response and coping mechanisms to stress in general (Lazarus and Folkman, 1984), with financial stress found to have more significant effects on the health of women (Ahnquist et al., 2007; Ahnquist et al., 2011). Additionally, employment has been found to have a buffering effect. Jahoda (1992) argues that employment provides psychological support through social contact, activity, status, purposefulness, time structure and being controlled. Other literature highlights how moderators such as marital support and social capital mitigate feelings of economic pressure (Reeves et al., 2014; Masarik et al., 2016). Individuals also report lower levels of worrying about debt where a partner has assumed financial responsibility for the household thus taking on the psychological burden

(Goode, 2012). A greater understanding of these individual level factors may help to explain the individual variation in the experience of financial strain.

The heterogeneous responses of households to financial strain are also not well understood. A broader knowledge of various household coping strategies used under situations of economic pressure is needed to allow for the design of improved policy initiatives and responses from the financial services industry. A number of studies highlight the variation in how households adjust their circumstances to financial hardship, with the number and variety of these adjustments impacting differently on psychological morbidity. For example, some households cope by reducing consumption, liquidating assets or increasing working hours. While on the other hand, some households do not address financial pressures through an economic response and these households may suffer adverse health consequences as severe as those who adjust too much. A number of studies in the field of psychology suggest that the connection between strain and health is non-linear. It is evident that being financially strained is detrimental to health but perhaps it is also equally damaging when households in supposedly difficult financial circumstances report no financial strain at all (Hughes et al., 2018).

No study has quantified the difference between the welfare impacts of chronic and acute strain. A sociological and a medical literature would argue that the effects are quite different with chronic stress being particularly injurious to health. According to Prior et al. (2018), chronic activation stimulates a cascade of dysregulations across multiple physiological systems, while the acute stress response is adaptive in the short-term and perhaps less influential to morbidity and mortality.

Alternatively, habituation may blunt the effects of financial strain over time. For example, in a US regional cross sectional study by Shen et al. (2014), it is shown how debt worries attenuate over time due to habituation as households get used to being in debt. Hence the roles of sensitization and habituation to financial problems would be another area requiring further research. For example, does the household become more worried or less worried about a persistent financial difficulty over time?

There are also a number of methodological concerns in the literature linking financial strain and illness. Many studies do not clearly establish evidence for a causal relationship from strain to health (Berkman et al., 2014). There is a need to use longitudinal data, clearly testing for a temporal ordering that indicates causation from strain to health. Moreover, in contrast to previous studies that have relied on experimental data or cross sectional studies, it is necessary to make use of non-experimental data to examine the links in the chain of causation.

The Office for National Statistics estimates that there were between 777,000 and 911,000 UK workers on zero-hours contracts in 2018Q4. The impact of the financial insecurity experienced by those in zero-hour or gig economy employment on diet, sleep, relationship problems and mental health is only now being studied. These workers have increased odds of developing a variety of health conditions and experience high levels of mental health problems (Bender and Theodossiou, 2018). With no right to statutory sick pay, anxiety, stress and depression can therefore be common. The welfare impact of flexible employment requires further research.

1.5. Research Contributions

1.5.1 Research aims

It is evident that the economics and health literatures document a strong association between financial strain and health however little work has been done to understand what it is in particular that drives this relationship. There is a need to go beyond this black-box view of causality and explore the underlying mechanisms of this connection. In order to achieve this, this PhD aims:

- To extend beyond current knowledge of the relationship between financial strain, mental and physical health and health related behaviours at the household level;
- To utilise the latest econometric techniques to further understand the causal mechanisms of the relationship between financial strain and health, and in

particular, test the role of various mediators and moderators with the use of longitudinal data.

1.5.2 Research objectives

These aims will be fulfilled by addressing the following objectives:

1. To conduct initial mediation analysis to investigate the role of time discounting as a mediator of the relationship between financial strain, health related behaviours and health using longitudinal household survey data.
2. To conduct additional longitudinal mediation analysis on a larger sample size to further investigate the behavioural pathway between financial strain and health, namely health behaviour as a mediator between strain and health and time discounting proxies as mediators of the relationship between strain and health behaviours.
3. To conduct total effects moderated mediation analysis to explore the moderating role of gender and employment status in the pathway from strain to health behaviours to health.
4. To evaluate alternative biological pathways through the use of biomarker data.
5. To develop a theoretical model which brings some of the rigour of lifetime economic decision-making models to bear on our understanding of the causes of financial strain. This will allow for a more complete analysis of the effects of low income, economic shocks, and liquidity constraints on self-reported financial difficulties than has been undertaken previously.
6. To utilise Becker's theory of investment in human capital (Becker, 1962) and Grossman's adaptation of this theory with specific focus on health (Grossman, 1972) to provide a theoretical framework for thinking about why some individuals chose optimising health behaviours while others behave otherwise.

The research aims and objectives will be fulfilled through three research papers.

Paper 1

In Paper 1, the effect of financial strain on physical health and health related behaviours is examined, and in particular, the extent to which changes in the rate of time discounting mediate the association between financial strain and health. We first develop a theoretical model based on lifetime economic decision-making models to improve our understanding of the causes of financial strain.

In order to conduct longitudinal mediation analysis and examine causal pathways, we require repeated measures for individuals and hence make use of data from the Dutch National Bank Household Survey from 1997-2002 as the time discounting variables of interest are only available for these dates. We use a sequential design, i.e. the time intervals between X, M and Y are staggered (e.g. the process $Xt-2 \rightarrow Mt-1 \rightarrow Yt$) (Mitchell and Maxwell, 2013). Such a model, presented by Cole and Maxwell (2003) is known as a cross lagged panel model and is based on structural equation modelling for repeated measures of X, M and Y in which each variable depends on both causally prior variables and on prior assessments of the same variable (Gollob and Reichardt, 1991). The cross-lagged panel model allows time for causes to have their effects, supports stronger inference about the direction of causation compared to models using cross sectional data, and reduces the probable parameter bias that occurs when using cross sectional data (Selig and Preacher, 2009).

The longitudinal mediation analysis is used to answer the following research questions:

1. To what extent does financial stress impact on physical health and health behaviours directly?
2. Does financial stress affect an individual's economic choice pattern, in particular, their discount rate?
3. Does time discounting act as a mediator between financial stress and health?

Our main conclusions are as follows: (1) Individuals experiencing financial stress report a lower level of self rated health, are more likely to be overweight, smoke and drink alcohol to excess. (2) After controlling for a large set of socioeconomic and

demographic characteristics, financial stress is not associated with the rate of time discounting. (3) Longitudinal mediation analysis reveals that time discounting does not act as a mediator between financial stress and any of our measures of health in this instance.

This article makes the following contributions. Currently, there are very few economic theories of financial strain. In this paper, we develop a theoretical model using lifetime economic decision-making models to broaden our understanding of the causes of financial strain. This allows for a more complete analysis of the effects of low income, economic shocks, and liquidity constraints on self-reported financial difficulties than has been undertaken previously. The study has greater breadth than in the literature reviewed as we not only consider the impact of financial stress on health, but also go beyond the black box view of causality and consider potential mediating variables in order to explain how this connection might exist. We address concerns in the literature linking stress and health about reverse causation and unmeasured confounders (Berkman et al., 2014) by carrying out sophisticated mediation analysis using longitudinal data controlling for individual heterogeneity. Furthermore, we make use of non-experimental data to examine the links in the chain of causation, in contrast to previous studies that have relied on experimental data or cross sectional studies.

Paper 2

In Paper 2, we again focus on financial strain as a particular stress and examine the behavioural pathway from financial strain to poor health to further explore the causal mechanisms.

Becker's theory of investment in human capital (Becker, 1962) and Grossman's adaptation of this theory with specific focus on health (Grossman, 1972) will be used as a theoretical framework for thinking about why some individuals chose optimising health behaviours while others behave otherwise. Health as a type of human capital can both depreciate and have investments made in it (Becker, 1962), with each individual possessing the ability to manipulate their own stock and differing in their willingness to undertake such investments i.e. they have different time preferences.

The mediation technique used in Paper 1 with data from the Dutch National Bank Household Survey from 1997-2017 will be adopted, first testing for the degree to which the effects of financial strain on health are mediated through changes in health behaviours as opposed to direct effects on biological processes. Research has shown that health behaviour acts as a key intermediating variable between financial problems and health (Drentea and Lavrakas, 2000). Secondly, we build on Paper 1 and re-analyse the links between financial strain, present-biases and changes in health behaviours in order to understand the lack of behavioural response to strain in our data given the extensive literature indicating the significance of this pathway. In this instance, we use four proxies for the rate of time discounting which each capture an aspect of impulsivity.

Having assessed the mediation effects, we attempt to determine if the strength of the mediation effect varies for different groups, i.e. males versus females and the employed compared to the non-employed. Hence, in the final part of our analysis we conduct a longitudinal moderated mediation analysis of both the indirect and direct pathways from strain to illness, an area where research is still limited (Sinclair et al., 2010). We examine two individual level moderators of the pathway between financial strain, health behaviours and health, namely gender and employment situation. Few studies have investigated whether the relationship between economic stress and health is different for women and men (Weekes et al., 2005; Ahnquist et al., 2007). Additionally few studies have addressed whether the relationship between financial strain and health varies according to employment status however the correlation between employment and health for the general population is well established and presented in several large-scale literature reviews and meta-analyses (Ross and Mirowsky, 1995; Mastekaasa, 1996; McKee-Ryan et al., 2005; Paul and Moser, 2009; Selenko and Batinic, 2011).

Consequently in Paper 2, we explore the following research questions:

1. To what extent does financial strain impact on self-assessed health and health behaviours directly?

2. Do health behaviours mediate the relationship between financial strain and health?
3. Does financial strain affect the degree of present bias exhibited by an individual?
4. Does present- bias mediate the relationship between financial strain and health?
5. Does the mediating effect of health behaviours in the financial strain- health relationship vary for different moderator variables i.e. gender and employment status?

Our main conclusions are as follows: 1) financial strain directly influenced self-rated health and health behaviours including smoking, heavy drinking and being overweight 2) health behaviours did not significantly mediate the relationship between financial strain and self-reported health 3) financial strain caused greater impulsivity but did not lead to worse health behaviours 4) the indirect effect of health behaviours in the financial strain- health pathway was larger for men but not statistically significant 5) the indirect effect of health behaviours in the financial strain- health pathway was also larger for those not in employment but not statistically significant.

This paper makes the following original contributions. We expand on the literature reviewed and consider potential mediating variables in order to explain how the connection between financial stress and health might exist. First, we examine the extent to which the response of health to financial strain is mediated by changes in health behaviours. Although many studies examine the behavioural sequelae of financial strain none to our knowledge quantify the relative importance of this pathway for health. Second, we examine the pathway from financial strain to changes in health behaviours to gain a greater understanding of the behavioural response. Using a number of different time preference measures we find evidence that financial strain causes greater impulsivity but this does not lead to worse health behaviours. Thirdly, we attempt to investigate the lesser-studied phenomenon of potential moderators of the indirect effect of financial strain on health via health behaviours using gender and employment status as moderators. By including interaction terms to test moderation in our meditational models we found that,

although statistically insignificant, being male and not employed slightly increased the indirect effect however there was no difference for those in employment compared to those that were not. We also found that being employed increased the direct effect of strain on health however this may have been due to how the variable was dichotomized, and suggest that it may be more helpful for future research to investigate the differences between unemployed and underemployed workers versus workers with stable jobs.

Our fourth contribution is that we address methodological concerns in the literature linking stress and illness. Many studies do not clearly establish evidence for a causal relationship from stress to health (Berkman et al., 2014). Using longitudinal data in our study, we clearly test for a temporal ordering that indicates causation from stress to health in our structural model. To avoid concerns about unmeasured confounders driving the relationship between financial strain and ill health, we use prior levels of the dependent variable in models of all the key variables (Cole and Maxwell, 2003). Furthermore, we make use of non-experimental data to examine the links in the chain of causation, in contrast to previous studies that have relied on experimental data or cross sectional studies.

Paper 3

The literature has indicated that the causal pathway from financial strain to poor health could be mediated through direct effects on biological processes. Hence in paper 3, allostatic load, described as a diminution of physiological functioning resulting from repeated and prolonged exposure to stressors (McEwen and Stellar, 1993; McEwen and Seeman, 1999), will be introduced to investigate the links between health and financial strain in the form of a negative wealth shock. Higher allostatic load has consistently been found to relate to mortality and worse health outcomes (Juster et al., 2010; Hwang et al., 2014).

The mediation and moderation methodology used in paper 1 and 2 will be repeated and extended in paper 3. However a change of dataset is used in order to develop a measure for allostatic load. The US Health and Retirement Study is employed as it contains a rich collection of biomarkers that can be used to construct a composite

index for allostatic load i.e. summarising the number of biomarkers falling into high-risk quartiles (Seeman et al., 1997). Focusing on a sample of retired households, some of the research questions answered in paper 3 include:

1. Does financial strain worsen allostatic load?
2. Is higher allostatic load associated with worse health?
3. Does allostatic load mediate the relationship between strain and health?
4. Is the behavioural or biological response to financial strain more important for health outcomes?

Our main conclusions are as follows: 1) a negative wealth shock has a large and statistically significant effect on self-reported health causing health to deteriorate across waves 2) meditation analysis provides some evidence that this effect is mediated not through changes in health behaviours but through biological changes in sensitive organ systems associated with exposure to stressors. This helps to confirm my prior work suggesting that the health-behavioural response to financial strain is relatively minor for health outcomes compared to the biological response to financial strain. The evidence in the empirical analysis is, however, at marginal levels of statistical significance.

The final research paper contributes to the literature in a number of ways. The broad existing literature on the wealth-health relationship is skeptical about causal effects of wealth or wealth shocks on adult health in developed countries, and so far physical health effects have only been documented for poor retirees in poor countries.[3] In this paper, we exploit stock market fluctuations in the wealth of elderly US retirees as a source of exogenous wealth shocks. In contrast to the existing literature, we find that wealth shocks significantly affect the health of elderly retirees in the United States. This paper is one of the first to our knowledge to report health impacts of wealth shocks on elderly in the developed world.

The second contribution is that we use a plausibly exogenous shock variable in the empirical analysis. By following the method of Schwandt (2018), an exogenous

[3] For reviews of the literature, see Smith (1999); Deaton (2003); Cutler et al., (2006); and Cutler et al., (2011).

shock is introduced by merging rich micro-data from the US Health and Retirement Study with aggregate stock market changes. The interaction of these macro shocks with a micro-level measure of the exposure to these shocks (the amount of stock holdings) allows us to better control for potential non-wealth effects of the macroeconomic environment. This natural experiment comes quite close to the ideal setting. Furthermore, this measure, the interaction of stock holdings with stock market changes, is of interest beyond the context of health economics. It could also be used to study, the effects of unearned income on labour supply, savings and consumption (Schwandt, 2018).

The third contribution is that this paper provides a broader understanding of the behavioural and biological pathways in the relationship between financial strain and health, which to date has been relatively understudied. We confirm our prior work suggesting that the health-behavioural response to financial strain is relatively minor for health outcomes compared to the biological response to financial strain, however results are at marginal levels of statistical significance.

Finally, this paper is one of the first to our knowledge that examines the specific relationship between financial strain and allostatic load in a longitudinal setting. Studies which have implicated stress exposure using allostatic load have typically focused on individual-level factors, such as socioeconomic status, poverty and adverse experiences (Gruenewald et al., 2012; Kakinami et al., 2013; Barboza Solís et al., 2015). By building on this work we find that economic hardships are positively associated with allostatic load (Patel, 2019).

1.6. Thesis outline

This PhD will take a three-paper format in the following arrangement:

- Chapter 1 - Introduction and background to the general topic area
- Chapter 2 – Paper 1:
  Time Discounting as a Mediator of the Relationship Between Financial Stress And Health: Evidence From The Dutch National Bank Household Survey

- Chapter 3 - Paper 2:

  Mediation and moderated mediation analysis of the relationship between financial strain and health: Evidence from the Dutch National Bank Household Survey
- Chapter 4 - Paper 3:

  An evaluation of the alternative mediating pathways from financial strain to worse health
- Chapter 5 - Conclusion and implications for policy and further research.

CHAPTER 2

TIME DISCOUNTING AS A MEDIATOR OF THE RELATIONSHIP BETWEEN FINANCIAL STRESS AND HEALTH: EVIDENCE FROM THE DUTCH NATIONAL BANK HOUSEHOLD SURVEY

Abstract

Individuals' choices often involve a trade-off between immediate gain and potential future reward. This phenomenon, known as time discounting, is one potential mechanism through which financial stress influences health. Stress causes a shift to a more immediate orientated mindset as demonstrated by more impulsive time discounting. In the attempt to relieve stress, individuals engage in unhealthy coping behaviours including overeating, smoking and excessive alcohol consumption, all of which lead to an increased likelihood of poor health. This paper uses mediation analysis to investigate time discounting as a mediator of the relationship between financial stress and health, using longitudinal data from the Dutch National Bank Household Survey from 1997-2002. A cross-lagged panel model was employed to address concerns of reverse causation and unmeasured confounders. Results indicate that the financially stressed exhibit worse health, are more likely to be overweight, smoke and drink excessively however evidence did not emerge of the mediating role of time discounting.

Key words: Financial Stress, Time Discounting, Present Bias, Unhealthy Behaviours, Longitudinal Data

2.1. Introduction

Household debt relative to disposable income has sharply increased in OECD countries in recent years, with many households facing debts that they are unable to cope with. In particular, the financial crisis at the turn of the century, preceded by irresponsible lending practices, produced some of the most significant economic shocks to European households and led to concerns about over-indebtedness (European Commission, 2008).

High levels of unpaid household debt have been linked to a reduced health status of those affected. Household debt, per se, is not a sign of financial strain as households need to borrow at various stages of the lifecycle. For example, the young need to borrow to invest in education or to set up a home and therefore high levels of debt in this group shouldn't necessarily cause problems (French, 2018). Others make frequent use of credit cards or obtain a consumer loan to finance private consumption, which allow them to enjoy an improved lifestyle (Guiso and Sodini, 2012). It is when these household debts escalate as a result of financial shock or individuals are unable to meet their debt repayments, for example, instances of unemployment, declines in house prices, increasing interest rates or illness, that it leads to financial stress (Turunen and Hiilamo, 2014). This suggested that the inability to borrow or liquidity constraints are the real cause of financial stress. The economic theory on lifetime consumption will be developed later in this paper as a useful framework for bringing together ideas on the causes of financial strain.

A number of studies have found that it is the subjective experience of feeling financially stressed which hinders the individual from making health maximising choices and impacts negatively on mental and physical health (Lange and Byrd, 1998; Selenko and Batinic, 2011; French and McKillop, 2015). However, the pathway of causation from financial stress to health at the household level remains relatively understudied and needs more exploration.

Stress can manifest itself as overt behaviours, but it can also lead to alterations in one's physical health, physiology, behaviour, affect and cognitions (Lupien and

Mcewen, 1997; Lupien et al., 2009). There is an emerging field of economic literature indicating that financial stress is linked to poor health through changes in time discounting, a phenomenon which involves making a trade off between immediate smaller reward versus future, higher gratification. The extent to which future gratification is discounted is referred to as the discount rate. Discount rates are believed to vary between individuals, and it has been found that they can be altered from situation to situation, with stress being a situation in which discount rates may change (Fields et al., 2014; Haushofer et al., 2015).

When individuals are under stress, they shift to a more immediate orientated mindset as demonstrated by more impulsive time discounting (Lawrance, 1991; Cornelisse, et al., 2013; Delaney et al., 2014; Haushofer et al., 2015). This is perhaps due to the reduction in cognitive performance (Muraven and Baumeister, 2000) or consumption of limited resources of self-control (Mani et al., 2013; Vohs, 2013) resulting from the exposure to stress. With the immediate goal being to relieve stress, individuals engage in maladaptive coping mechanisms such as risky health behaviours (Fields et al., 2014), for example, smoking, binge drinking, substance use and unhealthy food consumption (Nelson et al., 2008), all of which deliver immediate pleasure at the cost of potential future health risks.

This paper will use panel data from the Dutch National Bank Household Survey (DHS) to conduct longitudinal mediation analysis to examine the extent to which time discounting acts as mediator between financial stress and health. We hypothesise that financial stress works against an individual's typical impulse control patterns to shift from a more long-term focus on distal goals (saving money and health optimising behaviour) to a short-term focus on immediate rewards (spending immediately, smoking, alcohol consumption and eating unhealthy foods) (Tice et al., 2001) as represented by an increased rate of time discounting.

A full time lagged mediation analysis in the form of a cross-lagged panel model is conducted, which is based on structural equation modeling (SEM) for repeated measures of X, M and Y in which each variable depends not only on casually prior variables but also prior assessments of the same variable (Gollob and Reichardt, 1991). According to Cole and Maxwell (2003) and Preacher (2015) it is necessary

for some time to elapse between a cause and its associated effect to allow time for the effect to unfold, as this can yield more rigorous inferences about the causal relation implied than cross sectional designs. The cross-lagged panel model is estimated with MPlus version 7 and all analyses are conducted using robust weighted least squares (WLSMV) estimation (Muthen and Muthen, 1998-2011).

This article makes the following contributions. Currently, there are very few economic theories of financial strain. In this paper, we develop a theoretical model using lifetime economic decision-making models to broaden our understanding of the causes of financial strain. This allows for a more complete analysis of the effects of low income, economic shocks, and liquidity constraints on self-reported financial difficulties than has been undertaken previously. The study has greater breadth than in the literature reviewed as we not only consider the impact of financial stress on health, but also go beyond the black box view of causality and consider potential mediating variables in order to explain how this connection might exist. We address concerns in the literature linking stress and health about reverse causation and unmeasured confounders (Berkman et al., 2014) by carrying out sophisticated mediation analysis using longitudinal data controlling for individual heterogeneity. Furthermore, we make use of non-experimental data to examine the links in the chain of causation, in contrast to previous studies that have relied on experimental data or cross sectional studies.

Our main conclusions are as follows: (1) Individuals experiencing financial stress report a lower level of self rated health, are more likely to be overweight, smoke and drink alcohol to excess. (2) After controlling for a large set of socioeconomic and demographic characteristics, financial stress is not associated with the rate of time discounting. (3) Longitudinal mediation analysis reveals that time discounting does not act as a mediator between financial stress and any of our measures of health in this instance.

The structure of the paper is as follows. Section 2.2 presents the review of current literature; Section 2.3 presents the theoretical considerations; Section 2.4 presents the methodology and estimation procedure; Section 2.5 presents the empirical results;

Section 2.6 presents the robustness checks; Section 2.7 presents the discussion and Section 2.8 offers some conclusions and limitations of the study.

2.2. Literature Review

The association between financial stress and health has been studied before in an array of settings (Drentea and Lavrakas, 2000; Kahn and Pearlin, 2006; Keese and Schmitz, 2014; French and McKillop, 2015). Individuals' perceptions of their financial circumstances have been found to be a significant contributor to psychological health with financial stress or concern being linked to many types of mental disorders (Reading and Reynolds, 2001; Wildman, 2003; Cooke et al., 2004; Jessop et al., 2005; Bridges and Disney, 2010; Selenko and Batinic, 2011; Drentea and Reynolds, 2012). In particular, Turunen and Hillamo (2014) highlight that over-indebtedness is consistently associated with suicidal thoughts, depression and poorer subjective health assessments.

Evidence of the effect of financial stress on physical health is still forthcoming, however a number of studies have suggested that stress can lead to changes at the physiological level which impact on longevity and play a key role in disease pathogenesis, particularly those involving metabolic, immunological and cardiovascular systems (Cohen and Wills, 1985; Vitetta et al., 2005; McEwen, 2008). In particular, stress causes the body to react with a "fight-or-flight" response, leading it to release stress hormones such as adrenaline and cortisol. The body then adapts to these adverse conditions by developing a new level of equilibrium where the elevated levels of these chemicals can cause damage to vital bodily systems mentioned above (Vitetta et al., 2005; Choi, 2009).

In particular, the epidemiological and psychological literatures highlight that exposure to stress influences cardiovascular disease (Rozanski et al., 1999; Krantz and McCeney, 2002), upper respiratory infections (Miller and Cohen, 2005), autoimmune diseases (Heijnen and Kavelaars, 2005) and total mortality (Neilsen et al., 2008). Stress has also been linked to some cancers, although findings have been mixed. It is generally believed that stress is responsible for the progression and

recurrence of cancer rather than the initial onset of the disease (Cohen and Janicki-Denverts, 2012).

In terms of the economic literature, individuals suffering from high debt or financial stress (symptoms of which are representative of chronic stress according to medical research (Choi, 2009)) were found to have higher levels of physical impairment and illness than those with lower levels of financial stress (Drentea and Lavrakas, 2000). Specifically, Ferrie et al. (2005) and Georgiades et al. (2009) found greater incidences of coronary heart disease among the financially stressed, while Havlik et al. (1992) reported that twenty per cent of melanoma patients had suffered a major financial crisis involving bankruptcy or unemployment prior to clinical presentation. In addition, Ochsmann et al. (2009) report higher occurrences of back pain among those who sought the help of debt counselling agencies.

Stress can manifest as alterations not only to physical health and physiology, but also behaviour, affect and cognitions, which can influence susceptibility to and course of disease (Fields et al., 2014). Recent work has suggested that stress causes a shift in economic behaviour, leading to an increased discount rate (Lawrance, 1991; Lempert et al., 2002; Haushofer, 2011; Haushofer et al., 2011; Delaney et al., 2014; Fields et al., 2014; Haushofer et al., 2015). Haushofer et al. (2013) examined the effect of income shocks on time discounting in a laboratory experiment of participants who were assigned to “rich” and “poor” groups and found that negative income shocks increased discount rates over short time horizons, irrespective of wealth level. In particular, it has been found that financial shocks lead to increases in levels of the stress hormone cortisol among Kenyan farmers (Chemin et al., 2013); and elevated cortisol levels have been found to lead to an increase in temporal discounting (Cornelisse et al., 2013).

One explanation for the link between stress and time discounting is that stress leads to a behaviour shift from that which is goal directed to habitual or impulsive. There is no reconciliation as to the mechanism behind this shift to impulsivity (Fields, 2014) however a number of sources suggest that stress poses a cognitive load, impairing mental capacity and reducing self-control (Mooney et al., 2008; Mani et al., 2013; Haushofer and Fehr, 2014). The decision making process involved in time

discounting also requires the use of self control (Li, 2008), which has been described as a limited resource resembling a muscle (Muraven and Baumeister, 2000). Therefore, using up self-control in one area would increase time discounting in subsequent decisions (Angott, 2010). Hinson et al. (2003) demonstrated that taxing cognition in various ways led to higher discounting rates.

There is a rich literature linking increased rates of time discounting with suboptimal decisions and impulsive behaviours. A connection has been found with rates of time discounting and unhealthy behaviours such as cigarette smoking (Bickel et al., 1999; Mitchell et al., 1999; Reynolds, 2004; Khwaja et al., 2006; Adams, 2009; Fields et al., 2009; Ikeda, 2014) frequent alcohol consumption (Vuchinich and Simpson, 1998; Mitchell et al., 2005; MacKillop et al., 2005), illicit drug use (Madden et al., 1997; Kirby et al., 1999; Moeller et al., 2002; Coffey et al., 2003; Reynolds, 2006), lack of physical exercise (Chabris et al., 2008; Leonard et al., 2013) and health outcomes such as obesity (Smith et al., 2005; Borghans and Golsteyn, 2006; Weller, 2008; Zhang and Rashad, 2008; Ikeda et al., 2010), inflammation in later life (Delaney and Daly, 2014) and mortality (Boyle et al., 2013). From an economic perspective many of these behaviours involve a trade off between current pleasure and potential future health benefits. Foregone pleasures include loss of enjoyment from not eating a rich dessert or smoking a cigarette, or loss of time from spending an hour at the gym, while benefits could include decreased mortality or reduced probability of developing a life threatening illness in the future (Fuchs, 1982). Due to the evident influence of time discounting on health behaviours, it is crucial to understand the entire chain of causation driving this relationship so that changes in behaviour can be induced and maintained.

Another line of thought is that stress can influence health directly by increasing the frequency of unhealthy behaviours (Herbert & Cohen, 1994). Psychologists Folkman and Lazarus (1980) highlight health behaviours to be one of the many ‘‘ways of coping’’ with stress, for example eating, smoking and drinking alcohol are all behaviours that may help to alleviate stress and regulate mood state (Umberson et al., 2008), however research that has explicitly examined health behaviours as coping with stress are relatively limited (Park and Iacocca, 2013).

Assimilating the current literature, it can be hypothesised that when individuals experience financial stress, they shift to a more immediate-oriented mindset as represented by impulsivity and increases in the rate of time discounting. Consequently, individuals engage in risky health behaviours as a coping mechanism and, as a result, experience reduced states of physical and mental health. Figure 2.1. models this pathway along with a number of other potential mechanisms.

2.3. Theoretical Framework

Models of lifetime consumption can be used to explain the causes of financial strain. c_t represents consumption in period t, $u_t(c_t)$ within-period utility, β a discount factor, A_t net assets at the beginning of the period, y_t household income and the interest rate r_t for borrowing and saving. Following French and Vigne (2019), the head of an infinitely-lived household optimises consumption over time by solving the problem

$$max_{c_t} E\left[\sum_{t=0}^{\infty} \beta^t u_t(c_t)\right] \text{ subject to } A_{t+1} = (1 + r_{t+1})(A_t + y_t - c_t) \qquad [1]$$

In this basic model, households are permitted to hold debt. Younger households can rely on future income to pay down debt and subsequently invest in education and housing using borrowings. Hence, it can be difficult to gauge the extent of material hardship households are currently experiencing based on current income or current levels of debt (Sullivan et al., 2008). Intertemporal smoothing of consumption is useful in understanding that, although income is connected to financial strain at any time, changes in income over time do not generally reduce financial strain (Valentino et al., 2014). Also, there is variation in attitudes towards debt and overindebtedness depending on the country, time, socio-economic group and individual. Therefore, the objective level of debt doesn't give a clear picture of the impact on the household (Whelan et al., 2017). Despite this, many authors make the over-simple association of the stock of debt with financial difficulties (del Rio and Young, 2008; Christelis et al., 2009). The nature of the debt may provide more information, for example, non-collateralized debt such as credit card debt or non-performing debts with frequent creditor contact are known to generate especially high stress levels (Choi et al., 2016;

Dunn and Mirzaie, 2016).

Denoting the household's problem in the form of a Lagrangian, the household maximizes

$$L = E\left[\sum_{t=0}^{\infty} \beta^t u_t(c_t) - \sum_{t=0}^{\infty} \beta^{t+1}\lambda_t(A_{t+1} - (1 + r_{t+1})(A_t + y_t - c_t))\right]$$

where λ_t is the Lagrange multiplier for the budget constraint in time t. The Lagrange multipliers give the change in utility for a unit change in the budget constraint. This enables Hamermesh and Lee (2007) to associate subjective reports of financial strain with the Lagrange multiplier (French and Vigne, 2019). That is, households would enjoy an extra λ_t utils of happiness by the addition of an extra €1 to their household budget where λ_t is large for financially-strained households and small for households free of financial worries.

Optimality implies

$$\beta E_t[1 + r_{t+1}]\lambda_t = u_t'(c_t) \qquad [2]$$

and financial strain is then a function of the level of consumption at any time point. With CRRA preferences $u(c_t) = c_t^{1-\theta}/(1-\theta)$ and then optimality also implies

$$\lambda_t = E_t[\beta(1 + r_{t+2})\lambda_{t+1}] \implies c_t^{-\theta} = \beta E_t\left[(1 + r_{t+1})c_{t+1}^{-\theta}\right] \qquad [3]$$

If the growth rate of consumption is small then log-linearizing we get

$$E_t\left[\frac{c_{t+1}}{c_t} - 1\right] \approx E_t[\Delta \log c_{t+1}] \approx \theta^{-1}(E_t r_{t+1} + \log\beta) + \frac{\theta\omega_t^2}{2} \quad \text{(from [3])}$$

$$\implies E_t[c_{t+1}] \approx c_t(1 + \theta^{-1}(E_t r_{t+1} + log\beta) + \frac{\theta\omega_t^2}{2})$$

$$= c_t(1 + g(E_t r_{t+1}, \omega_t^2)) \qquad [4]$$

where $\omega_t^2 = var_t[\Delta log c_{t+1} - \theta^{-1} r_{t+1}]$.

Under the assumption that households do not plan to leave assets, the period budget constraint in [1] can be rewritten as a lifetime constraint

$$\sum_{k=0}^{\infty} \frac{c_{t+k}}{(1+r_{t+k})^k} = A_t + \sum_{k=0}^{\infty} \frac{y_{t+k}}{(1+r_{t+k})^k}$$

If interest rates and the variance term in consumption growth are constant in [4], we take expectations of both sides to get

$$c_t \sum_{k=0}^{\infty} \frac{(1+g)^k}{(1+r)^k} = A_t + \sum_{k=0}^{\infty} \frac{E_t y_{t+k}}{(1+r)^k}$$

$$\Longrightarrow c_t = \frac{r-g}{1+r} A_t + \frac{r-g}{1+r} \sum_{k=0}^{\infty} \frac{E_t y_{t+k}}{(1+r)^k} \qquad [5]$$

As in Meghir and Pistaferri (2011), we characterise the income process as the sum of a permanent and a transitory component:

$$y_t = \pi' \Gamma + p_t + \varepsilon_t$$
$$p_t = p_{t-1} + \zeta_t$$
$$\Longrightarrow y_{t+1} = y_t + \zeta_{t+1} + \Delta\varepsilon_{t+1} \qquad [6]$$

where Γ is a vector of time-invariant characteristics, ε_t is a qth-order moving average process[4] and p_t is a martingale process. Then

$$c_t = \frac{r-g}{1+r} A_t + \frac{r-g}{1+r} \sum_{k=0}^{\infty} \frac{E_t y_{t+k}}{(1+r)^k}$$

$$= \frac{r-g}{1+r} A_t + \frac{r-g}{1+r} \left(y_t \frac{y_t - \varepsilon_t}{1+r} + \frac{y_t - \varepsilon_t}{(1+r)^2} + \cdots \right)$$

[3] This model is a very popular specification in macroeconomics (Meghir and Pistaferri, 2011). It is motivated by theory developed in the Permanent Income hypothesis (Friedman, 1957) and empirical work on US and UK income time series (e.g. MaCurdy, 1982).

$$= \frac{r-g}{1+r}A_t + \frac{r-g}{1+r}\left(\frac{1+r}{r}(y_t - \varepsilon_t) + \varepsilon_t\right)$$

$$= \frac{r-g}{1+r}A_t + \frac{r-g}{r}y_t + \frac{g-r}{r(1+r)}\varepsilon_t \qquad [7]$$

The desirability of consumption across households i and time t is captured by a set of taste shifters ϕ_{it}. Then from [2] we have

$$\beta(1+r)\lambda_{it} = u'_{it}(c_t) = \phi_{it}u'(c_{it}) = \phi(w_{it})u'(c_{it})$$
$$= \phi(w_{it})\left(\frac{r-g}{1+r}A_t + \frac{r-g}{r}y_{it} + \frac{g-r}{r(1+r)}\varepsilon_{it}\right)^{-\theta}$$

from [7] and CRRA preferences

$$\Longrightarrow \quad \lambda_{it} = \lambda(w_{it}, A_{it}, y_{it}, \varepsilon_{it}) \qquad [8]$$

where w_{it} is a set of household variables including age of head of household, health of household members and the presence of children.

The equation in [8] motivates the choice of variables if not the functional form in subsequent empirical work. Furthermore, the theory provides guidance on the possible inclusion of additional variables if our assumptions are violated. For example, if interest rates are not constant, then expectations about interest rates would feature in [5] and ultimately in [8]. The presence of liquidity constrained households in our sample will imply the Euler equation for intertemporal allocation in [3] does not always hold (Deaton, 1992). These households accumulate further assets as insurance and therefore greater assets A_{it} in [8] does not always indicate less financial strain. An indicator that the household is subject to liquidity constraints could then be added to the specification in [8] (French and Vigne, 2019).

2.4. Methodology

2.4.1 Data

Data from De Nederlandsche Bank Household Survey (DNB) were used in this study. DNB is an online panel survey, representative of the Dutch population aged 16 and over, that has been active since 1993. The survey, collected by CentERdata (Tilburg University, the Netherlands) gathers information annually from a rotating panel of approximately 2000 households. Households without Internet access are given a device to access the Internet by means of their television sets, while households that do not have a television set are provided with one by CentERdata.

The data are grouped into eight categories, with six basic categories covering: (i) general information on the household; (ii) household and work; (iii) accommodation and mortgages; (iv) health and income; (v) assets and liabilities; (vi) economic and psychological concepts. Two more aggregated categories comprise: (vii) information on income and (viii) information on assets, liabilities, and mortgages of the households. All information is made freely available online to scholars [http://www.centerdata.nl/en/index.html] on an annual basis.

The survey is unique in that it allows longitudinal analysis of both the psychological and economic aspects of financial behaviour (Teppa and Vis, 2012). The current study will use all waves of data from the year 1997 to 2002, as the time discounting questions of interest are only available for these dates.

Households are recruited to the panel via a random national sample. They must complete a short survey on household characteristics, which are then stored in the database. If households do not complete questionnaires within six weeks of notification, they are dropped from the panel. It can be noted that response rates vary depending on the questionnaire and the particular questions within the questionnaire. There is also a significant dropout rate of approximately 25% each year. In order to deal with attrition, biannual refreshment samples are drawn in view of keeping the panel representative of the Dutch population aged 16 years and older. Further details

on survey methodology are provided in (Teppa and Vis, 2012).

In order to conduct longitudinal mediation analysis and examine casual pathways, we require repeated measures for individuals; therefore those who did not partake in three consecutive waves of the survey were dropped from the dataset leaving a dataset of 8074 observations. Despite this, a high rate of missingness was still evident for the key variables, as can be seen in Table 2.3. To account for item level missing data and obtain the maximum number of cases, multiple imputation (MI) was employed in MPlus for both continuous and categorical variables (Asparouhov and Muthen, 2010). The purpose of MI imputation is to handle missing data to achieve valid statistical inference, rather than re-create the individual missing values as close as possible to the true values (Schafer, 1997). We must assume that any missing data is missing at random (MAR) i.e. the probability of missing data on Y is unrelated to the value of Y after controlling for other variables in the analysis (Soley-Bori, 2013). There are no clear limits to the rate of missing data for MI (Gorelick, 2006) and some studies suggest rates as high as 60% are acceptable under the MAR assumption conditional on observed data (Kristman et al., 2004).

MI is carried out using the Bayesian method. Missing data is imputed but rather than imputations being based on a single data set, several data sets, based on previously observed data on the variables, are imputed using a Markov Chain Monte Carlo simulation, analysed separately and finally combined with standard errors adjusted for variability due to missing data (Rubin, 1987; Schafer, 1997). Fifty imputations (Graham et al., 2007; Enders, 2010) were carried out in this case to yield sufficient statistical power. Multiple imputation is less prone to parameter estimate bias, provides superior statistical power and takes better account of missing data sampling variability than case wise deletion or alternative missing data approaches (Sterne et al., 2009; Janssen et al., 2010; Feng et al., 2013).

2.4.2 Measurements

2.4.2.1 Health and Health-related behaviours

Our main measure of health is self-assessed health while our health related behaviours were tobacco smoking, alcohol consumption and being overweight. Self-

assessed health is derived from the question "In general, would you say your health is?" Answers are given according to a five-point ordinal response scale ranging from '5- poor' to '1-excellent'.[5] The use of self assessed health as a measure of actual health is often criticised due to its subjective nature, however, the measure has been proven to have value in predicting objective health outcomes, morbidity and mortality (Idler and Benyamini, 1997; Franks et al., 2003; Doorslear and Jones, 2003; Bridges and Disney, 2005). Furthermore, self-assessed health in a five-point response scale is a consistently used measure of health in surveys internationally, enabling cross-country comparisons to be made with ease (Cuesta et al., 2015).

The following question was asked to assess smoking status, "Do you smoke cigarettes at all?" Three possible responses were available: 1="No", 2= "Yes, I smoke every now and then" and 3= "Yes, I smoke every day". This variable was then dichotomised so as respondents could be classified as either smokers or non-smokers.

For alcohol consumption, respondents were asked about their typical daily alcohol consumption with the question "On average, do you have more than 4 alcoholic drinks a day?" with 1= "No" and 2= "Yes".

The survey provided self reported weight and height and so body mass index was calculated as weight in kilograms over the square of height in metres. Individuals were then classified as being either a normal weight (BMI <25 kg/m2) or overweight (BMI >25 kg/m2).

A limitation of the DNB survey is that it contains scarce information on other health-seeking behaviours such as regular exercise or consumption of fruit and vegetables, which would have potentially demonstrated a correlation with the rate of time discounting.

[5] The original scale was reverted so that the scale ranged from '1-poor' health to '5-excellent' health.

2.4.2.2 Financial Stress

Three different measures of financial stress were included in the model, subjective financial stress, the ratio of total consumer debt to total net annual household income and the ratio of total mortgage remaining to total net annual household income. We did not include objective debt figures but took the approach of Keese and Schmitz (2014), analysing the relative burden debt placed on the household's income, which is an adequate measure of debt intensity.

The independent variable, subjective financial stress, was collected by means of self-report, which required interviewees to state how well they could manage on the total income of their household. Responses were measured on an ordinal scale from '1-very hard' to '5-very easy'.

The ratio of total consumer debt to total net annual household income and the ratio of total mortgage remaining to total net household income were used as independent variables as a robustness check at the end of our analysis. The greater the value of these ratios, the higher the debt burden faced by the individual. In order to calculate the ratios, all consumer loans of the household including private loans, extended lines of credit, previously unmentioned outstanding debts, finance debts, loans from family or friends, study loans and credit card debts were summed to construct a total consumer loan value at the household level. Similarly, the values of total mortgage remaining for all mortgages held by the household were summed to give the total mortgage remaining value at the household level. Both the total consumer debt and the total mortgage remaining values were then divided by the total net annual household income.

2.4.2.3 Time Discounting

Starting from 1997, a consistent set of questions about time discounting was available in the DNB Household survey. Sixteen different questions are posed to respondents about the way they value opportunities in the present which subsequently represent their rate of time discounting. Each of these questions differs with four aspects, each aspect having two scenarios, resulting in sixteen questions in

total. 1) The amount of money concerned alternates between Dfl.1000 or Dfl. 100,000, 2) the time horizon is either three months or one year, 3) the amount of money is either to be received or paid and finally 4) the payment of the money can either be sped up or delayed (Tu et al., 2004). See appendix for the sixteen individual questions.

Annual discount rates for the two different time horizons and amounts of money were calculated as follows:

Three months, Dfl. 1000: $Discount\ rate = \left(\frac{x}{1000}\right)^4$

Three months, Dfl. 100,000: $Discount\ rate = \left(\frac{x}{100000}\right)^4$

One year, Dfl. 1000: $Discount\ rate = \left(\frac{x}{1000}\right)$

One year, Dfl. 100,000: $Discount\ rate = \left(\frac{x}{100000}\right)$

Where x represents the respondents answer to the various scenarios. Those with a preference for the more immediate smaller amount of money have a higher rate of time discounting than those with a preference for a longer time horizon and higher amount of money.

Table 2.1. shows the mean, standard deviation and percentage of observations reporting zero for the 16 time discounting measures for three of the six years analysed in the study. Note that only those observations with a discount rate of at most 120% are included to compute the descriptive statistics (Tu et al., 2004). Exponential discounting is assumed i.e. the same discount rate applies to a choice between outcomes available today versus next week as well as to a choice between outcomes available a year from today versus a year and a week from today (Samuelson, 1937).

Three variations of the time discounting measures were used in the study to test if there was any mediating effect of the rate of time discounting in the relationship between financial stress and health.

Firstly, factor analysis was performed using the principal factor method in order to obtain a discount rate for each individual, as recommended by Cole and Maxwell (2003) who state that researchers are turning to latent variable SEM with increasing regularity in order to test their mediational hypotheses (e.g., Dodge et al., 1995). The sixteen independent discounting variables were condensed into one underlying factor that is responsible for their covariation using Stata14 (StataCorp, 2015). Principal factors analysis uses the squared multiple correlation coefficient or some other measure as the basis for an assumption about communality (Yong and Pearce, 2013). Factor 1 accounted for the greatest amount of common variance (47.8%) representing an Eigenvalue of 2.539, therefore factor 1 was retained and factor scores, describing how much an individual would score on this factor, were used as the mediating variable representing time discounting in our analysis.

Secondly, we followed the method of Ikeda et al. (2010) and Takagi et al. (2015), using standardized values of the sixteen calculated discount rates and taking their average for further analysis as a measure of the respondent's discount rate.

It can be noted from table 2.1 that a high number of respondents give a zero value to the time discounting questions (approximately 44% on average across all discount rates for all years), indicating that they are unwilling to pay more or receive less for different time horizons. Therefore in the third case, we used the three variables with the lowest percentage of zero answers as mediators in the structural equation models for health and health behaviours.

2.4.2.4 Demographic controls

Age, gender, partner, level of education completed, number of children in the household, employment status, homeownership, annual total net household income and year effects were all controlled for. Variables that were dummy coded included partner (0=no partner, 1=partner), employment status (0=unemployed, 1=employed) and homeownership (0=non-homeowner, 1=homeowner). Level of education completed was included as a categorical variable with seven categories (no education, primary education, lower secondary education, higher secondary education, lower vocational education, higher vocational education and university

education). The survey records net household income as a categorical variable. This was recoded taking the midpoint of each category and upper (lower) interval boundaries for the lowest (highest) category.

2.4.3 Statistical Analysis

Causal mediation analysis was conducted to examine the direct effect of financial stress on health and various aspects of health behaviour, and the indirect associations via time discounting. The use of longitudinal data in this study will address some previous shortcomings in other papers where mediation analysis did not explicitly consider the role of time, despite the fact that it takes time for mediational effects to evolve (Maxwell et al., 2011) and furthermore, previous levels of the variables need to be controlled for or the paths in the mediation model may be over or underestimated relative to their true values (Selig and Preacher, 2009). Kraemer et al. (2008) stated "the necessity of using longitudinal studies with at least two and usually three time points to establish moderators and mediators" (p. 106). Gollob and Reichardt (1987) discuss the problems of using cross sectional data in detail.

We used a sequential design, i.e. the time intervals between X, M and Y were staggered (e.g. the process $X_{t-2} \rightarrow M_{t-1} \rightarrow Y_t$) (Mitchell and Maxwell, 2013). Such a model, presented by Cole and Maxwell (2003) is known as a cross lagged panel model and is based on structural equation modelling for repeated measures of X, M and Y in which each variable depends on both causally prior variables and on prior assessments of the same variable (Gollob and Reichardt, 1991). The cross lagged panel model allows time for causes to have their effects, supports stronger inference about the direction of causation compared to models using cross sectional data, and reduces the probable parameter bias that occurs when using cross sectional data (Selig and Preacher, 2009). The cross-lagged panel model for X, M and Y is shown in figure 2.2.

Path ab represents the indirect effect via time discounting while path c represents the direct effect from financial stress to health not via time discounting. Covariances among the variables at the first wave are included, as are covariances among the residual variances of X, M and Y at each wave.

This model can be expressed by the following three equations:

$$X_t = \beta_{X_{t-1}} X_{t-1} + \gamma^{X'} C_t + \zeta_{X_t}$$

$$M_t = \beta_{M_{t-1}} + \beta_{X_{t-1}} X_{t-1} + \gamma^{M'} C_t + \zeta_{M_t}$$

$$Y_t = \beta_{Y_{t-1}} + \beta_{M_{t-1}} M_{t-1} + \beta_{X_{t-2}} X_{t-2} + \gamma^{Y'} C_t + \zeta_{Y_t}$$

where X_t is the value of *X* at time *t,* $\beta_{X_{t-1}}$ represents the relationship between *X* at time *t* and the same construct measured at time *t*-1, $\gamma^{X'} C_t$ represents demographic controls and household characteristics and ζ_{X_t} represents the random disturbance that is different for each time point. The same interpretation can be applied to the corresponding terms in the equations for M_t and Y_t (Selig and Preacher, 2009).

Financial stress is regarded to be exogenous and is governed by a simple autoregressive model where the only explanatory variable is its own lag. Time discounting is also autoregressive but is additionally affected by a range of demographic and household controls. Health and health behaviours are autoregressive and affected by not only controls, but financial stress from two periods previously both directly and indirectly through the rate of time discounting in the previous period. By lagging the dependent variables, unmeasured and uncontrolled confounder variables are accounted for (Cole and Maxwell, 2003).

The mediation model is estimated on each triplet of three consecutive waves from 1999 (i.e. 1999, 1998, 1997) to 2002 (i.e. 2002, 2001, 2000) and parameters for both the stability and lagged effects were constrained to equality across all four triplets, making these parameters equivalent to 'average' effects over the duration of the panel (Berrington et al., 2006). In this way, intercepts and residuals variances can vary across time.

To account for the binary or categorical nature of our dependent variables, MPlus' default robust weighted least squares estimator was used (WLSMV) in which the diagonal weight matrix uses robust standard errors, and the chi-square test statistic is mean and variance adjusted (Muthén and Muthén, 1998–2004). Rather than listwise deletion the WLSMV estimator in Mplus uses the total available sample for analysis.

WLSMV is considered superior to "conventional" Maximum Likelihood when ordinal data on response variables are employed. With WLSMV, bivariate probit regressions are estimated for binary outcomes and ordered probit regressions for ordinal outcomes. The system was estimated using Mplus Version 7. Standard errors for the indirect effects were computed using the delta method (Sobel, 1982). According to Brown (2006), Mplus is the best software to deal with categorical data.

There is potential for reverse causality between financial stress and health. Financial stress causes ill health, however, ill health could cause financial stress through the effects of ill health on labour market status, therefore impacting on the ability to service debts. Health insurance in the Netherlands is compulsory and hence it can be ignored that health has a direct effect on debt due to medical expenses. Balmer et al. (2006) found that long-term illness and disability were the strongest predictors of debt. Furthermore, those experiencing poor health are likely to be less productive in the workforce and may become unemployed, reducing their ability to generate income or service debts, consequently leading to financial stress. To account for this, we include the direct pathway from health to financial stress and the indirect pathway from health to financial stress via time discounting as can be seen in Figure 2.3.

There are a number of reasons why the SEM method was chosen over other popular econometric methods for estimating dynamic panel models. One of its main strengths is its flexibility. It allows for complex causal structures with multiple dependent variables to be tested simultaneously. In longitudinal and hierarchical studies, both time-varying and invariant predictors can be included and effects can easily be allowed to vary over time. Furthermore, the SEM method allows for the incorporation of unobserved parameters and interaction between effects in a model. The other advantage of the SEM method is that it more accurately calculates the standard errors of the mediating relationship.

2.5. Results

Table 2.2 shows the number of individuals participating in each wave, the number of individuals who remained in the panel for three consecutive waves and the number of observations for each of the key variables each year from 1997 to 2002.

Descriptive statistics of all variables from the year 1997 to 2002 are presented in Table 2.3. It can be seen that the majority of respondents claim to be in good (62.29%) or excellent (14.90%) health, although despite this, 48.63% of the population are overweight, 28.45% are daily smokers and 7.88% drink alcohol excessively (>4 drinks daily). In terms of subjective financial stress, most people find it easy (45.55%) or neither hard nor easy (36.82%) to manage on the total income of their household. Only 6.62% of respondents find it hard or very hard to manage.

The objective measures of financial stress used later in the analysis are often only available for one member of the household and consequently, the dataset contains a lot of missing data for other members of the same household. The average ratio of total consumer debt to annual net household income was 4% while the average ratio of total mortgage debt to annual net household income was 101%.

Our sample has an approximately equal number of males and females, the mean age is 41.85 years and the mean annual total household net income is dfl. 60316.93.

The motivation for this research is twofold. Firstly, links have been established between perceived financial stress and health, however little work has been done to investigate what exactly drives this relationship. This study is the first to our knowledge that examines the links between financial stress and health through the mediator of time discounting.

Secondly, this perspective may be critically important for understanding the persistence of negative health behaviours such as smoking, drinking and eating unhealthy foods, despite widespread knowledge of their detrimental effects to future health and the many interventions targeted at changing them. If time discounting is found to mediate the relationship between financial stress and health, policies need to be designed which are aimed at enabling financially stressed individuals to make

optimal decisions that are in line with their long term economic and health interests. For example, some authors suggest increasing the availability of healthy food by low pricing campaigns to react to obesity caused by debt (Münster et al., 2009), while others call for interventions targeted at the cognitive mechanisms associated with discounting which are assumed to contribute to unhealthy behaviour, for example, working memory training (Story et al., 2014).

Figures 2.4, 2.5, 2.6 and 2.7 show the results of the mediation analysis of the effects of financial stress on health and health behaviours two years later mediated through changes in the time discounting factor one year later. The figures show the statistically significant pathways for the variables of interest omitting parameter estimates for the covariates and statistically insignificant pathways (see table 2.4 for full results).

The direct effect of financial stress at t-2 on self-rated health at time t and the indirect effect via time discounting at time t-1 were estimated via a structural equation model (figure 2.4). Financial stress at time t-2 has a statistically significant association with health at time t (path c) (β =-0.245). The rate of time discounting at time t was not influenced by financial stress at time t-2 (path a), nor did it influence self-rated health at time t (path b). This structural equation model was then re-estimated for each health behaviour individually (figure 2.5, 2.6 and 2.7) but results are practically identical. Being overweight, smoking and excessive alcohol consumption at time t are all predicted directly by financial stress at time t-2 (β =0.103, β =0.172, β =0.196 respectively) however there is no significant indirect effect of financial stress on health via time discounting (path a and b are both statistically insignificant).

Autoregressive effects ($X_{t-2} \rightarrow X_{t-1} \rightarrow X_t$, $M_{t-2} \rightarrow M_{t-1} \rightarrow M_t$, $Y_{t-2} \rightarrow Y_{t-1} \rightarrow Y_t$) were found to be statistically significant in all incidences across all four models. For all measures of health and health behaviours (self rated health, being overweight, smoking, excessive alcohol consumption), the effect of financial stress was entirely direct and there was no mediating or indirect effect of time discounting.

In figures 2.8, 2.9, 2.10 and 2.11, we repeat the mediation analysis to examine to what degree the effects of financial stress on health and health behaviours are mediated through the average of the standardized values of the sixteen discount rates.

Once again, the parameter estimates for the covariates are omitted in the figures but full results can be found in table 2.5.

Financial stress is seen to have a statistically significant direct effect on all four of the health measures; self rated health (β =-0.236) being overweight (β =0.111), smoking (β =0.173) and excessive alcohol consumption (β = 0.181). The estimates for the effects of financial stress on time discounting and the effects of time discounting on health reveal that there is no significant a or b pathways in any of the models, except for the structural equation model of being overweight where financial stress has a small statistically significant influence on time discounting (path a) (β =0.027).

In order to exhaust all possibilities of there being a mediating effect of the measures for the rate of time discounting in the relationship between financial stress and health, a final estimation was carried out using the three variables for the rate of time discounting which had the least number of zero responses. Results of this analysis can be found in table 2.6. A full set of controls including age, gender, education, whether employed, whether there was a partner present in the household, number of children, total annual household net income (log) and whether owner of current accommodation were used however for the sake of brevity they are not reported. The first set of results in panel A are estimates for the effect of financial stress on time discounting. Financial stress is seen to have a statistically significant effect on only one of the measures, d2, causing an increase in the rate of time discounting (β =0.023). The next set of results in panel B estimate the effects of time discounting on health and health behaviours once again omitting estimates for covariates. For self-rated health, being overweight and excessive alcohol consumption, there is no association with any of the measures for the rate of time discounting. Contrary to expectation, a higher discount rate (d3) is negatively associated with smoking (path b) (β =-0.251). The total effect of financial stress on health is once again found to consist of entirely direct effects for all health and health behaviours; self-rated health (β =-0.244), being overweight (β =0.1), smoking (β =0.172) and excessive alcohol consumption (β =0.176).

2.6. Robustness Checks

In this section we present a series of robustness checks that address two areas in particular, subjective financial stress versus actual debt measures and endogeneity.

The mediation analysis was repeated using objective measures of financial stress as the independent variable, including the ratio of total consumer debt to net annual household income and the ratio of mortgage debt to net annual household income (tables 2.7 and 2.8). Such measures were employed by Keese and Schmitz (2014).

In table 2.7, the ratio of total consumer debt to total net annual household income at time t-2 directly influences smoking at time t (β = 0.515) and the probability of being overweight at time t (β = 0.616) (path c) however there is no effect on self rated health or excessive alcohol consumption. No significant path a from stress to time discounting or path b from time discounting to health were found in any of the four models.

In table 2.8, there is a direct effect of the ratio of mortgage debt to net annual household income at time t-2 on the probability of being overweight (β = 0.062) (path c), however no statistically significant relationship emerged with any of the other measures of health. The mortgage debt ratio also has a significant effect on factor scores for the rate of time discounting within the structural equation model of being overweight and smoking (path a) (β = 0.108 and β = 0.084 respectively). As before, no significant path b from time discounting to health was found in any of the four models.

Findings in the cases where objective measures of financial stress (consumer debt ratio and mortgage debt ratio) were employed were less significant than the subjective measure and therefore in accordance with Lange and Byrd (1998) and Selenko and Batinic (2011), who state that subjective measures of financial stress may be more influential for health than objective measures.

Many studies linking stress and health are susceptible to concerns about reverse causation and unmeasured confounders (Berkman et al., 2014). Financial stress is widely known to cause poor health however poor health could equally cause

financial stress through the effects of ill health on labour market status, therefore impacting on the ability to service debts. As a result, the model was re-estimated incorporating endogeneity according to Model 7 found in Cole and Maxwell (2003, pp.563), where the direct pathway from health to financial stress and the indirect pathway from health to time discounting to financial stress were included in the structural equation model (figure 2.3) results of which can be found in table 2.9. Such a model helps to clarify causal order and to identify concurrent casual processes in which the meditational model may be embedded (Cole and Maxwell, 2003). In brief, health at t-2 was found to affect financial stress at time t in both the structural equation models for self rated health and smoking. In addition, the incorporation of endogeneity resulted in a reduction in the magnitude of the direct effect from financial stress to health in all four models.

2.7. Discussion

In this paper, we explore financial stress and in particular examine the behavioural pathway via time discounting from financial stress to self rated health and a number of health behaviours including being overweight, smoking and excessive alcohol consumption. Financial stress has a significant and sizeable direct effect on self reported health, being overweight, smoking and excessive alcohol consumption. The link between financial stress and self rated health alone is noteworthy as many studies relating financial difficulties and health do not clearly establish the direction of causation and do not fully account for confounders (Berkman et al., 2014). There is lack of a mediating pathway as financial stress was not found to influence time discounting, nor did time discounting have any effect on health in our data. This result is surprising given the extensive literature indicating the significance of this behavioural pathway.

One possible explanation for the lack of mediating effect of time discounting in the financial stress- health relationship could be due to problems with the actual measure for the rate of time discounting used in the DNB survey. One particular feature of the questions worth noting is that there are a large number of respondents that answer zero. In particular, after variable D4, the percentage of zero answers greatly increases. On average, approximately 50% of the answers are zero, indicating that

these respondents are unwilling to pay more or receive less.

In addition, all the questions involved purely hypothetical monetary choice tasks, assuming that participants are successful in an imaginative task (Locey et al., 2011). Individuals often cannot predict what they would do in certain situations. Reviews of decision experiments have found that real monetary rewards are stronger incentives than nominally equivalent hypothetical rewards (Smith and Walker, 1993; Camerer and Hogarth, 1999; Hertwig and Ortmann, 2001). According to Kirby (1997) real rewards, which are of true interest, may produce results different from those of hypothetical rewards with his analysis suggesting that real rewards are discounted to a greater extent than hypothetical rewards.

Furthermore, in this study we are assuming exponential discounting for rewards in line with normative economic theory (Lancaster, 1963; Meyer, 1976) i.e. the preference between an outcome now and in the future can be described by a single discount rate that is constant for all individuals and across all scenarios (Tu et al., 2004). However, a large body of evidence indicates that models of exponential discounting may not explain people's choices and hyperbolic discounting may fit the data more appropriately (Hoch and Loewenstein, 1991; Ainslie and Haslam, 1992; Kirby and Hernstein, 1995). Hyperbolic discounting infers that individuals have "time-inconsistent" preferences e.g. discount rates are higher for intertemporal trade offs that occur in the near future than for longer time horizons (Ainslie, 1991). In other words, an individual's preference may initially be for a large delayed reward compared to a smaller immediate reward, however as the smaller reward gets closer in time, its value hyperbolically increases and is preferred over the larger delayed reward. Although the larger reward is preferred in the present, as access becomes temporally closer, a preference reversal takes place because of the disproportionate changes in value, resulting in the preference for the imminent smaller reward (Cawley and Ruhm, 2011; DiClemente, et al., 2013). Odum et al. (2002) evaluated discounting on a group of smokers, using both an exponential and hyperbolic model, and found that the hyperbolic model provided a better fit between the two.

The lack of link between time discounting and health may be explained by the influence of the force of present biases increasing demand for each unhealthy consumption good (i.e. alcohol, cigarettes and unhealthy food) being outweighed by

the reduction in demand due to the lack of disposable income available to the financially stressed (French and McKillop, 2016). Karanikolos et al. (2016) similarly found lower overall alcohol consumption and improved diet occurred in developed countries as a result of the financial crisis, which they attribute to reductions in disposable income.

Despite the null result of the indirect pathway, the direct links between financial stress and self-rated health, being overweight, smoking and excessive alcohol consumption were strong in statistical significance. The negative affective states caused by stress are thought to influence health or the pathogenesis of physical disease via two general pathways: 1) by directly affecting biological processes and 2) by altering behavioural patterns that influence disease risk (Cohen et al., 2007).

Our results provide evidence for behavioural changes, other than that mediated through time discounting, that occur in response to stress, such as smoking (House el al., 1986; Steptoe et al., 1996), higher fat diets or greater fast food consumption (Steptoe et al., 1998; Laitinen et al., 2002; Ng and Jeffery, 2003) and increased alcohol consumption (Pearlin and Radabaugh, 1976; House et al., 1986; Jennision, 1992; Steptoe et al., 1998). Therefore, stress can influence health by increasing the frequency of unhealthful behaviours or alternatively, by decreasing the frequency of healthful behaviours (Herbert and Cohen, 1994). Psychologists Folkman and Lazarus (1980) highlight health behaviours to be one of the many ‘‘ways of coping’’ with stress, for example eating, smoking and drinking alcohol are all behaviours that may help to alleviate stress and regulate mood state (Umberson et al., 2008), however research that has explicitly examined health behaviours as coping with stress are relatively limited (Park and Iacocca, 2013). Numerous studies that consider the link between stress and health behaviours are based on cross sectional data or laboratory settings that rely on simulated studies, while our results provide longitudinal evidence of the unfolding of the relationship using a sample of the general population. Research that improves our understanding of health behaviours could greatly benefit public health, given the high levels of poor health behaviours evident in the UK and elsewhere around the world.

Secondly, the link between stress and self-rated health could be argued to be due to the contribution of psychological stress on physiological processes. Stress is known

to directly interfere with the regulation of immune and inflammatory processes (Cohen et al., 2007). The release of catecholamines in response to stressful events can interfere with control of physiological symptoms such as anti-inflammatory responses, metabolism of carbohydrates, fats and proteins; gluconeogenesis as well as regulation of cardiovascular, pulmonary, heptatic, skeletal, muscle and immune systems resulting in increased disease risk (McEwen, 1998). For example, evidence has revealed that stress is a contributor to depression (Hammen, 2005), cardiovascular disease (Esler et al, 2008; Richardson et al., 2012; Steptoe and Kivimäki, 2012), delayed wound healing (Broadbent et al., 2012), upper respiratory infections (Graham et al, 1986; Pederson et al., 2010), autoimmune diseases (Stojanovih and Marisavlijevich, 2008), greater symptom reporting (Cropley and Steptoe, 2005) and total mortality (Rutters et al., 2014).

There are however a lack of biological markers in the data to officially test the physiological response to stress i.e. inflammatory biomarkers or levels of glucose control, hence further research is required. However, as self-rated health has proven validity as a predictor of objective health (Idler and Benyamini, 1997; Franks et al., 2003; Bridges and Disney, 2005), the significant negative association of this measure with stress gives some indication of the physiological effects of stress. A recent meta-analysis finds those who report "poor" health have a twofold higher risk of all-cause mortality relative to those who report "excellent" health (DeSalvo et al., 2006).

2.8. Conclusions and limitations

We have focused on relations between financial stress and health, and the pathway by which these relations might exist. In general, it can be concluded that stress occurs when a person perceives a situation as threatening or demanding, senses that it is important to respond and doesn't have an appropriate coping response immediately to deal with it (Herbert and Cohen, 1994). Stress can then lead to poor psychological states such as depression or anxiety which in turn are thought to influence health, either directly via physiological processes that influence disease pathogenesis or through behavioural patterns, for example smoking, excessive alcohol consumption or being overweight, that can then contribute to disease or mortality (Steptoe et al, 1996). Despite expectation, there was surprisingly no mediating role of time discounting in the stress-health relationship, however a

number of explanations as to why this may be the case were given i.e. problems with the measures for the rate of time discounting, hypothetical versus real rewards, exponential versus hyperbolic discounting and present biases being outweighed by lack of disposable income.

This study uses nationally representative data, which permits longitudinal analysis of causation and therefore addresses numerous methodological concerns prevalent in the literature regarding financial stress and health and mediation analysis methods. There are however a number of limitations to this paper. There is a lack of measures on the biological responses to stress in the data (for example, inflammatory biomarkers, levels of glucose control), which, if present, would allow testing of the physiological effects of stress on health. Furthermore, additional data on other health behaviours associated with stress e.g. physical exercise and poor adherence to medical advice may have provided more insight into the pathway of study. The model considered in the analysis examined the effects of financial stress on health over a three-year window but taking measures at annual intervals may miss the more immediate responses of health and health behaviours to financial stress therefore misrepresenting the effect sizes (Cole and Maxwell, 2003).

Appendix

Time discounting questions

TIJD1N

Imagine you win a prize of Dfl. 1000 in the National Lottery. The prize is to paid out today. Imagine, however, that the lottery asks if you are prepared to wait THREE MONTHS before you get the prize. There is no risk involved in this wait.

How much extra money would you ask to receive AT LEAST to compensate for the waiting term of three months? If you agree on the waiting term without the need to receive extra money for that, please type 0 (zero).

AT LEAST a compensation of Dfl.....TIJD2N

TIJD2N

Now imagine that the National Lottery asks if you are prepared to wait A YEAR before you get the prize of Dfl. 1000. There is no risk involved in this wait.

How much extra money would you ask to receive AT LEAST to compensate for the waiting term of a year? If you agree on the waiting term without the need to receive extra money for that, please type 0 (zero).

AT LEAST a compensation of Dfl. TIJD3N

TIJD3N

Now imagine that the prize you win in the National Lottery is worth Dfl. 100,000. The prize is to be paid out today. Imagine, again, that the lottery asks if you are prepared to wait THREE MONTHS before you get the prize. There is no risk involved in this wait.

How much extra money would you ask to receive AT LEAST to compensate for the waiting term of three months? If you agree on the waiting term without the need to receive extra money for that, please type 0 (zero).

AT LEAST a compensation of Dfl. TIJD4N

TIJD4N

Now imagine that the National Lottery asks if you are prepared to wait A YEAR before you get the prize of Dfl. 100,000. There is no risk involved in this wait.

How much extra money would you ask to receive AT LEAST to compensate for the waiting term of a year? If you agree on the waiting term without the need to receive extra money for that, please type 0 (zero).

AT LEAST a compensation of Dfl. TIJD5N

TIJD5N

Imagine you have to pay a tax assessment of Dfl. 1000 today. Suppose that you could wait THREE MONTHS with settling the tax assessment.

How much extra money would you be prepared to pay AT MOST to get the extension of payment of THREE MONTHS? If you are not interested in getting an extension of payment or if you are not prepared to pay more for the extension of payment, please type 0 (zero).

AT MOST Dfl. … extra. TIJD6N

TIJD6N

Imagine again that you have to pay a tax assessment of Dfl. 1000 today. Suppose that you could wait A YEAR with settling the tax assessment.
How much extra money would you be prepared to pay AT MOST to get the extension of payment of A YEAR? If you are not interested in getting an extension of payment or if you are not prepared to pay more for the extension of payment, please type 0 (zero).

AT MOST Dfl. …extra. TIJD7N

TIJD7N

Imagine you receive an assessment for tax arrears of Dfl. 100,000. Suppose that you could wait THREE MONTHS with settling the tax assessment.

How much extra money would you be prepared to pay AT MOST to get the extension of payment of THREE MONTHS? If you are not interested in getting an extension of payment or if you are not prepared to pay more for the extension of payment, please type 0 (zero).

AT MOST Dfl. …extra. TIJD8N

TIJD8N

Imagine again that you receive an assessment for tax arrears of Dfl. 100,000. Suppose that you could wait A YEAR with settling the tax assessment.

How much extra money would you be prepared to pay AT MOST to get the extension of payment of A YEAR? If you are not interested in getting an extension of payment or if you are not prepared to pay more for the extension of payment, please type 0 (zero).

AT MOST Dfl. … extra. TIJD9N

TIJD9N

Imagine you receive notice from the National Lottery that you have won a prize worth Dfl. 1000. The money will be paid out after THREE MONTHS. The money can be paid out at once, but in that case you receive less than Dfl. 1000.

How much LESS money would you be prepared to receive AT MOST if you would get the money at once instead of after three months? If you are not interested in receiving the money earlier or if you arenot prepared to receive less for getting the money earlier, please type 0 (zero).

AT MOST Dfl. ... LESS. TIJD10N

TIJD10N

Imagine again that you receive notice from the National Lottery that you have won a prize worth Dfl. 1000. The money will be paid out after A YEAR. The money can be paid out at once, but in that case you receive less than Dfl. 1000.

How much LESS money would you be prepared to receive AT MOST if you would get the money at once instead of after a year? If you are not interested in receiving the money earlier or if you are not prepared to receive less for getting the money earlier, please type 0 (zero).

AT MOST Dfl. … LESS. TIJD11N

TIJD11N

Imagine you receive notice from the National Lottery that you have won a prize worth Dfl. 100,000. The money will be paid out after THREE MONTHS. The money can be paid out at once, but in that case you receive less than Dfl. 100,000.

How much LESS money would you be prepared to receive AT MOST if you would get the money at once instead of after three months? If you are not interested in receiving the money earlier or if you are not prepared to receive less for getting the money earlier, please type 0 (zero).

AT MOST Dfl. … LESS. TIJD12N

TIJD12N

Imagine again you receive notice from the National Lottery that you have won a prize worth Dfl. 100,000. The money will be paid out after A YEAR. The money can be paid out at once, but in that case you receive less than Dfl. 100,000.

How much LESS money would you be prepared to receive AT MOST if you would get the money at once instead of after a year? If you are not interested in receiving the money earlier or if you are not prepared to receive less for getting the money earlier, please type 0 (zero).

AT MOST Dfl. … LESS. TIJD13N

TIJD13N

Imagine you receive a tax assessment of Dfl. 1000. The assessment has to be settled within THREE MONTHS. It is, however, possible to settle the assessment now, and in that case you will get a REDUCTION.

How much REDUCTION would you like to get AT LEAST for settling the assessment now instead of after three months? If you are not interested in getting a reduction for paying early or if you think there is no need to get a reduction for paying early, please type 0 (zero).

AT LEAST a reduction of Dfl. TIJD14N

TIJD14N

Imagine again that you receive a tax assessment of Dfl. 1000. The assessment has to be settled within A YEAR. It is, however, possible to settle the assessment now, and in that case you will get a REDUCTION.

How much REDUCTION would you like to get AT LEAST for settling the assessment now instead of after a year? If you are not interested in getting a reduction for paying early or if you think there is no need to get a reduction for paying early, please type 0 (zero).

AT LEAST a reduction of Dfl. TIJD15N

TIJD15N

Imagine you receive a tax assessment of Dfl. 100,000. The assessment has to be settled within THREE MONTHS. It is, however, possible to settle the assessment now, and in that case you will get a REDUCTION.

How much REDUCTION would you like to get AT LEAST for settling the assessment now instead of after three months? If you are not interested in getting a reduction for paying early or if you think there is no need to get a reduction for paying early, please type 0 (zero).

AT LEAST a reduction of Dfl. TIJD16N

TIJD16N

Imagine you receive a tax assessment of Dfl. 100,000. The assessment has to be settled within A YEAR. It is, however, possible to settle the assessment now, and in that case you will get a REDUCTION.

How much REDUCTION would you like to get AT LEAST for settling the assessment now instead of after a year? If you are not interested in getting a reduction for paying early or if you think there is no need to get a reduction for paying early, please type 0 (zero).

AT LEAST a reduction of Dfl. ..... ROUTING VARIABLE 7

Figures and Tables

Figure 2.1: Links between financial stress and health

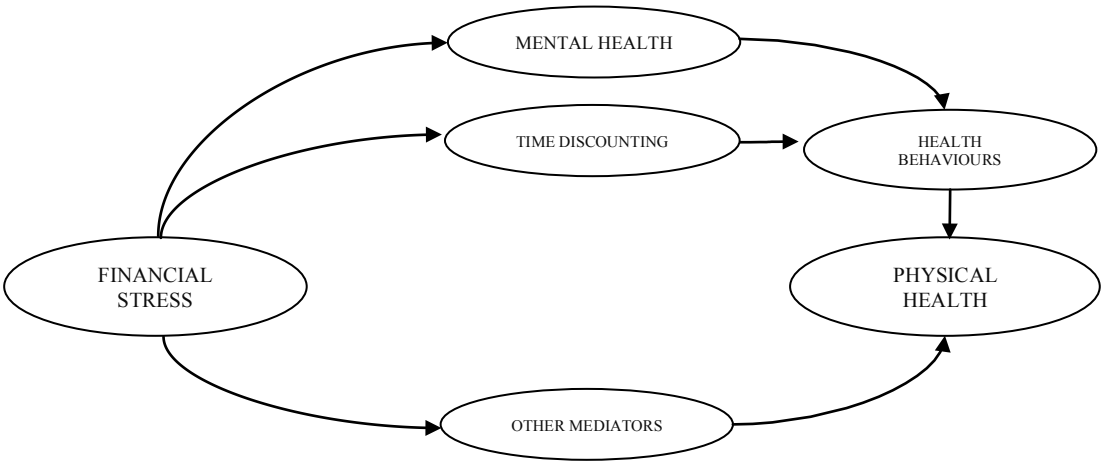
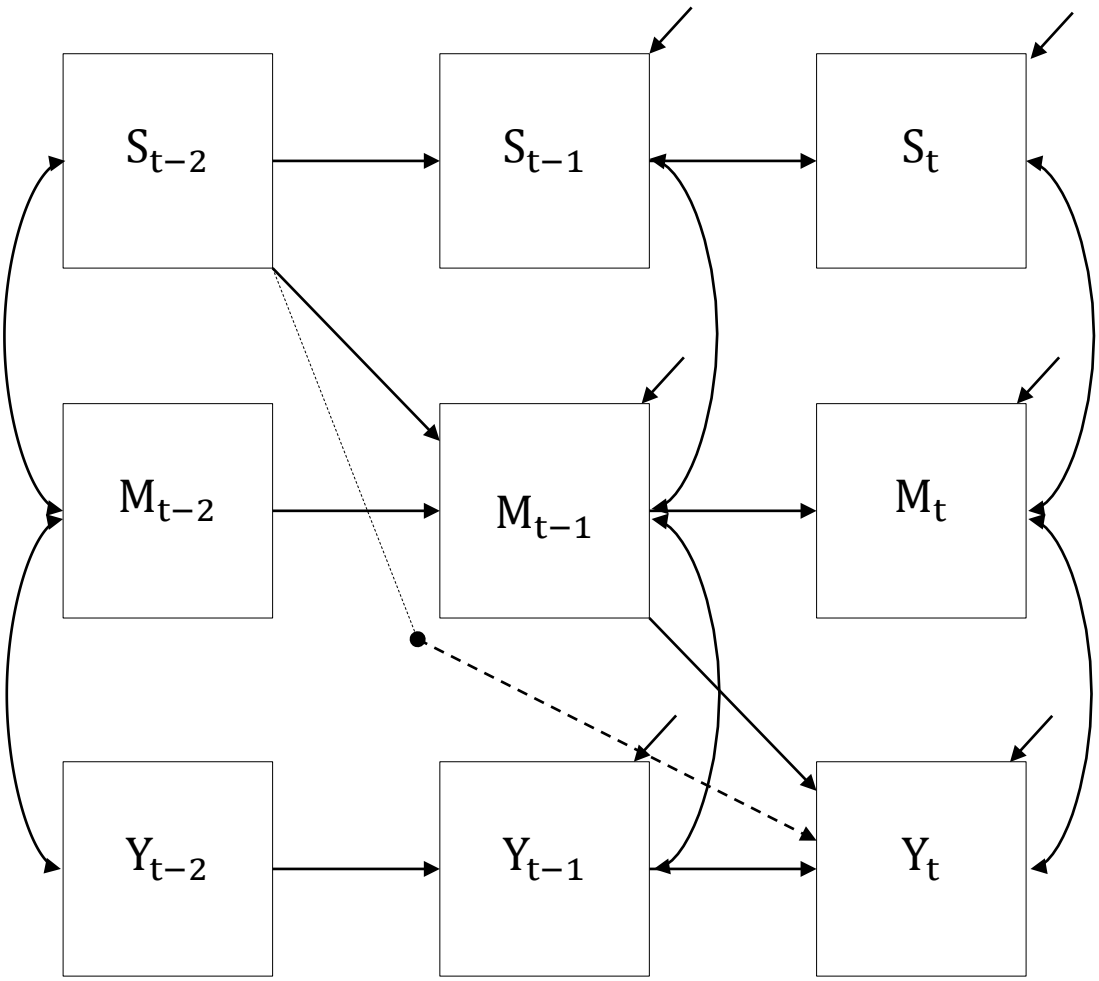
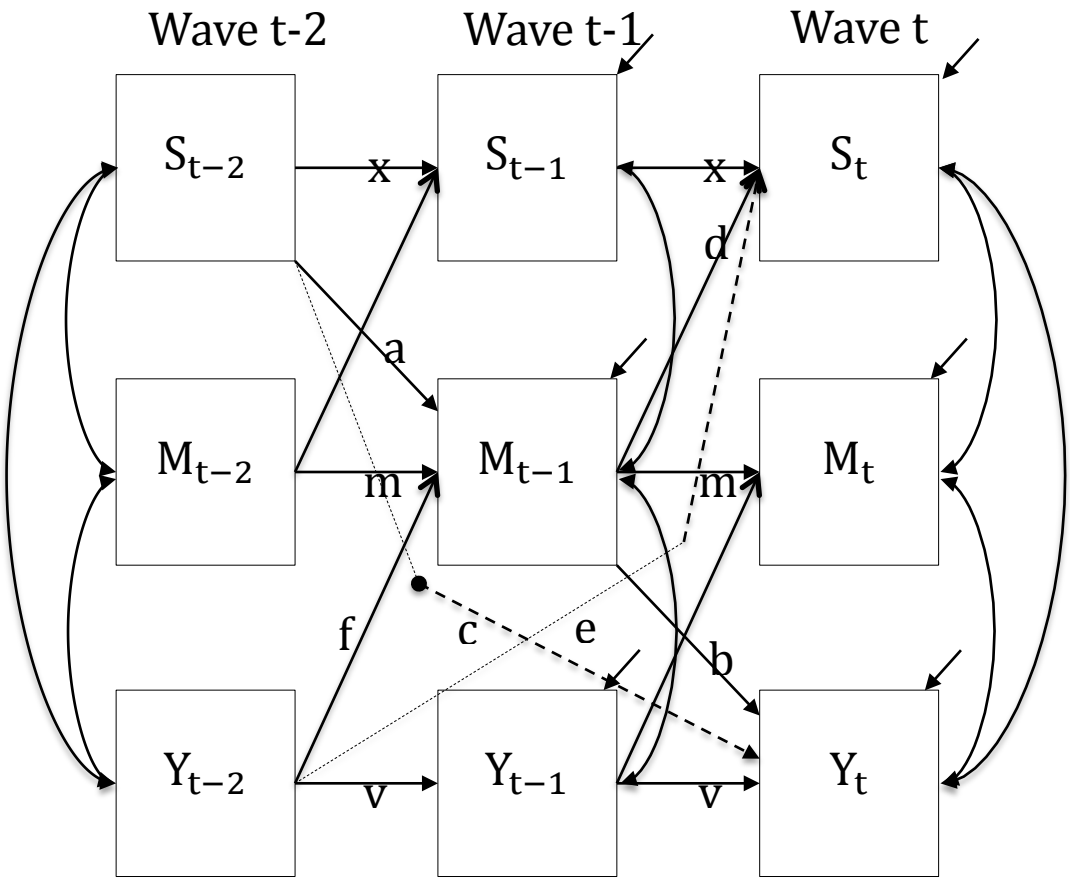


Figure 2.2: Three-wave autoregressive model of the effect of financial stress (S_{t-2}) on health outcome (Y_t) mediated by changes in time discounting (M_{t-1})



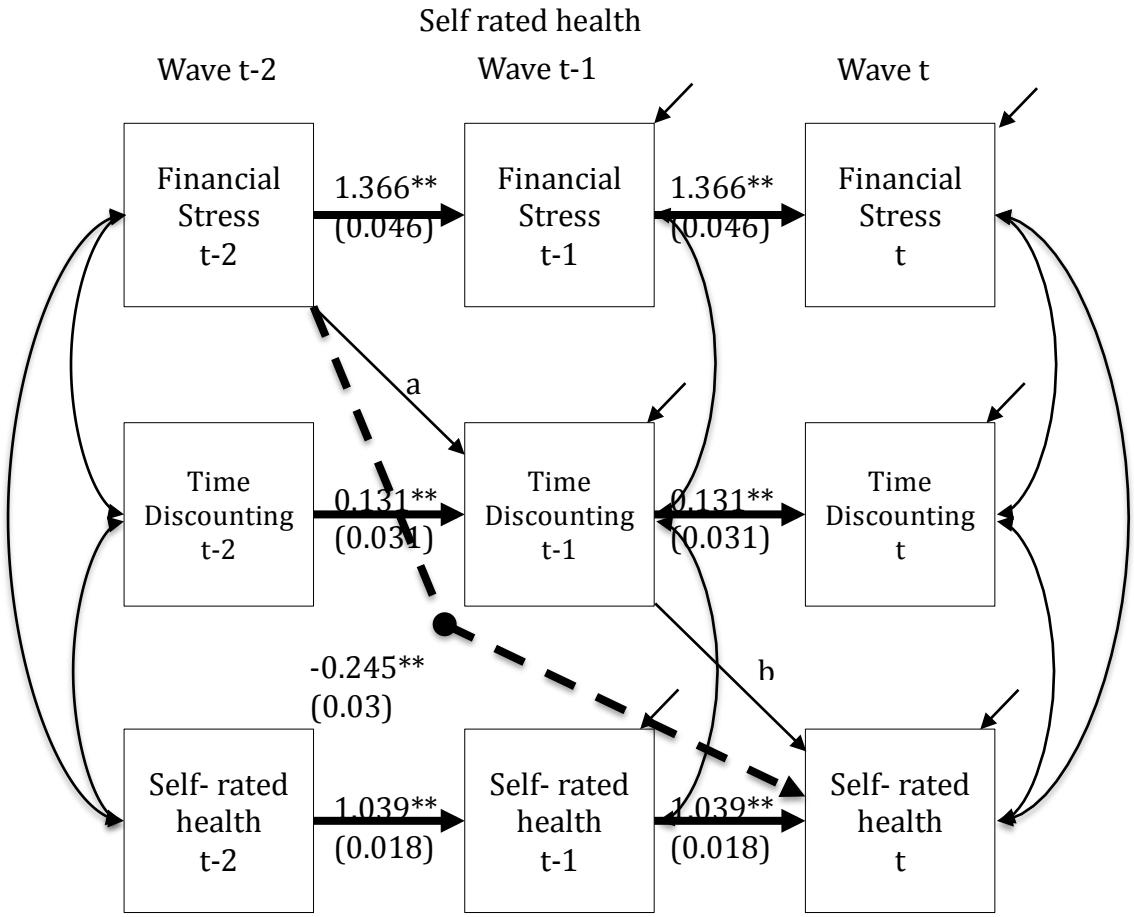
Notes: Additional demographic and household control applied to the health outcome and mediator models.

Figure 2.3: Three-wave autoregressive model of the effect of financial stress (S_{t-2}) on health outcome (Y_t) mediated by changes in time discounting (M_{t-1}) accounting for endogeneity



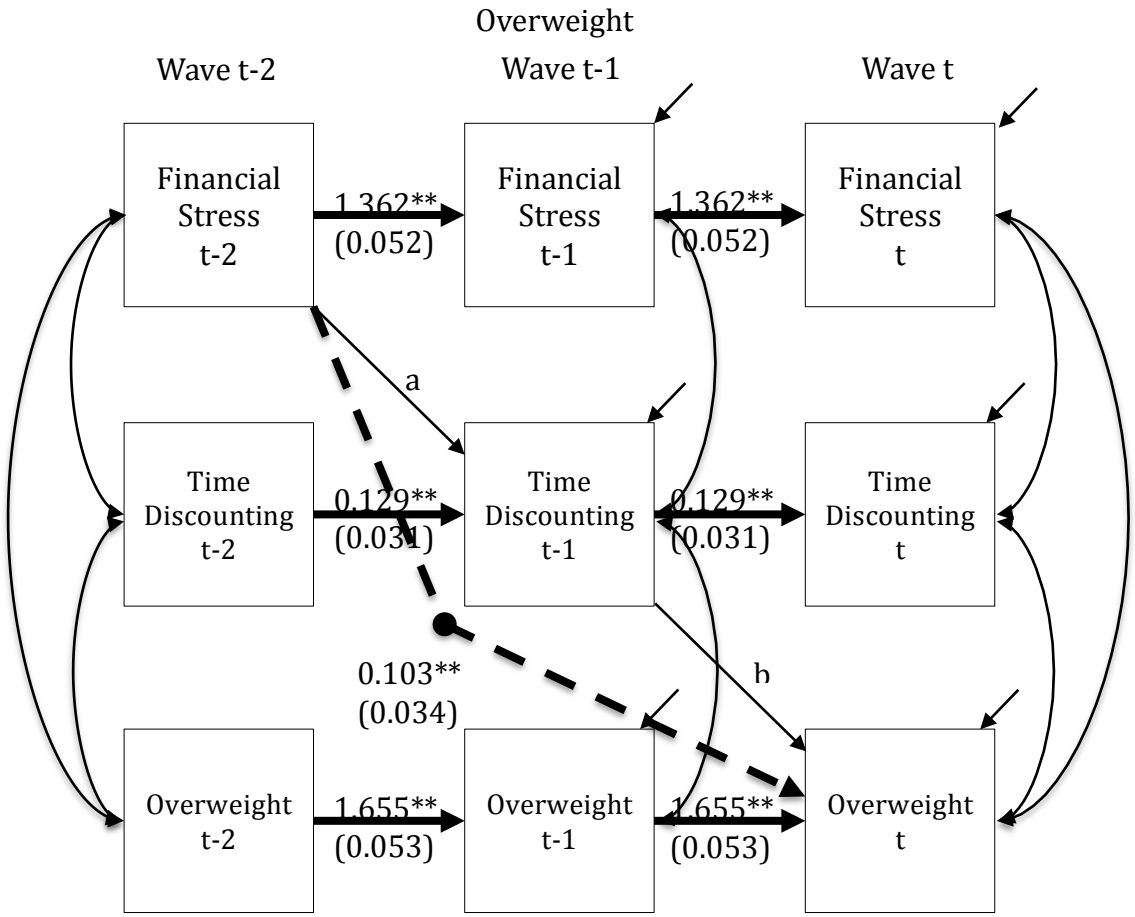
Notes: Additional demographic and household control applied to the health outcome and mediator models.

Figure 2.4: Results of the three-wave autoregressive model of the effect of financial stress (t-2) on self rated health (t) mediated by changes in time discounting factor (t-1)



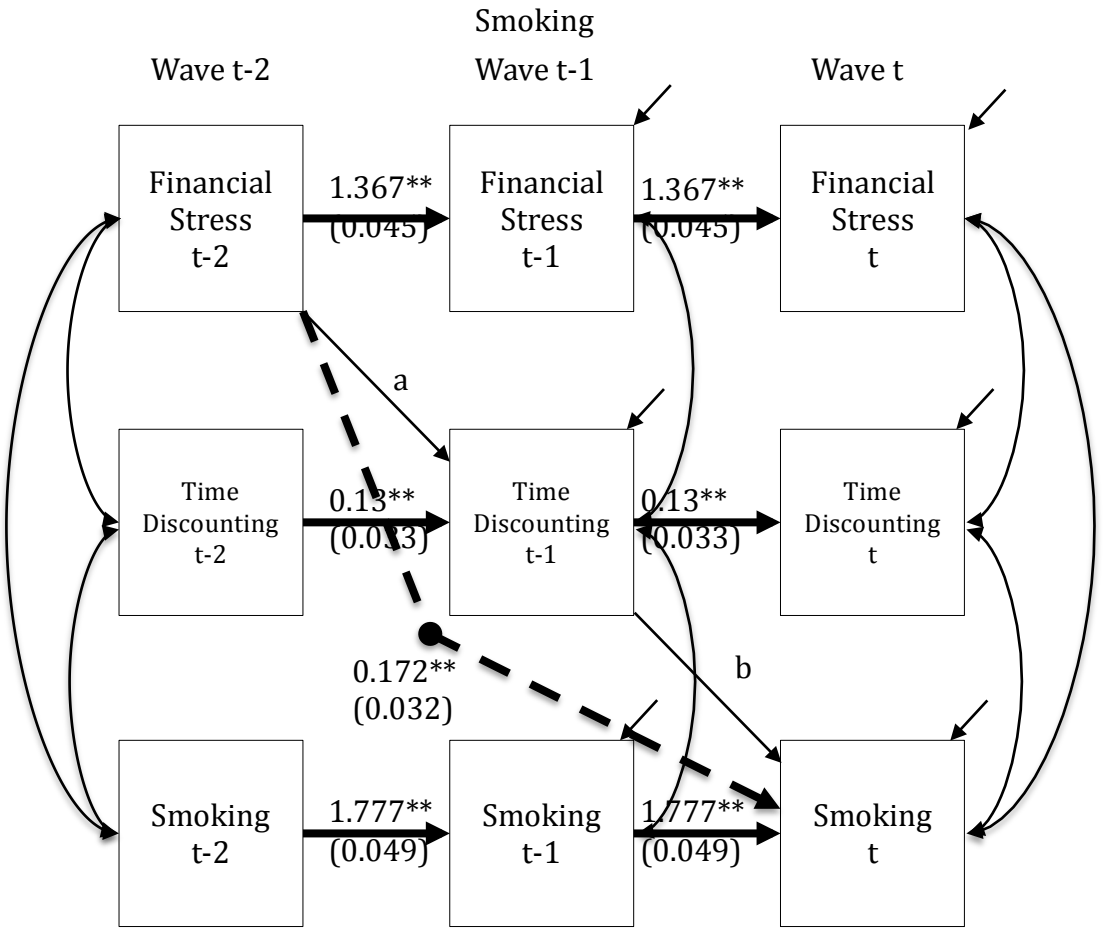
Notes: Additional demographic and household control applied to the health outcome and mediator models.

Figure 2.5: Results of the three-wave autoregressive model of the effect of financial stress (t-2) on being overweight (t) mediated by changes in time discounting factor (t-1)



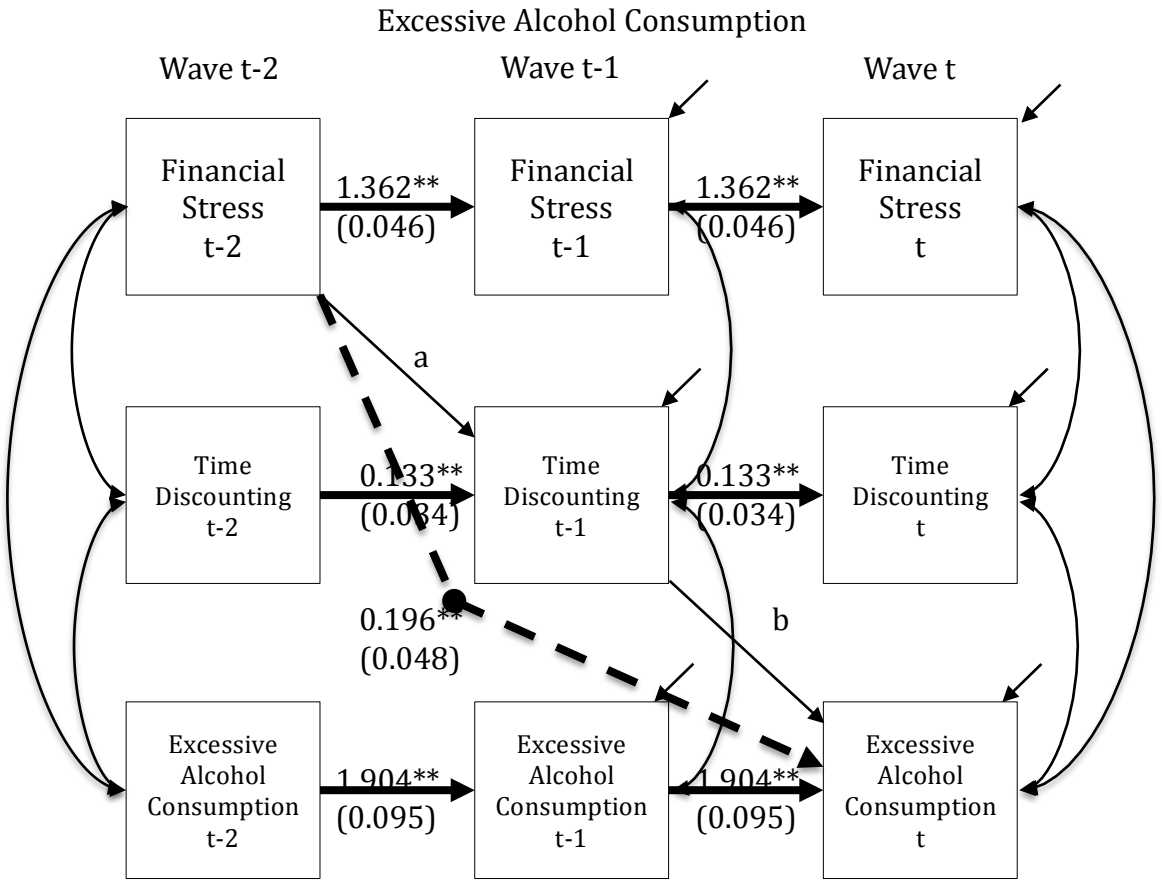
Notes: Additional demographic and household control applied to the health outcome and mediator models.

Figure 2.6: Results of the three-wave autoregressive model of the effect of financial stress (t-2) on smoking (t) mediated by changes in time discounting factor (t-1)



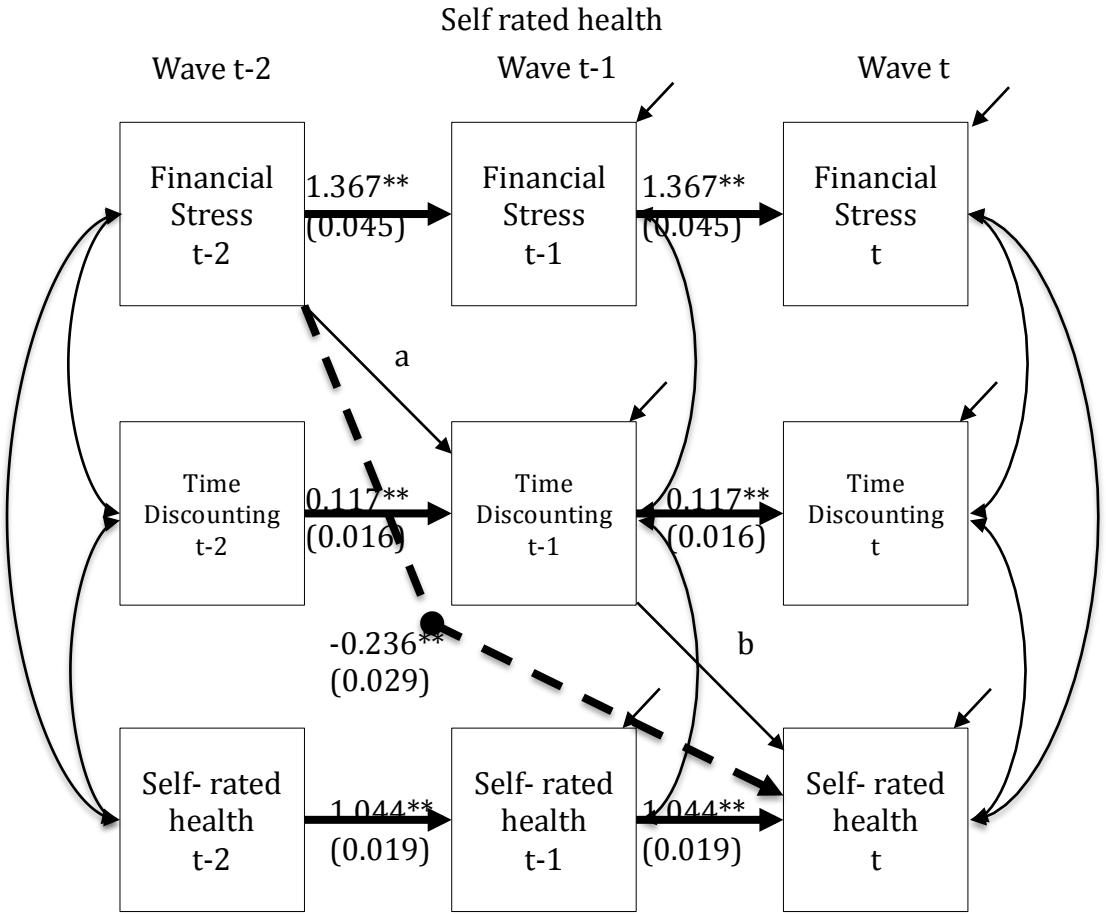
Notes: Additional demographic and household control applied to the health outcome and mediator models.

Figure 2.7: Results of the three-wave autoregressive model of the effect of financial stress (t-2) on excessive alcohol consumption (t) mediated by changes in time discounting factor (t-1)



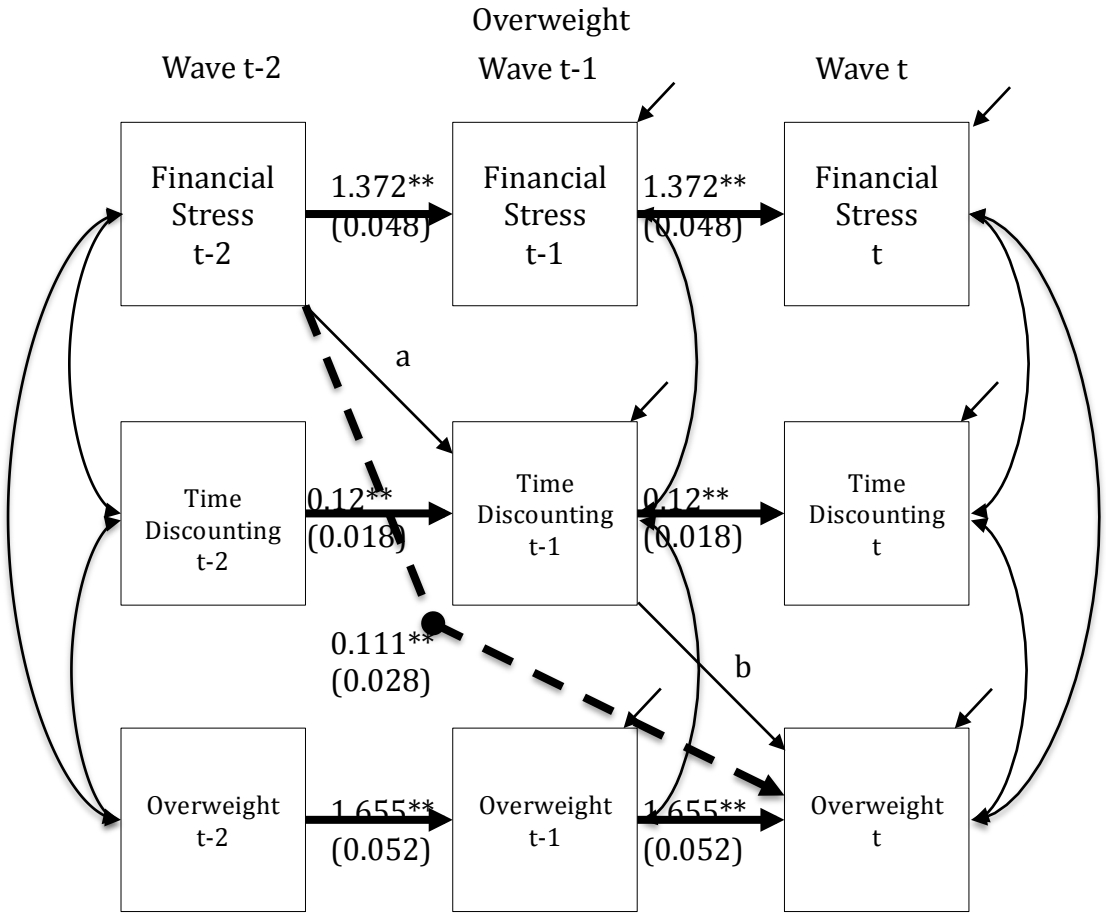
Notes: Additional demographic and household control applied to the health outcome and mediator models.

Figure 2.8: Results of the three-wave autoregressive model of the effect of financial stress (t-2) on self rated health (t) mediated by changes in the average standardized rate of time discounting (t-1)



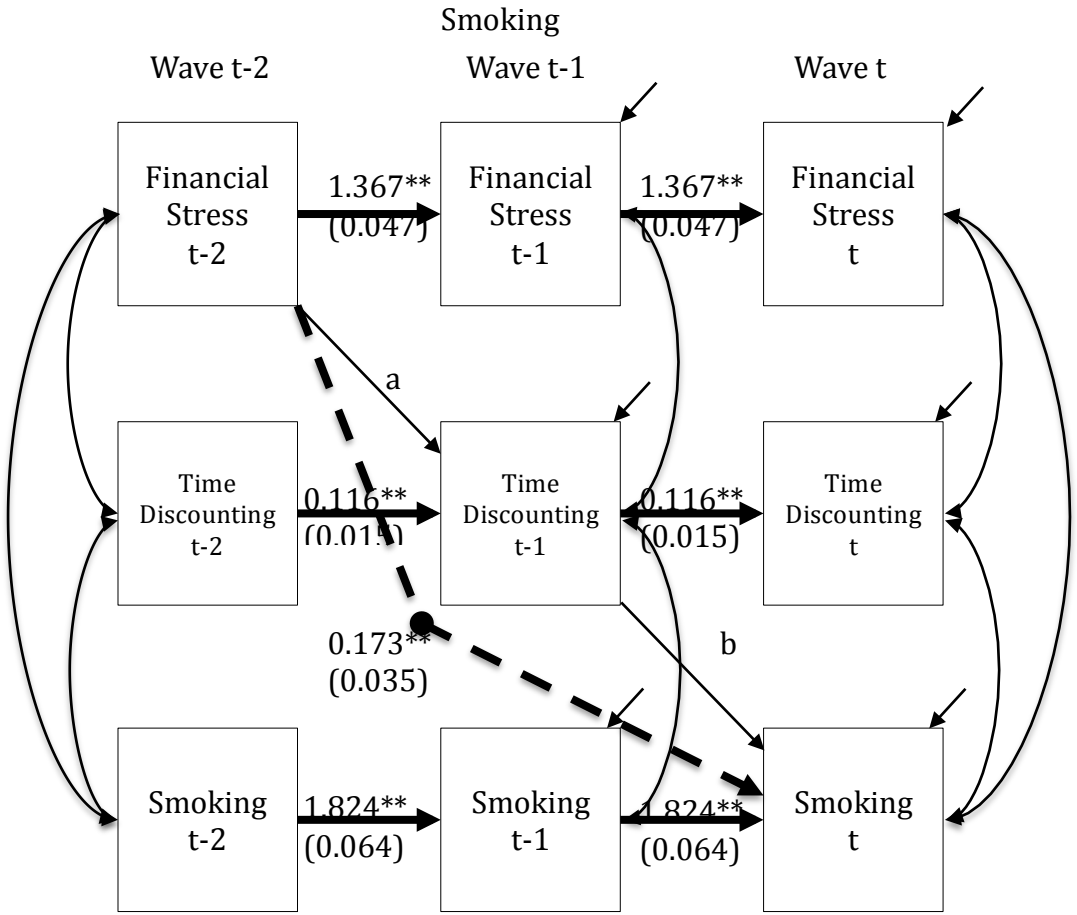
Notes: Additional demographic and household control applied to the health outcome and mediator models.

Figure 2.9: Results of the three-wave autoregressive model of the effect of financial stress (t-2) on being overweight (t) mediated by changes in the average standardized rate of time discounting (t-1)



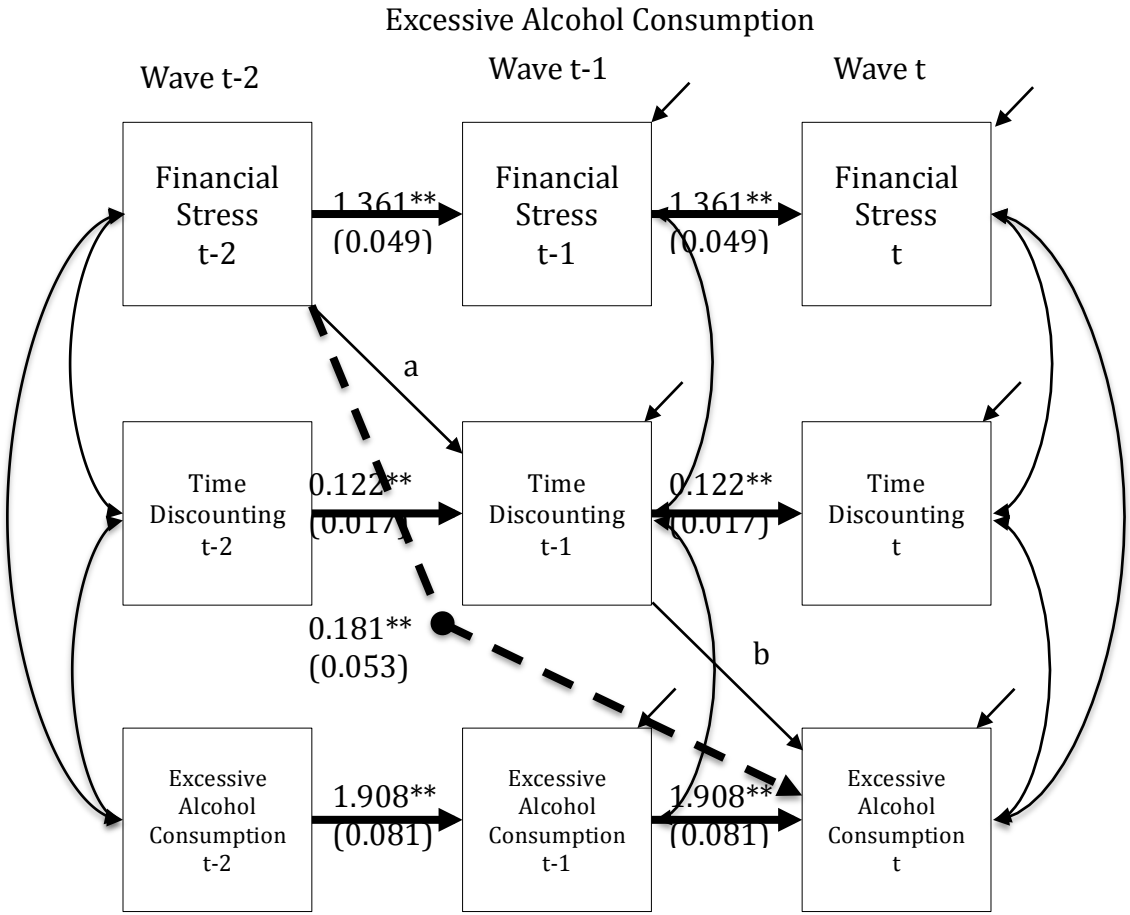
Notes: Additional demographic and household control applied to the health outcome and mediator models.

Figure 2.10: Results of the three-wave autoregressive model of the effect of financial stress (t-2) on smoking (t) mediated by changes in the average standardized rate of time discounting (t-1)



Notes: Additional demographic and household control applied to the health outcome and mediator models.

Figure 2.11: Results of the three-wave autoregressive model of the effect of financial stress (t-2) on excessive alcohol consumption (t) mediated by changes in the average standardized rate of time discounting (t-1)



Notes: Additional demographic and household control applied to the health outcome and mediator models.

Table 2.1: Time Discounting Descriptive Statistic

	1997			1999			2002		
	Mean	S.D.	% of zero obs.	Mean	S.D.	% of zero obs.	Mean	S.D.	% of zero obs.
D1	0.03	0.16	33.49	0.04	0.19	27.03	0.01	0.10	14.19
D2	0.21	0.26	18.24	0.24	0.30	14.46	0.22	0.25	6.52
D3	0.03	0.16	19.26	0.04	0.19	16.40	0.01	0.10	8.92
D4	0.14	0.23	14.02	0.15	0.25	11.81	0.13	0.20	5.66
D5	0.01	0.10	76.73	0.02	0.12	72.07	0.00	0.05	65.71
D6	0.04	0.13	67.60	0.05	0.14	62.16	0.04	0.08	54.39
D7	0.01	0.10	61.28	0.01	0.10	56.92	0.00	0.03	47.57
D8	0.03	0.12	56.86	0.03	0.11	52.53	0.02	0.04	42.06
D9	0.00	0.03	82.73	0.00	0.03	81.14	0.00	0.05	77.04
D10	0.02	0.07	71.52	0.03	0.07	70.75	0.03	0.07	64.72
D11	0.00	0.03	68.49	0.00	0.03	66.17	0.00	0.00	63.45
D12	0.02	0.05	59.95	0.02	0.05	57.65	0.02	0.05	51.68
D13	0.01	0.07	41.54	0.01	0.08	37.87	0.01	0.09	21.56
D14	0.11	0.18	39.24	0.11	0.16	35.46	0.13	0.17	20.07
D15	0.00	0.06	38.99	0.00	0.06	34.07	0.01	0.07	18.92
D16	0.06	0.12	39.13	0.06	0.11	33.92	0.08	0.14	18.56
Observations			2660			1368			1995

Table 2.2: Data Structure

Year	No. of individuals		No. of observations					
	This Wave	Three Waves	Factor	Financial Stress	Health	Smoking	Heavy Drinking	Overweight
1997	6139		2404	2417	3513	3512	3512	3469
1998	4533		1235	1264	2392	2392	2392	2353
1999	3972	2570	1208	1300	2250	2250	2250	2214
2000	4207	1419	1305	1345	1052	1052	1052	1035
2001	5201	1566	1790	2097	2074	2074	2074	2026
2002	4948	2519	1917	1994	2139	2139	2139	2088
Total		8074						

Table 2.3: Descriptive Statistics (N=8074)

	n	%	(% non-missing)
Financial Stress			
Very easy	396	4.90%	11.01%
Easy	1638	20.29%	45.55%
Neither hard nor easy	1324	16.40%	36.82%
Hard	196	2.43%	5.45%
Very hard	42	0.52%	1.17%
Missing	4478	55.46%	-
Time Discounting Factor			
(Mean) and (SD)	(0.03)	(0.91)	
Missing	4859	60.18%	
Self rated health			
Poor	29	0.36%	0.75%
Not so good	111	1.37%	2.89%
Fair	737	9.13%	19.17%
Good	2395	29.66%	62.29%
Excellent	573	7.10%	14.90%
Missing	4229	52.38%	-
Smoking			
No	2751	34.07%	71.55%
Yes	1094	13.55%	28.45%
Missing	4229	52.38%	-
Heavy Drinker			
No	3542	43.87%	92.12%
Yes	303	3.75%	7.88%
Missing	4229	52.38%	-
Overweight			
No	1949	24.14%	51.37%
Yes	1845	22.85%	48.63%
Missing	4280	53.01%	-
Sex			
Male	4156	51.47%	
Female	3918	48.53%	
Education			
No education(yet)	931	11.53%	13.11%
Primary education	1386	17.17%	19.51%
Lower Secondary	483	5.98%	6.80%
Higher Secondary	762	9.44%	10.73%
Lower Vocational	1896	23.48%	26.69%
Higher Vocational	1194	14.79%	16.81%
University Education	452	5.60%	6.36%
Missing	970	12.01%	-
Employed			
No	5007	62.01%	

Yes	3067	37.99%	
Partner			
No	1184	14.66%	
Yes	6890	85.34%	
Homeowner			
No	778	9.64%	33.55%
Yes	1541	19.09%	66.45%
Missing	5755	71.28%	-
No. of children			
(Mean) and (SD)	(1.15)	(1.27)	
Missing	0	0	
Age			
(Mean) and (SD)	(41.85)	(21.28)	
Missing	0	0	
Annual household net income (Dfl.)			
(Mean) and (SD)	(60316.93)	(26327.96)	
Missing	6057	75.02%	
Total HH debt/income			
(Mean) and (SD)	(0.04)	(0.14)	
Missing	6369	78.88%	
Total HH mortgage debt/income			
(Mean) and (SD)	(1.01)	(1.41)	
Missing	6339	78.51%	
Observations	8074		

Notes: Individuals participating in three consecutive waves of the CentERpanel.

Table 2.4: Structural equation model estimates of the effects of stress on health and health behaviours mediated by changes in time discounting

Independent Variable	Health Outcome							
	Self-rated health		Overweight		Smoking		Excessive alcohol	
	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.
b. Time discounting effect on outcome	-0.026	0.024	0.016	0.025	-0.009	0.018	-0.071	0.092
y. Lagged health effect on health	1.039**	0.018	1.655**	0.053	1.777**	0.049	1.904**	0.095
c. Direct effect on outcome	-0.245**	0.03	0.103**	0.034	0.172**	0.032	0.196**	0.048
Sex	-0.105*	0.041	-0.113**	0.043	-0.024	0.045	-0.692**	0.080
Age	-0.008**	0.002	0.019**	0.002	-0.013**	0.002	0.000	0.003
Education	-0.007	0.015	-0.034*	0.016	-0.092**	0.017	-0.085**	0.024
Job	0.246**	0.042	0.322**	0.052	0.225**	0.058	0.027	0.087
Partner	0.088	0.056	0.110	0.064	-0.184**	0.066	-0.440**	0.110
Children	0.083**	0.020	-0.034	0.024	-0.040	0.025	-0.071*	0.035
Household income (log)	0.058	0.072	-0.004	0.087	0.093	0.087	0.690**	0.125
Homeownership	0.057	0.065	0.006	0.082	-0.315**	0.08	-0.065	0.119
x. Lagged financial stress on stress	1.366**	0.046	1.362**	0.052	1.367**	0.045	1.362**	0.046
m. Lagged time discounting on time discounting	0.131**	0.031	0.129**	0.031	0.13**	0.033	0.133**	0.034
a. Financial stress on time discounting	0.041	0.026	0.041	0.028	0.039	0.03	0.034	0.033
Sex	-0.077	0.041	-0.081*	0.033	-0.073*	0.034	-0.074*	0.035
Education	-0.027*	0.013	-0.029*	0.013	-0.025	0.015	-0.027	0.015
Job	0.012	0.046	0.017	0.038	0.011	0.047	0.010	0.047
Partner	-0.007	0.055	-0.011	0.059	0.00	0.057	0.003	0.06
Age	-0.010**	0.001	-0.010**	0.002	-0.010**	0.002	-0.010**	0.002
Children	-0.004	0.020	-0.002	0.020	-0.005	0.022	-0.004	0.023
Household income (log)	0.092	0.074	0.085	0.082	0.063	0.071	0.046	0.078

Homeownership	-0.058	0.072	-0.052	0.072	-0.034	0.078	-0.026	0.080
Residual Covariances								
Financial stress with time discounting	0.027	0.024	0.022	0.028	0.017	0.028	0.023	0.024
Financial stress with health	-0.043*	0.020	0.004	0.011	0.023*	0.012	0.004	0.005
Time discounting with health	0.004	0.015	-0.001	0.009	0.002	0.007	-0.007	0.050
New/Additional Parameters								
Indirect effect via time discounting	-0.001	0.001	0.001	0.001	0.000	0.001	-0.002	0.005
Direct effect not via time discounting	-0.245**	0.030	0.103**	0.034	0.172**	0.032	0.196**	0.048
Total effect of financial stress on outcome	-0.246**	0.029	0.104**	0.034	0.172**	0.032	0.193**	0.049
n	8074		8074		8074		8074	

Notes: Autoregressive model used for financial stress. Thresholds and residual variances vary by year. * p<0.05, **p<0.01

Table 2.5: Structural equation model estimates of the effects of stress on health and health behaviours mediated by changes in the average standardized rate of time discounting

	Health Outcome							
Independent Variable	Self-rated health		Overweight		Smoking		Excessive alcohol	
	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.
b. Time discounting effect on outcome	-0.060	0.039	-0.039	0.055	0.021	0.039	-0.019	0.103
y. Lagged health effect on health	1.044**	0.019	1.665**	0.052	1.824**	0.064	1.908**	0.081
c. Direct effect on outcome	-0.236**	0.029	0.111**	0.028	0.173**	0.035	0.181**	0.053
Sex	-0.102**	0.038	-0.119**	0.046	-0.020	0.045	-0.707**	0.076
Age	-0.008**	0.002	0.019**	0.002	-0.013**	0.002	0.000	0.003
Education	-0.008	0.013	-0.036*	0.016	-0.097**	0.016	-0.081**	0.029
Job	0.247**	0.048	0.329**	0.050	0.220**	0.055	0.023	0.081
Partner	0.083	0.057	0.097	0.063	-0.179**	0.069	-0.452**	0.099
Children	0.084**	0.02	-0.035	0.022	-0.039	0.024	-0.06	0.035
Household income (log)	0.068	0.068	-0.004	0.072	0.089	0.098	0.651**	0.135
Homeownership	0.054	0.063	0.025	0.076	-0.297**	0.072	-0.034	0.109
x. Lagged financial stress on stress	1.367**	0.045	1.372**	0.048	1.367**	0.047	1.361**	0.049
m. Lagged time discounting on time discounting	0.117**	0.016	0.12**	0.018	0.116**	0.015	0.122**	0.017
a. Financial stress effect on time discounting	0.023	0.014	0.027**	0.015	0.025	0.015	0.026	0.017
Sex	-0.022	0.019	-0.02	0.017	-0.021	0.016	-0.018	0.018
Education	-0.004	0.006	-0.004	0.007	-0.002	0.007	-0.004	0.007
Job	0.010	0.022	0.014	0.021	0.013	0.021	0.013	0.024
Partner	0.027	0.029	0.023	0.028	0.032	0.030	0.029	0.031
Age	-0.003**	0.001	-0.003**	0.001	-0.003**	0.001	-0.003**	0.001
Children	-0.015	0.009	-0.015	0.01	-0.016	0.009	-0.016	0.009
Household income (log)	0.011	0.043	0.010	0.037	-0.003	0.040	0.009	0.042
Homeownership	-0.030	0.037	-0.026	0.027	-0.028	0.029	-0.032	0.032

Residual Covariances								
Financial stress with time discounting	0.011	0.013	0.012	0.011	0.008	0.015	0.009	0.014
Financial stress with health	-0.044**	0.016	0.001	0.010	0.023*	0.012	0.002	0.006
Time discounting with health	0.003	0.007	-0.001	0.004	-0.003	0.004	-0.003	0.003
New/Additional Parameters								
Indirect effect via time discounting	-0.001	0.001	-0.001	0.002	0.000	0.001	-0.001	0.003
Direct effect not via time discounting	-0.236**	0.029	0.111**	0.028	0.173**	0.035	0.181**	0.053
Total effect of financial stress on outcome	-0.237**	0.029	0.110**	0.028	0.173**	0.035	0.180**	0.052
n	8074		8074		8074		8074	

Notes: Autoregressive model used for financial stress. Thresholds and residual variances vary by year. * $p < 0.05$, ** $p < 0.01$

Table 2.6: Structural equation model estimates of the effects of financial stress on health mediated by changes in time discounting

Panel A: Effect of financial stress on mediators

	Time discounting at t-1		
	d2	d3	d4
Financial stress at t-2	0.023**	0.003	0.006
	(0.008)	(0.003)	(0.007)

Panel B: Effect of mediators on health and health behaviours

	Time discounting at t-1			
	Self rated health	Overweight	Smoking	Excessive alcohol consumption
Time discounting at t-1				
d2	0.034	0.025	-0.001	0.045
	(0.071)	(0.074)	(0.070)	(0.152)
d3	-0.141	0.137	-0.251*	-0.645
	(0.168)	(0.207)	(0.112)	(0.838)
d4	-0.120	0.105	-0.156	-0.039
	(0.086)	(0.090)	(0.092)	(0.254)
Direct effect of financial stress at t-2	-0.244**	0.100**	0.172**	0.176**
	(0.028)	(0.031)	(0.035)	(0.053)

Notes: Controls for the health behaviour and time discounting models were age, gender, education, whether employed, whether there was a partner present in the household, number of children, total annual household net income (log), whether owner of current accommodation. A simple autoregressive model was used for financial stress. *p < 0.05, **p < 0.01

Table 2.7: Structural equation model estimates of the effects of consumer debt ratio on health and health behaviours mediated by changes in time discounting

Independent Variable	Health Outcome							
	Self-rated health		Overweight		Smoking		Excessive alcohol	
	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.
b. Time discounting effect on outcome	-0.035	0.023	0.019	0.025	-0.002	0.021	0.011	0.058
y. Lagged health effect on health	1.043**	0.022	1.654**	0.05	1.774**	0.056	1.919**	0.104
c. Direct effect of financial stress on outcome	0.022	0.175	0.616**	0.222	0.515**	0.189	0.268	0.253
Sex	-0.121**	0.039	-0.089*	0.045	-0.019	0.046	-0.693**	0.085
Age	-0.007**	0.002	0.02**	0.002	-0.011**	0.002	0.001	0.004
Education	-0.006	0.016	-0.022	0.016	-0.086**	0.016	-0.073**	0.024
Job	0.257**	0.044	0.326**	0.05	0.21**	0.055	-0.004	0.091
Partner	0.103	0.063	0.119	0.066	-0.199	0.070	-0.41**	0.104
Children	0.043*	0.020	-0.014	0.023	-0.005**	0.021	-0.029	0.035
Household income (log)	0.199**	0.069	-0.094	0.085	0.004	0.093	0.499**	0.132
Homeownership	0.096	0.073	0.023	0.079	-0.340**	0.073	-0.050	0.099
x. Lagged financial stress on stress	0.604**	0.018	0.601**	0.020	0.610**	0.022	0.611**	0.021
m. Lagged time discounting on time discounting	0.132**	0.032	0.132**	0.032	0.134**	0.034	0.136**	0.032
a. Financial stress effect on time discounting	0.022	0.244	-0.086	0.217	0.013	0.242	-0.040	0.250
Sex	-0.084*	0.039	-0.074*	0.037	-0.081*	0.04	-0.078*	0.037
Education	-0.027	0.014	-0.027	0.015	-0.026*	0.012	-0.027*	0.013
Job	0.008	0.046	0.022	0.046	0.007	0.043	0.009	0.040
Partner	-0.017	0.06	-0.008	0.060	-0.011	0.056	-0.012	0.054
Age	-0.010**	0.002	-0.010**	0.002	-0.01**	0.002	-0.010**	0.002
Children	0.004	0.018	0.003	0.021	0.004	0.020	0.001	0.019

Household income (log)	0.046	0.077	0.012	0.081	0.040	0.068	0.036	0.062
Homeownership	-0.049	0.083	-0.041	0.069	-0.040	0.072	-0.037	0.068
Residual Covariances								
Financial stress with time discounting	0.020	0.005	0.004	0.005	0.003	0.005	0.003	0.005
Financial stress with health	0.004	0.002	-0.001	0.001	0.003**	0.001	0.000	0.001
Time discounting with health	-0.002	0.015	0.001	0.008	0.003	0.011	-0.004	0.005
New/Additional Parameters								
Indirect effect via time discounting	-0.002	0.010	-0.003	0.007	0.000	0.005	-0.006	0.015
Direct effect not via time discounting	0.022	0.175	0.616**	0.222	0.515**	0.189	0.268	0.253
Total effect of financial stress on outcome	0.021	0.172	0.613**	0.221	0.515**	0.189	0.262	0.254
n	8074		8074		8074		8074	

Notes: Autoregressive model used for financial stress. Thresholds and residual variances vary by year. * $p < 0.05$, ** $p < 0.01$

Table 2.8: Structural equation model estimates of the effects of mortgage debt ratio on health and health behaviours mediated by changes in time discounting

Independent Variable	Health Outcome							
	Self-rated health		Overweight		Smoking		Excessive alcohol	
	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.
b. Time discounting effect on outcome	-0.022	0.026	0.009	0.028	-0.010	0.027	-0.053	0.093
y. Lagged health effect on health	1.051**	0.024	1.675**	0.051	1.763**	0.058	1.925**	0.09
c. Direct effect of financial stress on outcome	-0.024	0.032	0.061*	0.029	-0.033	0.042	0.018	0.050
Sex	-0.128**	0.040	-0.100*	0.042	-0.028	0.044	-0.683**	0.086
Age	-0.007**	0.002	0.020**	0.002	-0.013**	0.002	0.000	0.003
Education	-0.009	0.014	-0.028	0.014	-0.094**	0.017	-0.078**	0.027
Job	0.249**	0.049	0.331**	0.054	0.218**	0.054	0.019	0.086
Partner	0.090	0.057	0.121	0.068	-0.208**	0.075	-0.421**	0.103
Children	0.047**	0.018	-0.022	0.023	-0.008	0.024	-0.036	0.040
Household income (log)	0.189**	0.059	-0.084	0.078	-0.034	0.096	0.513**	0.124
Homeownership	0.137	0.085	-0.099	0.079	-0.237**	0.086	-0.066	0.140
x. Lagged financial stress on stress	0.532**	0.033	0.518**	0.028	0.512**	0.034	0.519**	0.035
m. Lagged time discounting on time discounting	0.130**	0.035	0.143**	0.034	0.135**	0.029	0.142**	0.039
a. Financial stress on time discounting	0.075	0.049	0.108*	0.043	0.084	0.048	0.070	0.048
Sex	-0.082*	0.038	-0.070	0.040	-0.076*	0.037	-0.067	0.035
Education	-0.025*	0.012	-0.024	0.014	-0.023	0.013	-0.024	0.014
Job	0.007	0.042	0.014	0.044	0.011	0.047	0.006	0.051
Partner	-0.006	0.058	0.012	0.057	0.006	0.057	0.005	0.058
Age	-0.010**	0.001	-0.009**	0.002	-0.009	0.002	-0.010**	0.002
Children	-0.012	0.019	-0.015	0.022	-0.008	0.021	-0.005	0.023
Household income (log)	0.078	0.080	0.052	0.080	0.040	0.076	0.048	0.071

Homeownership	-0.183	0.111	-0.216*	0.096	-0.178*	0.085	-0.165	0.099
Residual Covariances								
Financial stress with time discounting	-0.041	0.040	-0.045	0.036	-0.035	0.038	-0.032	0.043
Financial stress with health	0.007	0.020	-0.002	0.010	0.017	0.013	0.000	0.005
Time discounting with health	0.076	0.015	-0.005	0.007	0.003	0.009	-0.006	0.006
New/Additional Parameters								
Indirect effect via time discounting	-0.002	0.003	0.001	0.003	-0.001	0.003	-0.003	0.007
Direct effect not via time discounting	-0.024	0.032	0.061*	0.029	-0.033	0.042	0.018	0.050
Total effect of financial stress on outcome	-0.025	0.031	0.062*	0.028	-0.033	0.041	0.015	0.048
n	8074		8074		8074		8074	

Notes: Autoregressive model used for financial stress. Thresholds and residual variances vary by year. * $p < 0.05$, ** $p < 0.01$

Table 2.9: Structural equation model estimates of the effects of stress on health and health behaviours mediated by changes in time discounting accounting for endogeneity

Independent Variable	Health Outcome							
	Self-rated health		Overweight		Smoking		Excessive alcohol	
	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.
y. Lagged health effect on health	0.946**	0.040	1.516**	0.065	1.675**	0.092	1.471**	0.098
c. Direct effect of financial stress on outcome	-0.096**	0.031	0.059	0.048	0.046	0.056	0.169**	0.064
Sex	-0.050	0.05	-0.053	0.066	-0.152	0.084	-0.493**	0.090
Age	-0.005*	0.002	0.008**	0.003	-0.005	0.003	-0.002	0.004
Education	-0.019	0.017	-0.020	0.022	-0.054	0.031	-0.075*	0.031
Job	0.122*	0.054	0.224**	0.073	0.143	0.088	0.034	0.105
Partner	0.019	0.065	0.009	0.093	-0.113	0.119	-0.288*	0.121
Children	0.034	0.022	-0.034	0.035	0.065	0.042	-0.030	0.050
Household income (log)	0.076	0.087	0.162	0.104	-0.09	0.144	0.553**	0.154
Homeownership	0.044	0.084	-0.124	0.107	-0.184	0.126	-0.092	0.150
x. Lagged financial stress effect on stress	0.866**	0.012	0.872**	0.013	0.868**	0.014	0.872**	0.013
Lagged time discounting on stress	-0.037	0.029	-0.041	0.027	-0.032	0.025	-0.035	0.025
m. Lagged time discounting on time discounting	0.128**	0.028	0.141**	0.032	0.133**	0.032	0.134**	0.032
a. Financial stress effect on time discounting	0.036	0.032	0.039	0.027	0.031	0.029	0.033	0.029
Lagged health effect on time discounting	-0.039	0.047	0.009	0.078	-0.006	0.055	-0.209	0.203
Sex	-0.078*	0.036	-0.084*	0.037	-0.069	0.043	-0.076	0.044
Education	-0.026*	0.013	-0.028*	0.012	-0.023	0.014	-0.025	0.014
Job	0.010	0.043	0.008	0.042	0.014	0.040	0.018	0.038
Partner	-0.011	0.056	-0.009	0.055	0.007	0.061	0.004	0.058
Age	-0.010**	0.001	-0.010**	0.002	-0.010**	0.002	-0.01**	0.002
Children	-0.002	0.02	-0.003	0.02	-0.004	0.021	-0.008	0.022

Household income (log)	0.100	0.072	0.109	0.066	0.064	0.090	0.062	0.085
Homeownership	-0.073	0.073	-0.076	0.067	-0.049	0.082	-0.050	0.079
Lagged financial stress effect on stress	0.866**	0.012	0.872**	0.013	0.868**	0.014	0.872**	0.013
Lagged time discounting effect on stress	-0.037	0.029	-0.041	0.027	-0.032	0.025	-0.035	0.025
Lagged health effect on stress	-0.086**	0.033	0.005	0.050	0.125*	0.062	0.022	0.092
Sex	-0.017	0.054	-0.014	0.047	-0.019	0.050	-0.012	0.048
Age	-0.001	0.003	-0.001	0.002	0.000	0.002	-0.001	0.002
Education	0.026	0.017	0.026	0.016	0.028	0.017	0.022	0.017
Job	-0.117	0.063	-0.121*	0.060	-0.13*	0.056	-0.128*	0.060
Partner	0.144*	0.073	0.121	0.077	0.145*	0.064	0.133	0.075
Children	0.136**	0.028	0.137**	0.025	0.129**	0.03	0.127**	0.029
Household income (log)	-0.844**	0.099	-0.86**	0.105	-0.865**	0.094	-0.859**	0.096
Homeownership	0.121	0.081	0.126	0.077	0.149	0.085	0.153	0.086
Residual Covariances								
Financial stress with time discounting	0.029	0.035	0.030	0.033	0.020	0.032	0.022	0.032
Financial stress with health	-0.027	0.015	0.004	0.006	0.004	0.005	0.003	0.003
Time discounting with health	0.003	0.013	0.007	0.007	-0.005	0.005	-0.005	0.005
New/Additional Parameters								
Indirect effect via time discounting	-0.002	0.003	0.002	0.004	-0.002	0.003	-0.006	0.008
Direct effect not via time discounting	-0.096**	0.031	0.059	0.048	0.046	0.056	0.169**	0.064
Total effect of financial stress on outcome	-0.098**	0.032	0.06	0.047	0.044	0.056	0.163**	0.063
n	8074		8074		8074		8074	

Notes: Thresholds and residual variances vary by year. * $p < 0.05$, ** $p < 0.01$

CHAPTER 3

MEDIATION AND MODERATED MEDIATION ANALYSIS OF THE RELATIONSHIP BETWEEN FINANCIAL STRAIN AND HEALTH: EVIDENCE FROM THE DUTCH NATIONAL BANK HOUSEHOLD SURVEY[6]

Abstract

There is widespread evidence that financial strain can take its toll on physical and mental health, however the mechanisms through which this relationship operates are yet to be studied in detail. Conducting both a longitudinal mediation analysis and moderated mediation analysis with data from the Dutch National Bank Household Survey from 1997-2017, we first test for the degree to which the effects of financial strain on health are mediated through changes in health behaviours as opposed to direct effects on biological processes and find that 15.8% of the response of self-reported health to financial strain is mediated by these behaviours, however this result is statistically insignificant. Secondly, we analyse the links between financial strain, time discounting and changes in health behaviours in order to understand the lack of behavioural response to strain but find that although strain increases impulsivity, this has little effect on unhealthy behaviours. Having assessed the mediating pathways, we attempt to determine if the strength of the mediation effect of health behaviours varies for different moderators, i.e. gender and employment status. In the final part of our analysis we conduct a moderated mediation analysis and find that there is slight variation between males and females and the employed and non-employed but this result is not significant enough to draw conclusions.

Keywords: financial strain, health, mediation, moderated mediation, time discounting, health behaviours.

[6] A version of this paper, co- authored with my supervisors Dr Declan French and Professor Donal McKillop was published in Social Science and Medicine (see Prentice et al., 2017).

3.1. Introduction

The 2008 recession and subsequent sovereign debt crisis have had far reaching effects on countries around the world. Turmoil in the banking sector led to downturns in stock markets, bankruptcies, housing repossessions, and rises in unemployment (Chang et al., 2013). While the obvious symptoms of the crisis were widely documented, the impact of the worry posed by such financial turmoil on population health received less attention. A growing body of evidence documents the association of the financial crisis with a decline in health status at national level.

In a Eurobarometer public opinion survey which measures European individuals' attitudes (European Commission, 2015), almost half of the respondents stated that unemployment was the most important issue facing their country and, in 2013, 41% said they had difficulties paying bills at least some of the time. Such financial worries negatively affect mental health (Jessop et al., 2005; Bridges and Disney, 2010; Selenko and Batinic, 2011; Fitch et at al. 2011), perhaps even more so than lack of money per se or the actual debt amount (Fitch et al., 2011). Furthermore, financial worries worsen self-reported health (Drentea and Lavrakas, 2000; Sweet et al., 2013), health satisfaction (Keese and Schmitz, 2014) and increase physical impairment (Turunen and Hiilamo, 2014). According to Whitehead and Bergman (2017) financial strain, or perceptions that one's financial resources are not sufficient for one's needs, is most predictive of health problems in later life.

In this paper, we focus on financial strain as a particular stress and examine the behavioural pathway from financial strain to poor health to better understand the causal mechanisms. Conducting a longitudinal mediation analysis with the Dutch National Bank Household Survey, we first test for the degree to which the effects of financial strain on health are mediated through changes in health behaviours as opposed to direct effects on biological processes. Research has shown that health behaviour acts as a key intermediating variable between financial problems and health (Drentea and Lavrakas, 2000). Secondly, we analyse the links between financial strain, present-biases and changes in health behaviours in order to understand the lack of behavioural response to strain in our data given the extensive literature indicating the significance of this pathway. Having assessed the mediation

effects, we attempt to determine if the strength of the mediation effect varies for different groups, i.e. males versus females and the employed compared to the non-employed. Hence, in the final part of our analysis we conduct a longitudinal moderated mediation analysis of both the indirect and direct pathways from strain to illness, an area where research is still limited (Sinclair et al., 2010).

3.2. Literature Review

The link between stress and health is not clear, however studies have suggested that stress can lead to changes at the physiological level which impact on longevity and play a key role in disease pathogenesis (Cohen and Wills, 1985). In particular, stress may directly interfere with the regulation of immune and inflammatory processes and has been implicated as a risk factor in cardiovascular disease (Rozanski et al., 1999; Richardson et al., 2012), the progression of HIV/AIDS (Remor et al., 2007), wound healing response (Broadbent et al., 2012), upper respiratory infections (Miller and Cohen, 2005; Pedersen et al., 2010) and autoimmune diseases (Porcelli et al., 2016). Release of catecholamines in response to stressful events can interfere with control of physiological systems such as anti-inflammatory responses; metabolism of carbohydrates, fats, and proteins; gluconeogenesis as well as regulation of cardiovascular, pulmonary, hepatic, skeletal, muscle, and immune systems resulting in increased disease risk (Cohen et al., 2007).

Stress can manifest as alterations not only to physical health and physiology, but also behaviour, affect and cognitions, which can influence susceptibility to and course of disease (Fields et al., 2014). Adopting unhealthy behaviours is one of the coping strategies used to relieve the burden felt by financial strain (Bennett et al., 2009; Shim et al., 2009; Jones et al., 2010; Nakao, 2010) and it has been found that stress is a significant correlate of snacking or emotional eating (van Strien et al., 1986), higher levels of smoking and reduced probability of smoking cessation (Steptoe et al. 1996; Adams et al., 2007; Grafova, 2007; Nelson et al. 2008; Umberson et al., 2008), drinking (Steptoe et al. 1998) and substance use (Gerber and Pühse, 2009; Guo, 2013). The most relevant research connects smoking, drinking, non-nutritional food, and sedentary activities to morbidity and mortality through the onset of cardiovascular diseases, diabetes, hypertension, and cancers, etc. (Adler et al., 1994).

Many of these unhealthy behaviours are wider in scope that the simple inability to purchase health promoting goods and services. Smoking, alcohol and fast food consumption require the expenditure of money to purchase an unhealthy product, while some forms of exercise cost nothing. The tendency of those struggling financially to adopt unhealthy behaviours despite the monetary and health costs is a puzzle which has not been addressed in a comprehensive way (Pampel et al., 2010). One behavioural attribute that may explain this relationship is time discounting. Time discounting describes the extent to which an individual discounts the value of an outcome because of a delay in its occurrence (Fields et al., 2009). Discount rates are believed to vary between individuals, and it has been found that they can be altered from situation to situation, with stress being a situation in which discount rates may change (Fields et al., 2014; Haushofer et al., 2015).

When individuals are under stress, they shift to a more immediate orientated mindset as demonstrated by more impulsive time discounting (Lawrance, 1991; Cornelisse, et al. 2013; Delaney et al., 2014; Haushofer et al., 2015). This is perhaps due to the consumption of limited resources of self-control (Mani et al., 2013; Vohs, 2013) resulting from the exposure to stress. With the immediate goal being to relieve stress, individuals engage in maladaptive coping mechanisms such as risky health behaviours (Fields et al., 2014). Higher rates of intertemporal discounting have consistently been correlated with cigarette smoking (Bickel et al., 1999; Mitchell, 1999; Reynolds et al., 2004; Adams, 2009). In a meta-analysis of studies, MacKillop and Kahler (2009) compared discount rates with addictive behaviours and found a significant effect in studies specifically comparing discount rates in smokers versus non-smokers. Higher discount rates additionally display significant positive relationships with frequent alcohol consumption (MacKillop and Kahler, 2009). In two studies by Vuchinich and Simpson (1998), heavy social drinkers and so called "problem drinkers" had higher rates of time discounting, compared to light social drinkers, with the most pronounced difference between problem and light drinkers.

Researchers have also found connections between health outcomes such as obesity and time discounting (Ikeda et al., 2010). Using longitudinal data from the US and international cross-sectional data, Komlos et al. (2004) hypothesized that the trend in

obesity could be related to an increase in time preference. In addition, Smith et al. (2005) explored the hypothesis that higher time preference rates were associated with a higher BMI using the National Longitudinal Study of Youth (NLSY) and their results showed a positive association with BMI for men with the effect being less strong for women. Links have also been found with illicit drug use, such as cocaine and heroin (Madden et al., 1997; Coffey et al., 2003; Kirby and Petry, 2004), lack of physical exercise (Leonard et al., 2013) and mortality (Boyle et al., 2013).

The above studies have made the association between financial difficulties and both biological and non-biological pathways to illness, however a lesser studied phenomenon is that of potential moderators of this relationship (Sinclair et al., 2010). Certain groups deal better with financial strain than others and therefore the magnitude of the effect of financial strain on health may vary according to individual level factors. In this study we examine two individual level moderators of the pathway between financial strain, health behaviours and health, namely gender and employment situation.

Few studies have investigated whether the relationship between economic stress and health is different for women and men (Weekes et al., 2005; Ahnquist et al., 2007), although there is robust evidence in the literature that the sexes differ in their response and coping mechanisms to stress in general (Lazarus and Folkman, 1984). Studies investigating gender differences in stress responses indicate that women consider stressors as more threatening (Lazarus and Folkman, 1984; Ptacek et al., 1992), showing a greater psychological reactivity to stress (Mirowsky and Ross, 1995; Kudielka et al., 1998), and a greater propensity for depression (Piccinelli and Wilkinson, 2000). Men on the other hand show greater physiological reactivity to stress (Nolen-Hoeksema, 1990; Flinn et al., 1996) and greater usage of negative health behaviours such as smoking, alcohol usage and aggressive behaviours (Cleary, 1987; Pearlin, 1989; Aneshensel et al., 1991; Weekes et al., 2005).

In the few studies that do examine gender differences in the relationship between strain and health, Weekes et al. (2005) found that measures of perceived stress (i.e. state anxiety, trait anxiety, perceived stress, and depression) were strongly correlated with health problems only for women indicating that males may have more effective

coping mechanisms in stressful situations. Furthermore, Blomgren et al. (2016) found that severe over-indebtedness had a clear association with increased psychological and physical morbidity with associations being stronger among women than men. Nettleton and Burrows (1998) reached a similar conclusion concerning the association between mortgage problems and worsening health. Ahnquist et al. (2007) and Ahnquist (2011) found that financial stress showed persistent and statistically significant effects on all health outcomes among women, but not for men in their longitudinal analysis.

Kemeny (1991) indicates that gender differences in stress-related health outcomes arise from the finding that poorer immune functioning is related to psychological or emotion based coping techniques (often exhibited more frequently in females) rather than problem-based coping techniques exhibited by males.

Other studies have arrived at different conclusions regarding gender differences in associations of economic hardships variables and poor health outcomes, finding only small or even insignificant effects (Martikainen et al., 2003; Laaksonen et al. 2009).

The second factor we investigate as a moderator of the relationship between perceived financial strain and mental health is the respondent's employment situation. The correlation between employment and health for the general population is well established and presented in several large-scale literature reviews and meta-analyses (Ross and Mirowsky, 1995; Mastekaasa, 1996; McKee-Ryan et al., 2005; Paul and Moser, 2009; Selenko and Batinic, 2011).

A cross sectional study by Rosenthal et al. (2012) found that full time employment was associated with less damaging psychological factors, healthier eating habits, more physical activity and lower levels of cigarette smoking and alcohol consumption compared with part time employment or unemployment. This may be due to the fact that employment has a direct benefit of increasing household income meaning individuals can cope more successfully with economic strain than those that are unemployed (Selenko and Batinic, 2011). Additionally, employed individuals often have the option of working more hours to increase their income if need be. On the other hand, unemployed individuals may find their financially adverse situation is

beyond their control due to lack of work/financial income, leading to an amplification of the effect of financial stress on health and an increase in depressive symptoms and subsequent unhealthy behaviours (Frese and Mohr, 1987; Selenko and Batinic, 2011).

Additionally, Jahoda (1982) argues that there are benefits of employment beyond the obvious financial income that may buffer the negative relationship between financial strain and health. In summarizing the work of Jahoda (1982), Selenko and Batinic (2011) talk of the latent benefits of employment which have a positive effect on health:

"[…] imposes a time structure on the waking day; it enlarges the scope of social relations [...] it demonstrates that the purpose and achievements of a collectivity transcend those for which an individual can aim; it assigns social status [...]; it requires regular activity." (p. 83)

Hence, being employed satisfies a psychological need, which must be fulfilled to maintain good mental health (Jahoda, 1982). Therefore, because of this psychological need which is fulfilled by employment, not only are the unemployed at risk for mental health problems, but also those who are not in the labour force such as students, homemakers, and retirees (Paul et al., 2009).

3.3. Theoretical Framework

Becker's theory of investment in human capital (Becker, 1962) and Grossman's adaptation of this theory with specific focus on health (Grossman, 1972) provides an important theoretical framework for thinking about why some individuals chose optimising health behaviours while others behave otherwise.

It is assumed that every person is endowed with a particular stock of health capital, influenced by genetic and environmental factors, which forms part of their overall human capital (Heston and Finke, 2003). Health as a type of human capital can both depreciate and have investments made in it (Becker, 1962), with each individual possessing the ability to manipulate their own stock and differing in their willingness

to undertake such investments i.e. they have different time preferences. Investments may take the form of health care or engaging in health promoting behaviours (i.e. goods that add to future utility) and not engaging in harmful habits or addictions (i.e. goods that lower future utility). Costs to the individual such as time, money and foregone pleasurable activities determine the size of the investment. Consequently, time preferences play an important role in investment decisions as costs are often felt far sooner than the benefit of the health investment. The extent to which an individual or consumer values future benefits and costs less and present costs more determines the attractiveness of potential health investments (Gray, 2011).

In the health capital model, the product of health capital is a flow of healthy days from a given level of health capital stock. As health capital stock grows, there are an increased number of healthy days available. There are diminishing returns to health capital.

$$h = h(H), h^{l} > 0, h^{ll} < 0$$

H is the health capital stock; h is the number of healthy days.

Net investments lead to changes in the level of health stock over time (depreciation plus investment) as:

$$\dot{H} = I - \delta H$$

where $\dot{H}$ is the change in the individual's stock of health from period to period. We assume that the production function for health is linear in investment in health, I, and that δ the rate of depreciation of the stock of health H is constant over time (Laporte, 2014).

Investments in health are determined by the equilibrium of the demand for health and the supply of health due to household production i.e. the marginal benefit of a unit of health equals the marginal cost of supply. Marginal benefit is a result of the sum of benefits from market and non-market activities (Grossman, 1972). Individuals aim to maximize the present value of the sum of the market and non-market benefits minus

health investment costs across all time periods in the future, given by the equation (Dardanoni, 1986):

$$max \int_0^\infty e^{-rt}\{(p+w)h - \pi I\}dt$$

r is the individuals rate of time preference, *w* is the market benefit and *p* is the non-market benefit. π is the marginal cost of a health investment. Incorporating health stock depreciation by replacing investment (I) with net investment, continuing to discount all arguments by the time preference rate, the individual's maximization problem is then given by:

$$max \int_0^\infty e^{-rt}\{(p+w)h(H) - \pi(H + \delta H)\}dt$$

A solution via Euler's equation shows that equilibrium can be found at:

$$(p+w)h^l(H) = \pi(r+\delta) - \dot{\pi}$$

Therefore when r is greater $h^l(H)$ is greater, as $h^{ll} < 0$. This suggests that a higher rate of time preference leads to a smaller maximizing level of health stock (H) (Gray, 2011). An example of a smaller health stock would be obesity compared to normal BMI or bad self-rated health compared to excellent self-rated health.

3.4. Contribution

Although the studies mentioned in the literature review have made the association between financial difficulties and both biological and non-biological pathways to illness, no study to date has quantified the relative importance of each of these pathways. This is critical for identifying interventions to mitigate the health consequences of economic downturns as well as austerity programmes. Also, this literature has indicated that both impulsivity and stress are risk factors for negative health behaviours but there has been little work on understanding the causal mechanism from stress to time discounting to worse health-related behaviour especially for economic stresses. Furthermore, there has been little research into potential moderators of the strain-health pathway; an area that would be beneficial for policy makers and health practitioners to identify which groups are most

vulnerable to stress related illnesses. This study aims to fill these gaps through mediation and moderated mediation analysis using the Dutch National Bank Household Survey (DNB) from 1997-2017. This is a large nationally-representative sample of over 40000 observations covering the years before and after the financial crisis.

This paper makes the following original contributions. The study has greater breadth than in the literature reviewed as we not only consider the impact of financial stress on health, but also go beyond the black box view of causality and consider potential mediating variables in order to explain how this connection might exist. First, we examine the extent to which the response of health to financial strain is mediated by changes in health behaviours. Although many studies examine the behavioural sequelae of financial strain none to our knowledge quantify the relative importance of this pathway for health. We consider smoking, heavy drinking and being overweight as plausible behavioural responses to financial strain and find that 15.8% of the response of self-reported health to financial strain is mediated by these behaviours. Second, we examine the pathway from financial strain to changes in health behaviours to gain a greater understanding of the behavioural response. The DNB dataset is unique in that it collects individual time preference data annually permitting the analysis of variation in time preferences in response to fluctuating levels of financial strain. Using a number of different time preference measures including time horizon, difficulty controlling expenditure, spending discretionary income and consideration of future consequences score, we find evidence that financial strain causes greater impulsivity but this does not lead to worse health behaviours. In this regard, economic stresses appear to be distinct from other forms of stress. Thirdly, we attempt to investigate the lesser-studied phenomenon of potential moderators of the indirect effect of financial strain on health via health behaviours using gender and employment status as moderators. By including interaction terms to test moderation in our meditational models we found that, although statistically insignificant, being male and not employed slightly increased the indirect effect however there was no difference for those in employment compared to those that were not. We also found that being employed increased the direct effect of strain on health however this may have been due to how the variable was dichotomized, and suggest that it may be more helpful for future research to

investigate the differences between unemployed and underemployed workers versus workers with stable jobs.

Our fourth contribution is that we address methodological concerns in the literature linking stress and illness. Many studies do not clearly establish evidence for a causal relationship from stress to health (Berkman et al., 2014). Using longitudinal data in our study, we clearly test for a temporal ordering that indicates causation from stress to health in our structural model. To avoid concerns about unmeasured confounders driving the relationship between financial strain and ill health, we use prior levels of the dependent variable in models of all the key variables (Cole and Maxwell, 2003). Furthermore, we make use of non-experimental data to examine the links in the chain of causation, in contrast to previous studies that have relied on experimental data or cross sectional studies.

3.5. Methodology

Data from De Nederlandsche Bank Household Survey (DNB) were used in this paper. The survey contains a large number of questions about the individual's financial situation, financial attitudes and health and these questions are generally consistent over a long period of time. The measure of financial strain is constructed using two subjective questions on the household's financial situation. A number of variables used elsewhere in the literature provide us with measures of time preferences. The health measures used include self-reported health, height and weight measurements as well as indicators of health behaviours including alcohol consumption and smoking. An extensive set of household characteristics allow us to control in our analysis for many social and demographic factors. The longitudinal survey design allows us to test for mediation effects using the temporal ordering of the variables to account for potential reverse causation. Allowing for multiple mediators, we consider the causal relationship from financial strain to health and also the causal relationship from financial strain to changes in health behaviours. We then consider whether gender and employment status moderated the causal relationship from financial strain to health. These relationships are estimated over a twenty-year period from 1997-2017. The literature on the health consequences of stress would indicate that economic stressors should also impact negatively on health and this

effect will be mediated through both non-biological pathways captured by health behaviours and biological pathways indicated by the non-mediated direct effects. For the mediation analysis of the causal relationship between financial strain and health behaviours, the literature reviewed above would indicate a strong effect largely mediated by changes in time preferences. Furthermore, the literature indicates that a moderating effect should be expected depending on gender and employment status. We expect a stronger mediating effect for men as research has shown they exhibit greater physiological reactivity to strain and use negative health behaviours as coping mechanisms (Cleary, 1987; Pearlin, 1989; Aneshensel et al., 1991; Weekes et al., 2005). We also expect a larger moderated mediating effect for those not in employment as they do not have access to the obvious benefits of work such as working longer hours and earning an income along with other latent benefits mentioned in the literature.

The following sections describe the data source, variables used, variables constructed and the statistical methods used in the analysis in more detail.

3.5.1 Data

DNB is an online panel survey, representative of the Dutch population aged 16 and over, that has been active since 1993. The survey, collected by CentERdata (Tilburg University, the Netherlands) gathers information annually from a rotating panel of approximately 2000 households. Households without Internet access are given a device to access the Internet by means of their television sets, while households that do not have a television set are provided with one by CentERdata.

The data are grouped into eight categories, with six basic categories covering: (i) general information on the household; (ii) household and work; (iii) accommodation and mortgages; (iv) health and income; (v) assets and liabilities; (vi) economic and psychological concepts. Two more aggregated categories comprise: (vii) information on income and (viii) information on assets, liabilities, and mortgages of the households. All information is made freely available online to scholars [http://www.centerdata.nl/en/index.html] on an annual basis.

The survey is unique in that it allows longitudinal analysis of both the psychological and economic aspects of financial behaviour (CentERdata, 2015). The current study will use all waves of data from the year 1997 to 2017, as the variables of interest are only available for these dates.

Households are recruited to the panel via a random national sample. They must complete a short survey on household characteristics, which are then stored in the database. If households do not complete questionnaires within six weeks of notification, they are dropped from the panel. It can be noted that response rates vary depending on the questionnaire and the particular questions within the questionnaire. There is also a significant dropout rate of approximately 25% each year. In order to deal with attrition, biannual refreshment samples are drawn in view of keeping the panel representative of the Dutch population aged 16 years and older. Further details on survey methodology are provided in (Teppa and Vis, 2012).

In order to conduct longitudinal mediation and moderated mediation analysis and examine casual pathways, we require repeated measures for individuals; therefore those who did not partake in three consecutive waves of the survey were dropped from the dataset leaving a dataset of 45041 observations for individuals in participating households aged 16 or over.

3.5.2 Measurements

3.5.2.1 Health measures

Our main measure of health is self-assessed health while our health related behaviours were tobacco smoking, alcohol consumption and being overweight. Self-assessed health is a measure of health that takes the physical, emotional and personal components of health at the specific point in time of the interview into consideration. Self-assessed health is derived from the question "In general, would you say your health is?" Answers are given according to a five-point ordinal response scale ranging from '5- poor' to '1-excellent'.[7] The use of self assessed health as a measure of actual health is often criticised due to its subjective nature, however, the measure

[7] The original scale was reverted so that the scale ranged from '1-poor' health to '5-excellent' health.

has been proven to have value in predicting objective health outcomes, morbidity and mortality (Idler and Benyamini, 1997; Franks et al., 2003; Doorslear and Jones, 2003; Bridges and Disney, 2005). Furthermore, self-assessed health in a five-point response scale is a consistently used measure of health in surveys internationally, enabling cross-country comparisons to be made with ease (Cuesta and Budria, 2015). Although self reported health assessments are principally assessments of the respondent's physical functioning they are also influenced by negative affect states but to a much lesser degree (Mavaddat et al., 2011). A binary variable was created which was one for those reporting their general health as "excellent' or 'good' and zero otherwise.

The following question was asked to assess smoking status, "Do you smoke cigarettes at all?" Three possible responses were available: 1="No", 2= "Yes, I smoke every now and then" and 3= "Yes, I smoke every day". This variable was then dichotomised so as respondents could be classified as either smokers or non-smokers.

For alcohol consumption, respondents were asked about their typical daily alcohol consumption with the question "On average, do you have more than 4 alcoholic drinks a day?" with 1= "No" and 2= "Yes".

The survey provided self-reported weight and height and so body mass index was calculated as weight in kilograms over the square of height in metres. Individuals were then classified as being either a normal weight (BMI <25 kg/m2) or overweight (BMI >25 kg/m2).

A limitation of the DNB survey is that it contains scarce information on other health-seeking behaviours such as regular exercise or consumption of fruit and vegetables, which would have potentially demonstrated a correlation with time preferences.

3.5.2.2 Time preferences

In the economics literature, time preferences are conventionally represented by time discounting rates derived from experimental elicitation procedures (Frederick et al., 2002). The DNB Household Survey does not contain a time preference question of

this sort for the period of study, however a number of suitable proxies will be applied. Time discounting has a number of related concepts, including present orientation, impulsivity, self-control and patience therefore four variables portraying these concepts will be used: time horizon, expenditure control, spending decisions and consideration of future consequences score. We expect that financial strain increases time discounting leading to an increased incidence of poor health-related behaviours.

Time horizons have been used elsewhere as an index of time preferences (Picone et al., 2004; van der Pol et al., 2017) and in Adams and Nettle (2009) it was shown that planning horizon and time preference rate, measured using hypothetical trade-offs over time, were correlated. In economic models of household decision-making, a higher discount rate will lead to a shorter time horizon and a lower discount rate will lead to a longer time horizon (Hong and Hanna, 2014). In particular, time horizon has been used to understand saving (Lusardi, 1998; Samwick, 1998) as well as the demand for cancer screening (Picone et al., 2004), adherence to physical activity advice (Adams, 2009; Brown and van der Pol, 2014; van der Pol et al., 2016), smoking (Khwaja et al., 2006; Peretti-Watel et al., 2013) and obesity (Kyanko and Elbel, 2016). In the DNB survey, respondents were asked 'Which of the time-horizons mentioned below is in your household most important with regard to planning expenditures and savings?'. There were five possible responses of increasing duration to this question: 'the next couple of months', 'the next year', 'the next couple of years', 'the next 5 to 10 years' and 'more than 10 years from now'. This variable was coded to make a higher score correspond to shorter time horizons.

Preference for spending in terms of discretionary income, developed by Ritzema (1992), was used as our second proxy for the rate of time discounting, as has been the case in other papers such as Nyphus and Webley (2006). The variable asks whether respondents tend to spend the money that is left over after having paid for food, rent and other necessities immediately or if they save as much as possible. The respondent answered by using a 7-point scale labelled (1) 'I like to spend all my money immediately' and (7) 'I want to save as much as possible'. This variable was coded to make a higher score correspond to a greater preference for spending in terms of discretionary income.

The third measure, perceived difficulty of controlling expenditure (PLANNING), was measured by the question "Many people find it difficult to plan or control their expenditures. Do you find it difficult to control your expenditures?" Individuals respond by using a 7-point scale ranging from '1-very easy' to '7-very difficult'. We expect this variable to be a successful proxy for the rate of time discounting, with other studies such as Borghans and Golsteyn (2006) finding this to be the case. The relationship between perceived difficulty of expenditure control and self-control is that it is related to the general amount of self-control resources available (Rabinovich and Webley, 2007). Furthermore this variable has been found to be an established predictor of savings behaviour (Nyhus, 2002). Secondly, this variable is related to self-efficacy and could reflect the perceived difficulty of achieving a long-term financial goal. In this vein, the variable reflects a perceived balance between a long-term goal's demand on limited resources of self-control and the actual availability of these resources. Therefore those with strong self-control are likely to have sufficient resources to pursue a long-term goal and therefore possess a lower rate of time discounting (Rabinovich and Webley, 2007).

The final measure is the Consideration of Future Consequences scale, a psychological construct used to measure an individual's future orientation developed by Strathman et al. (1994). It was found that those who were more concerned about the future smoked and drank less than others and engaged in more environmentally concerned behaviour (Strathman et al., 1994; Ebreo and Vining, 2001). Respondents indicate to what extent they agree with the 11 statements (FUTURE01 to FUTURE11) on attitudes referring to the trade off between the present and the future using a 7-point scale (1= completely disagree; 7=completely agree). Other studies have used this measure as a proxy for time discounting (Borghans and Golsteyn, 2006; Nyphus and Webley, 2006; Huizen and Plantenga, 2013). Those who agree with the statement "I think it is more important to work on things that have important consequences in the future, than to work on things that have immediate but less important consequence" are likely to exhibit a lower rate of time discounting. When constructing the CFC score, FUTURE01, FUTURE02, FUTURE06 and FUTURE08 were recoded so that a higher score would result in more present focus, and hence a negative correlation with time horizon. Further detail is provided in the appendix. These questions were not asked in 2008 and, from 2010, they were only asked of

those not asked in previous waves. The treatment of missing data is discussed below in section 2.3. CFC scores differed minimally across the 20 years examined.

3.5.2.3 Financial strain

Two different measures of the respondent's current financial situation were used to construct our measure of financial strain. When asked 'How well can you manage on the total income of your household?' respondents chose from five possible answers: '1-it is very hard','2-it is hard', '3-it is neither hard nor easy','4-it is easy' and '5-it is very easy'. A second question asked 'How is the financial situation of your household at the moment?' with possible responses: '1-there are debts', '2-need to draw upon savings', '3-it is just about manageable', '4-some money is saved' and '5-a lot of money can be saved'. A dichotomous financial strain variable was constructed which was one if the response in either of these questions was 1 or 2 and zero otherwise.

3.5.2.4 Gender

The respondent's gender was represented by a binary variable and was included as a covariate in the mediation analysis however was used as the moderator in the first moderated mediation model.

3.5.2.5 Employment status

The twelve categories of response to primary occupation were reduced to a dichotomous indicator of whether employed or not. Those who were included in the employed category were employed on a contractual basis, worked in their own business or were classified as free profession, freelance or self employed. Those who were not in employment were those looking for work after having lost a job, looking for first time work, students, working in own household, retired, disabled, benefit recipients and volunteers. As with gender, this new dichotomous variable was included as a covariate in the mediation analysis but served as a moderator in the second moderated mediation analysis.

3.5.2.6 Covariates

A number of covariates were used as control variables. The highest education level completed, whether they had a partner present in the household and whether they lived in owner-occupied accommodation were represented by binary variables. Age and the number of children in the household entered the model as continuous variables. The survey records net household income as a categorical variable. This was recoded taking the midpoint of each category and upper (lower) interval boundaries for the lowest (highest) category. The average net household income response within the household was taken where responses differed or the response was missing.

3.5.3 Statistical analysis

Causal mediation analysis was conducted to examine the direct effect of financial stress on health, and the indirect associations via health behaviours in the first instance and secondly changes in time preferences. Next, a total effects moderation analysis (Edwards and Lambert, 2007) was carried out to test if gender and employment situation moderated the direct effect of financial strain on ill health or the indirect mediated effect of changes in health behaviours.

The use of longitudinal data in this study will address some previous shortcomings in other papers where mediation and moderation analysis did not explicitly consider the role of time, despite the fact that it takes time for meditational and moderational effects to evolve (Maxwell et al., 2011) and furthermore, previous levels of the variables need to be controlled for or the paths in the models may be over or underestimated relative to their true values (Selig and Preacher, 2009). Kraemer et al. (2008) stated "the necessity of using longitudinal studies with at least two and usually three time points to establish moderators and mediators" (p. 106). Gollob and Reichardt (1987) discuss the problems of using cross sectional data in detail.

We used a sequential design, i.e. the time intervals between X, M and Y were staggered (e.g. the process $X_{t-2} \rightarrow M_{t-1} \rightarrow Y_t$) (Mitchell and Maxwell, 2013). Such a model, presented by Cole and Maxwell (2003) is known as a cross lagged panel model and is based on structural equation modelling for repeated measures of X, M

and Y in which each variable depends on both causally prior variables and on prior assessments of the same variable (Gollob and Reichardt, 1991). The cross-lagged panel model allows time for causes to have their effects, supports stronger inference about the direction of causation compared to models using cross sectional data, and reduces the probable parameter bias that occurs when using cross sectional data (Selig and Preacher, 2009). The cross-lagged panel model for X, M and Y is shown in figure 3.1.

Path ab represents the indirect effect via the mediators (1:health behaviours, 2: changes in time preferences) while path c represents the direct effect from financial stress to health. Covariances among the variables at the first wave are included, as are covariances among the residual variances of X, M and Y at each wave.

This model can be expressed by the following equations:

$$M_{i,t-1} = \delta^{M} M_{i,t-2} + \beta^{\alpha} S_{i,t-2} + \gamma^{M'} X_{i,t-1} + \epsilon^{M}_{i,t-1}$$

$$Y_{it} = \delta^{y} Y_{i,t-1} + \beta^{b} M_{i,t-1} + \beta^{c} S_{i,t-2} + \gamma^{Y'} X_{it} + \epsilon^{Y}_{it}$$

In the first mediation analysis of the effects of financial strain on poor health mediated by health behaviours, the mediators are smoking, heavy drinking and being overweight. In the second mediation analysis of the effects of financial strain on health behaviours the mediators are time horizons, spending discretionary income, difficulty controlling expenditure and consideration of future consequences.

The mediating variable M_{it-1} depends on its own lag $M_{i,t-2}$ but is also affected by financial strain in the previous period $S_{i,t-2}$ and a vector of demographic and household characteristics $X_{i,t-1}$. Health outcomes, Y_{it}, are also dependent on their own lag $Y_{i,t-1}$ and affected by financial strain from two periods before $S_{i,t-2}$, both directly and indirectly through changes in the mediator(s) in the previous period $M_{i,t-1}$. A vector of demographic controls and household characteristics further affects health outcomes.

In the first analysis, the health outcome is self-reported health and in the second

analysis the health outcomes are the health behaviours smoking, heavy drinking and being overweight. Lagged dependent variables are included to account for unmeasured and uncontrolled confounder variables that correlate with the predictor variable in the previous period and cause the dependent variable in the current period (Cole and Maxwell, 2003) and also allow modelling of longer-term effects of financial strain.

Additionally, financial strain, $S_{i,t}$, is governed by a simple autoregressive model where the only explanatory variable is its own lag $S_{i,t-1}$. The residual from this equation ϵ_{it}^{S} and the residuals from the equations above $\epsilon_{it}^{M}$and ϵ_{it}^{Y}t are then allowed to correlate to account for contemporaneous changes in unmeasured variables that may be correlated across equations. In the estimation that follows, the primary parameters of interest are the effect(s) of financial strain on the mediator(s) β^{α}, the effect(s) of the mediator(s) on health outcomes $\beta^{b}$and the direct effect of financial strain on health outcomes β^{c}.

Next, we investigated whether the mediation pathways linking financial strain and health indicated by each health behaviour differed for men and women or employment status. Going beyond the mediation analysis approach used above, we used moderated path analysis based on simple regression equations to assess moderated mediation (Edwards and Lambert, 2007), where a mediated effect is moderated by some variable (Baron and Kenny, 1986). There were two "course correcting" publications, one by Edwards and Lambert (2007) and the other by Preacher, Rucker, and Hayes (2007), which discussed simultaneous mediation and moderation strategies. According to Edwards and Lambert (2007), moderated-mediation implies that the mediated effects are dependent on the levels of a moderator variable.

We used a total effect moderation model (Edwards and Lambert, 2007), where gender and employment status were included as moderators of the IV-Mediator path, the Mediator-DV path and the direct IV-DV path. The model diagram is shown in figure 3.2.

Moderated mediation can be expressed by using interaction terms. To test moderated mediation, the same two equations as those used to assess mediation were adjusted to include the following interaction terms: the product of financial strain and the moderator and the product of the mediator and the moderator. If the coefficient on the interaction term is found to be statistically significant this indicates a moderating effect exists. In each equation, S = main independent variable (financial strain), W = moderator (gender or employment status), M = mediator (health behaviour), and Y = main dependent variable (health).

The equations for such a model are demonstrated below.

$$M_{it-1} = \delta^M M_{i,t-2} + \beta^\alpha S_{i,t-2} + \beta^b W_{i,t-1} + \beta^c S_{i,t-2} W_{i,t-1} + \gamma^{M'} X_{i,t-1} + \epsilon^M_{i,t-1}$$

$$Y_{it} = \delta^y Y_{i,t-1} + \beta^d M_{i,t-1} + \beta^e S_{t-2} + \beta^f W_{it} + \beta^g M_{i,t-1} W_{it} + \beta^h S_{t-2} W_{it} + \gamma^{Y'} X_{it} + \epsilon^Y_{it}$$

In the first moderated mediation analysis we assess whether the effects of financial strain on poor health mediated by health behaviours varies by gender. In the second instance, the analysis is repeated with employment status as the moderator.

In this instance, the mediating variable M_{it-1} depends on its own lag $M_{i,t-2}$, financial strain in the previous period $S_{i,t-2}$, the moderator $W_{i,t-1}$ and the interaction between the independent and moderator variable $S_{i,t-2}W_{i,t-1}$ as well as a vector of demographic and household characteristics. As was the case in the initial mediation model, health Y_{it} is influenced by its own lag $Y_{i,t-1}$, financial strain from two periods previously S_{t-2}, both directly and indirectly through changes in the mediator in the previous period and demographic and household controls. However, in the moderated mediation analysis it is additionally affected by the moderator W_{it} and the interaction between the moderator and financial strain from two periods previously $S_{i,t-2}\,W_{it}$ and the interaction between the moderator and the mediator one period previously $M_{i,t-1}W_{it}$.

Both the mediation and moderated mediation models are estimated on each triplet of three consecutive waves from 1997 (1997, 1996, 1995) to 2017 (2017, 2016, 2015) and parameters are constrained to be equal across all twenty triplets. In this way,

intercepts and residual variances can vary across time. Bivariate probit models are used in all cases except for time preferences where an ordered probit model was specified. The system was estimated using weighted least squares in Mplus version 7. Standard errors for the indirect effects were computed using the delta method (Sobel, 1982).

A high rate of missingness was evident for the key variables as all participants do not necessarily respond to all questionnaires and to all questions within questionnaires, as can be seen in Table 3.1. The rate of missing observations was about 40% for the key variables used. To account for item level missing data and obtain the maximum number of cases, multiple imputation (MI) was employed in MPlus for both continuous and categorical variables (Asparouhov and Muthen, 2010). The purpose of MI is to handle missing data to achieve valid statistical inference, rather than re-create the individual missing values as close as possible to the true values (Schafer, 1997). We must assume that any missing data is missing at random (MAR) i.e. the probability of missing data on Y is unrelated to the value of Y after controlling for other variables in the analysis (Soley-Bori, 2013). There are no clear limits to the rate of missing data for MI (Gorelick, 2006) and some studies suggest rates as high as 60% are acceptable under the MAR assumption conditional on observed data (Kristman et al., 2004).

MI is carried out using the Bayesian method. Missing data is imputed but rather than imputations being based on a single data set, several data sets, based on previously observed data on the variables, are imputed using a Markov Chain Monte Carlo simulation, analysed separately and finally combined with standard errors adjusted for variability due to missing data (Rubin, 1987; Schafer, 1997). Fifty imputations (Graham et al., 2007; Enders, 2010) were carried out in this case to yield sufficient statistical power. Multiple imputation is less prone to parameter estimate bias, provides superior statistical power and takes better account of missing data sampling variability than case wise deletion or alternative missing data approaches (Sterne et al., 2009; Janssen et al., 2010; Feng et al., 2013). Feng et al. (2013) provide an accessible overview of methodological approaches for dealing with missing data in longitudinal studies.

Although the strength of our study design is that the temporal ordering of financial strain and health consequences in our model controls for potential reverse causation, the cross wave structure may not capture short term periods of financial strain which can also impact on health i.e. strain may affect health sooner than the two year time lag that we are testing in this paper. This is a limitation of the data available to us.

3.6. Results

Descriptive statistics of all variables from the year 1997 to 2017 are presented in Table 3.1. It can be seen that the majority of respondents are in good or excellent health (77.9%) although despite this, 53.1% of the population are overweight, 20.9% smoke and 6.1% are heavy drinkers. The percentage of adults reporting financial strain is 13.2% of the constructed dataset (or 22.1% of responses). This figure is low by European standards especially post crisis (European Commission, 2015). Over half the sample (53.4%) have time horizons of a year or less, 0.9% like to spend all their disposable income immediately, 16.8% have difficulty controlling their expenditures and, on average, respondents show no preference between distant and future consequences of potential behaviours (average = 4.1). Our sample has an approximately equal number of males and females, the mean age is 51 years and the mean annual total household net income is €38858.52.

Table 3.2 shows the results of the mediation analysis of the effects of financial strain on health two years later mediated through changes in health behaviour.

Higher levels of financial strain are seen to be a statistically significant predictor of a greater tendency for heavy drinking (β = 0.156). However, there is no statistically significant relationship between financial strain and a propensity for smoking (β = 0.004) or of being overweight (β = 0.053). The effects of these health behaviours on the probability of reporting good or excellent health indicate that smoking ($\beta = -0.114$), heavy drinking ($\beta = -0.097$), and being overweight ($\beta = -0.083$) all have a statistically significant negative effect on health as expected. The direct effect of strain on the probability of reporting excellent or good health is relatively large ($\beta = -0.126$). As a proportion of the overall effect of strain on health, the indirect effect of strain on health mediated through these health behaviours is 15.8%,

p=0.085 (i.e. I/(-0.106 + I) = 0.158 where total indirect (I) = 0.004*(-0.114) + 0.156*(-0.097) + 0.053*(-0.083)=-0.02.

The mediation analysis is then repeated to examine the extent to which the effects of financial strain on health behaviours are mediated through changes in our four time preference proxies, namely time horizon, spending discretionary income, difficulty controlling expenditures and consideration of future consequences score. The results of this analysis can be found in table 3.3. Financial strain is seen to have a statistically significant effect on two of the four time preference measures used causing an increase in the rate of intertemporal discounting. The strongest impact is on the perceived difficulty of controlling expenditure (β=0.171) with a weaker effect on preference for spending disposable income (β=0.055). These effect sizes are small when the scales of these measures are considered (1–7 for spending discretionary income and difficulty controlling expenditure). There was no statistically significant effect on time horizon (β=0.028) or consideration of future consequences (β=−0.010).

In the results of the effects of time preferences on health behaviours we find that for smoking, there is a positive association with consideration of future consequences ($\beta = 0.069$) however there is a trivial indirect mediated effect of -0.00069 (-0.010*0.069, p=0.298). There is no significant association between smoking and the other time preference measures, time horizon (β=-0.024), spending discretionary income (β=0.025) and difficulty controlling expenditure (β=0.017).

In terms of heavy drinking, there is no statistically significant effect of any of the time preference measures on health behaviour. Time horizon (β=-0.009), spending discretionary income (β=0.025), difficulty controlling expenditure (β=-0.011) and consideration of future consequences (β=0.017).

Similarly, there is little effect of the time preference measures on being overweight (time horizon (β=0.006), spending discretionary income (β=0.004) and consideration of future consequences score (β=0.021)) with the exception being difficulty controlling expenditure which has a statistically significant positive effect (β=0.040). There is a small but statistically significant mediated effect of difficulty controlling

expenditure of 0.007 (0.040*0.171, p=0.000).

Despite expectation, there is no significant direct effect of financial strain on smoking, heavy drinking or being overweight.

In the third step, the moderating effect of gender and employment on the association between financial strain and health behaviours were assessed. Interaction terms indicating moderation did not contribute to any model with statistical significance.

Table 3.4 shows the moderated mediation of the effect of gender on the relationship between financial strain on health mediated by health behaviours. As before in the mediation model, higher levels of financial strain are seen to be a statistically significant predictor of a greater tendency for heavy drinking (β = 0.177). However, there is no statistically significant relationship between financial strain and a propensity for smoking (β = 0.012) or of being overweight (β = 0.058). It can be seen that the coefficients on these variables have slightly increased in size from the basic mediation model. The interaction term of gender*financial strain which demonstrates a moderating effect, if any, has no statistically significant association with smoking (β = 0.018), heavy drinking (β = -0.043) or the tendency to be overweight (β = 0.001).

As before, smoking ($\beta = -0.116$), heavy drinking ($\beta = -0.106$), and being overweight ($\beta = -0.099$) all have a statistically significant negative effect on the probability of reporting good health. These coefficients have also slightly increased in size from the basic mediation model. None of the interaction terms of gender with health behaviours are statistically significance, female*overweight ($\beta = 0.027$), female*heavy drinking (β =0.026), female*smoking (β =-0.012).

The direct effect of strain on the probability of reporting excellent or good health has remained the same and is still relatively large ($\beta = -0.107$), however the interaction term of gender*financial strain is small and insignificant (β =-0.011).

Comparing males versus females, as a proportion of the overall effect of strain on

health, the indirect effect of strain on health mediated through these health behaviours for males is 19.3% p=0.101 (i.e. I/(-0.107+ I) = 0.193 where total indirect effect for males (I) = -0.116*(0.012) + -0.106*(0.177) + -0.099*(0.058) =-0.025, p=0.086. As a proportion of the overall effect of strain on health, the indirect effect of strain on health mediated through these health behaviours for females is smaller: 12.8%, p=0.536 (i.e. I/(-0.118+ I) = 0.128 where total indirect effect for females (I) = -0.018, p=0.470.

The total effect for both males and females is large and statistically significant. Total effect (indirect effect + direct effect) for males= -0.107+(-0.025)=-0.132, p=0.003. The total effect for females=-0.118+(-0.018)=-0.136, p=0.009.

Table 3.5 shows the moderated mediation of the effect of employment status on the relationship between financial strain on health mediated by health behaviours. A high level of financial strain is positively associated with a greater tendency for heavy drinking (β = 0.168), but not with propensity for smoking (β =- 0.010) or of being overweight (β = 0.049), as was the case in all previous tables. The interaction term of employment*financial strain has no statistically significant association with smoking (β = 0.036), heavy drinking (β = -0.012) or the tendency to be overweight (β = 0.024).

Smoking ($\beta = -0.126$) and being overweight ($\beta = -0.066$) have a statistically significant negative effect on the probability of reporting good health, whereas heavy alcohol consumption did not in this case ($\beta = -0.110$). None of the interaction terms of employment with health behaviours are statistically significant, employment*overweight (β =-0.046), employment *heavy drinking (β =0.010), employment *smoking (β =0.010).

The direct effect of strain on the probability of reporting excellent or good health two years later has decreased slightly from the previous mediation and moderated mediation models however is still significant ($\beta = -0.087$). The interaction term of employment*financial strain is small and insignificant (β =-0.053).

Comparing those in employment versus those that are not, as a proportion of the overall effect of strain on health, the indirect effect of strain on health mediated through these health behaviours for the non-employed is 19.1% p=0.303 (i.e. I/(-0.087+ I) = 0.191 where total indirect effect for the non-employed (I) = -0.126*(0.010) + -0.110*(0.168) + -0.066*(0.049) =-0.022, p=0.262. As a proportion of the overall effect of strain on health, the indirect effect of strain on health mediated through these health behaviours for the employed is smaller: 16%, p=0.159 (i.e. I/(-0.14+ I) = 0.160 where total indirect effect for the employed (I) = -0.026, p=0.164.

The total effect for both those in employment and those that are not is again relatively large and statistically significant. Total effect (indirect effect + direct effect) for the non-employed= -0.087+(-0.020)=-0.107, p=0.020. The total effect for the employed=-0.140+(-0.026)=-0.166, p=0.001.

3.7. Discussion and Limitations

The first mediation analysis examines the response of self-reported health to financial strain and estimates the proportion of the response mediated by changes in health behaviours. Financial strain has a large and statistically significant negative direct effect on self reported health ($\beta = -0.106^{**}$). This result is consistent with the findings of other longitudinal studies that demonstrate that repeated periods of economic hardship are associated with lower self-reported health (Kahn and Pearlin, 2006; Ahnquist et al., 2007). However, while financial strain is widely known to cause poor health, poor health could equally cause financial strain through the effects of ill health on labour market status, therefore impacting on the ability to service debts. Hence, our result is noteworthy in itself; by carrying out mediation analysis longitudinally we address concerns in the literature that many studies relating financial strain and health do not clearly establish the direction of causation and do not fully account for confounders (Berkman et al., 2014).

In terms of the indirect pathway, over the three year time frame considered, behavioural change mediates 15.8% of the effect of financial strain on health,

however this result was not significant, indicating that the biological pathway from financial strain to illness may in fact be more important than the influence of financial strain on the regulation of health related behaviours. There is a vast literature on the effects of stress on the regulation of immune and inflammatory processes which are known to influence mental health; infectious autoimmune and coronary artery diseases and some cancers (Cohen et al., 2007). However, the lack of measures on the biological responses to stress in the data (for example, inflammatory biomarkers and levels of glucose control) means that we cannot test the physiological effects of stress on health. Such analysis is necessary for future research. Additionally, the statistically insignificant behavioural response may be due to the type of stress we are testing. Perhaps, economic stress is different to other forms of stress that have been proven to influence health behaviours such as smoking, drinking and fast food consumption (Gerber and Puhse, 2009).

We find evidence that the behavioural response to strain is not due to the influence of changes in time preferences. Financial strain leads to an increase in two of the time preference measures used in this study, namely difficulty in controlling expenditure and the more immediate spending of discretionary income. Evidence has revealed that stress results in a reduction in cognitive abilities and self control strength (Muraven and Baumeister, 2000; Vohs, 2013), hence inducing impulsive decision-making. Consequently individuals experiencing financial strain are lacking in self-control resources due to the mental effort required to deal with financial strain and therefore do not have the capacity to regulate their behaviours.

According to the literature, those with difficulty exercising control are more likely to yield to their myopic selves and engage in present orientated behaviour such as smoking (Reynolds, 2004; Khwaja et al., 2006; Adams, 2009: Fields et al., 2009), drinking (Vuchinich and Simpson, 1998; Mitchell et al., 2005) and consuming unhealthy foods. Despite this, we found there was little to no response of health behaviours to changes in the four time preference measures employed. None of the four measures were associated with propensity to drink alcohol excessively, consideration of future consequences significantly affected smoking, while difficulty controlling expenditure affected being overweight. The overall response of health behaviour to financial strain mediated by time preferences is therefore very slight.

According to Borghans and Golsteyn (2006), the relationship between discount rates and health outcomes are not very robust. Fuchs (1982) and Chapman and Coups (1999) among others, only find a minor association between discount rates and health behaviours, where the relations are not found for all measures of time preference or for all behaviours. This could be explained by the fact that the influence of the force of present biases increasing demand for each unhealthy consumption good (i.e. alcohol, cigarettes or fast food) is outweighed by the reduction in demand due to the lack of disposable income available to those who are financially strained (French and McKillop, 2016; Jofre-Bonet et al., 2018).

Ruhm (2000) shows that in economic booms, health outcomes deteriorate, while health improves during recessions. Likewise, a number of studies find lower levels of alcohol consumption, reduced cigarette smoking and improved diet as a result of the financial crisis in developed countries which they attribute to reductions in disposable income or an income effect (Ruhm and Black, 2002; Charles and DeCicca, 2008; Karanikolos et al., 2016).

Other research has shown that young adults from higher family background socio-economic status were most prone to alcohol and drug use due to an abundance of disposable income, among other reasons (Patrick et al., 2012). Furthermore, a higher occupation status among adults is found to be associated with more alcohol and substance use disorders (Diala et al., 2004; Wohlfarth and Van den Brink, 1998), and higher income predicts more frequent drinking and less smoking (Schoenborn and Adams, 2010).

Hence, policy interventions suggested elsewhere such as therapies to improve impulse control are therefore likely to have limited efficacy in preventing illness for those with financial difficulties (Fields et al., 2014). There is no additional direct effect of strain on health behaviours unrelated to time preferences. A direct effect might have been expected given studies indicating individuals dampen psychological arousal to stress by engaging in unhealthy behaviours (Kassel et al., 2003; Ensel and Lin, 2004).

In order to examine the relative insignificance of the mediation results, we investigate how the relative contributions of the multiple behavioural pathways linking financial strain and health vary between men and women and between those that are employed versus those not in employment. The particular health behaviours in response to financial strain do vary by gender, however as mentioned previously the results are not strong in statistical significance. As a proportion of the overall effect of strain on health, we find that the indirect effect of strain on health mediated through health behaviours for females (12.8%, p=0.536) is smaller than for men (19.3%, p=0.101). However, the opposite is the case for the direct and total effects, with a slightly larger significant effect emerging for females (-0.118, p=0.014) than for males (-0.107, p=0.010).

Gender differences in stress-related health outcomes have been mentioned previously in other studies (Kessler and McLeod, 1984; Thoits, 1987; Turner and Avison, 1989; Weekes et al., 2005). Aneshensel et al. (1991) demonstrate that men and women respond to stressors in gender-specific ways with women being more vulnerable to the psychological ramifications of stress developing the onset of affective and anxiety disorders and heightened symptoms of depression, and men showing greater physiological reactivity to stress converting their feelings of strain into other realms of behaviour such as substance-use and drinking to excess (Aneshensel et al., 1991; Mirowski and Ross, 1995; Flinn et al., 1996; Rosenfield, 1999). Such evidence in the literature lends support to our results that the indirect effect or behavioural pathway to health is stronger for males. In contrast, the smaller indirect and larger direct effect for women indicates that there is something else in the chain of causation that has greater significance for health i.e. psychological ramifications. For example, Kemeny (1991) found poorer immune functioning with emotion-based responses to strain.

Another possible explanation for the stronger indirect effect for males is that the societal views on gender roles may place constraints on women, limiting the types of behaviours used to cope with strain (both positive and negative) that are socially acceptable. For example, some research suggests that women who drink heavily are viewed more negatively than men and may be more concerned with how others perceive their drinking (George et al., 1988; Armeli et al., 2000). This is one hypothesized explanation for the finding that the association between strain and

suboptimal health behaviours is stronger among men than women (Cooper et al. 1992; Armeli, et al., 2000).

At present, we are drawing inferences from our results, and hence, in future research physiological measures of the correlates of stress and health in the two sexes may be useful to better disentangle the mechanisms responsible for these gender differences. Specifically, hormones related to stress (e.g. adrenaline, cortisol, and oxytocin), as well as immune markers related to health (e.g. salivary Immunoglobulin-A) may prove crucial in furthering our understanding (Weekes et al., 2005).

In the second moderated mediation analysis, we find the mediating role of health behaviours in the relationship between financial strain and health does not vary significantly by employment status. As a proportion of the overall effect of strain on health, the indirect effect of strain on health mediated through these health behaviours for the non-employed is 19.1% p=0.303 while for the employed it is 16%, p=0.159, however there is no statistical significance of these results.

It was hypothesized that the financially stressed who are not in employment should present a stronger indirect effect compared to the employed due to a number of factors. First, it was anticipated that the non-employed would be more likely to exhibit negative health behaviours as coping mechanisms to deal with their financially adverse situation as they do not have the control to alleviate such strain through means such as working more to increase income (Frese and Mohr, 1987; Selenko and Batinic, 2011). Secondly, the non-employed do not have access to work which fulfills human needs by shaping personal identity, securing social status and giving structure and purpose to daily life, all of which would help alleviate symptoms of financial strain and subsequently lessen the need for negative coping mechanisms which worsen health (Black, 2008; Waddell, 2006). While the results do point in this direction, they are not strong enough to draw any conclusions.

The total effect for both those in employment and those that are not is relatively large and statistically significant, however in this instance the effects were stronger for the employed group. The total effect (indirect effect + direct effect) for the non-employed= -0.087+(-0.020)=-0.107, p=0.020. The total effect for the employed=-

0.140+(-0.026)=-0.166, p=0.001. A possible explanation for this result, and lack of result in the indirect case may be due to how the dichotomous employment variable is set up, as guided by the responses to the primary occupation question in the DNB survey. The employed category includes anyone who is employed on a contractual basis, works in own business, free profession, freelance and the self-employed. The non-employed covers those looking for work, students, retired, home keepers and volunteers. While some individuals fit into the employed category, they may not be in full time permanent employment. Rather they may be shift workers or zero hour contract holders and subsequently may be no more able than the non employed to manage their financial strain in the same way as those who are in more secure, permanent employment. In fact, zero hour contracts or flexible work may actually heighten feelings of strain due to instability of working hours and uncertain income (Benach et al., 2007). It has been found that those with a precarious relationship to the labour market (shift workers and zero hour contract holders) are more at risk of poor mental and physical health than their peers (Centre for Longitudinal Studies, 2017) including sleep disturbance, fatigue, digestive problems and other stress related illness (Bambra et al., 2008). Therefore, future research needs to move away from investigations that compare the effect of strain on health of the non-employed and employed persons towards an analysis of greater distinctions looking at unemployed and underemployed workers versus workers with stable jobs.

Past research has not always considered how strain and health unfold in relation to one another over the life course. While numerous studies consider the relationship between stress and specific health behaviours or health outcomes, much of this research is based on clinical samples and/or conducted in laboratory settings that rely on simulated stressors. Other studies often rely on cross-sectional data analyses of measures at one point in time, which fail to clarify the direct of causation from strain to health. Furthermore, the link between naturally occurring strain and health behaviours in the general population and how that link unfolds over the life course has not received enough attention to date (Umberson et al., 2008). In utilising nationally representative panel data over a 20-year period, we have been able to conduct longitudinal analysis of causation and addressed many of the concerns prevalent in the literature on economic strain and health.

There are however a number of limitations to any conclusions that can be drawn from this work. Stress is known to directly interfere with the regulation of immune and inflammatory processes (Cohen et al., 2007), leading to an increased risk of disease or illness (McEwen, 1998), such as cardiovascular disease (Esler et al., 2008; Richardson et al., 2012; Steptoe and Kivimäki, 2012), upper respiratory infections (Graham et al, 1986; Pederson et al., 2010) and autoimmune diseases (Stojanovih and Marisavlijevich, 2008). However, there are a lack of biological measures in the data to test this association, which if present, would allow testing of the biological effects of stress on health and hence provide directly comparable results with the behavioural pathway. However, as self-rated health has proven validity as a predictor of objective health (Idler and Benyamini, 1997; Franks et al., 2003; Bridges and Disney, 2010), the significant negative association of this measure with stress gives some indication of the biological effects of stress. For example, a meta-analysis finds those who report "poor" health have a twofold higher risk of all-cause mortality relative to those who report "excellent" health (DeSalvo et al., 2006).

Furthermore, additional data on other health behaviours associated with stress e.g. physical exercise and poor adherence to medical advice (Vedhara, 2005) may have provided more insight into the behavioural pathway. Also more nuanced questions on health behaviours might show different results.

The model considered in the analysis examined the effects of financial strain on health over a three-year window but taking measures at annual intervals may miss the more immediate responses of health behaviours to financial strain therefore misrepresenting the effect sizes (Cole and Maxwell, 2003). Finding the optimal time lag for longitudinal mediation and moderation models requires further research.

Additionally, it has been shown that strain is associated with worse physical and mental health outcomes, however it remains less clear how financial strain differs from other stresses. Perhaps different types of strain influence health behaviours such as smoking, drinking and fast food consumption in different ways. If this is the case, further investigation is required as to how individuals fair when they are faced with financial strain which causes impulsivity and worse health versus a reduction in the ability to afford unhealthy consumption due to lower spending power.

This paper focuses on financial strain measured at one point in time and its effects on health two years later, however using one measurement occasion of strain for each individual may miss important variation over time. There is a sociological and a medical literature that argues that the duration of strain is important with chronic strain being more damaging for health than acute or episodic strain (French and Vigne, 2018). According to Shippee et al. (2012) single-occasion measures of financial strain may not be consequential for health and preclude estimation of the recurrent nature of financial strain, which may be more detrimental to the health of those who face such misfortune. Shippee et al. (2012) point to the necessity of considering life course variability in financial strain and the subsequent impact on health. In a study of older people, Kahn and Pearlin (2006, p. 24) found that "the greater the persistence of financial strains across the earlier years of the life course, the greater the damage to multiple dimensions of later-life health", while Szanton et al. (2010) showed that recurrent financial strain was associated with poor health among African Americans.

In terms of the extended moderated mediation models, some variability was found between males and females and those in employment compared to those who are not. However, the high degree of missing responses on other potential moderators of interest meant that further sources of variation in the relationship between strain and health could not be explored. A resilience literature highlights how social capital helps mitigate feeling of economic strain (Reeves et al., 2014; Masarik et al., 2016). Additionally, in households where a partner has assumed financial responsibility for the entire household thus taking on the psychological burden, individuals report lower levels of feelings of financial strain (Goode, 2012).

3.8. Conclusions

In this paper, we have used the Dutch National Bank Household Survey to focus on the relations between financial strain and health, and the pathway by which these relations might exist. We conducted an initial longitudinal mediation analysis to examine the causal relationship from financial strain to health and the degree to which this relationship is mediated through changes in health behaviours. Despite

much evidence that shows the association between stress and unhealthy behaviours (Herbert and Cohen, 1994; Park and Iacocca, 2014; Berger and Owen, 1988; Salmon, 2001; Wardle et al., 2000), we found that 15.8% of the response of self-reported health to financial strain was mediated by changes in smoking, heavy drinking and being overweight however this was statistically insignificant. We offer a number of explanations as to why this effect is not as expected. Given the high levels of poor health behaviours evident in the UK and elsewhere around the world, research that increases our understanding of health behaviours could significantly benefit public health. Economic stresses therefore appear to be distinct from other forms of stress in the relatively minor influence of non-biological pathways to ill-health.

A second mediation analysis was used to understand this lack of behavioural response as other authors have linked stress to intertemporal discounting (Lawrance, 1991; Cornelisse et al., 2013; Haushofer et al. 2015) and intertemporal discounting to changes in health behaviours (Reynolds et al. 2004; Komlos et al., 2004; MacKillop and Kahler, 2009; Ikeda et al., 2010). We found evidence that financial strain causes greater impulsivity but this does not lead to worse health behaviours. The lack of link between time discounting and health may be explained by the influence of the force of present biases increasing demand for each unhealthy consumption good (i.e. alcohol, cigarettes and unhealthy food) being outweighed by the reduction in demand due to the lack of disposable income available to the financially stressed (French and McKillop, 2017).

Despite the relatively insignificant indirect pathway, the direct links between financial stress and self-rated health, being overweight, smoking and excessive alcohol consumption were strong in statistical significance. The negative affective states caused by stress may influence health through physiological alterations more so than changes in behavioural patterns however this could not be tested due to data limitations.

In the third part of the analysis a moderated mediation analysis was performed to examine if certain groups deal better with financial strain than others. In particular, we tested if gender and employment status affect the magnitude of the effect of financial strain on health via health behaviours. Our first assessment of moderation

by gender suggests that the indirect effect of health behaviours is larger, but not statistically significant, for men than for women. We suggested that this was because of the gender specific ways of dealing with strain. Furthermore, we suggested that societal views on gender roles potentially placed constraints on the types of behaviours women use to cope with strain, hence the smaller indirect effect.

In the second moderated mediation analysis using employment status as a moderator, we found that the indirect effect of those that are not in employment is slightly stronger compared to those that are, however again this result was statistically insignificant. Potential reasons as to why the effect should be stronger for the non employed were offered. Despite expectation, the direct effect from strain to health was found to be stronger for the employed however we argued that this may be due to the dichotomization of the primary occupation variable in the DNB Household Survey. More nuanced questions on employment status and contract types would be helpful and future work should look more specifically at the differences between unemployed and underemployed workers versus workers with stable jobs.

Unfortunately analysis of other potential moderators were not feasible with the data in the Dutch National Bank Household Survey, however future research looking at aspects such as access to social capital, whether the respondent is the financial decision maker and access to financial advice would all prove interesting avenues of investigation.

Figures and Tables

Table 3.1: Descriptive statistics *(N=45041)*

	n	%	(% non missing)
	Financial strain		
No	20997	46.6	(77.9)
Yes	5951	13.2	(22.1)
Missing	18093	40.2	
	Health		
Fair/Not so good/Poor	6120	13.6	(23.0)
Excellent/Good	20500	45.5	(77.0)
Missing	18421	40.9	
	Smoking		
No	21067	46.8	(79.1)
Yes	5553	12.3	(20.9)
Missing	18421	40.9	
	Heavy drinking		
No	25005	55.5	(93.9)
Yes	1615	3.6	(6.1)
Missing	18421	40.9	
	Overweight		
No	12474	27.7	(46.9)
Yes	14143	31.4	(53.1)
Missing	18424	40.9	
	Time horizon		
>10 years	1116	2.5	(4.0)
5+ years	3543	7.9	(12.7)
Next couple of years	8323	18.5	(29.9)
Next year	6703	1.0	(24.1)
Next couple of months	8139	18.1	(29.3)
Missing	17217	38.2	
	Spending discretionary income		
1= Save as much as possible	2318	5.1	(8.4)
2	7629	16.9	(27.6)
3	9184	20.4	(33.2)
4	5637	12.5	(20.4)
5	1802	4	(6.5)
6	810	1.8	(2.9)
7= Spend money immediately	247	0.5	(0.9)
Missing	17414	38.7	
	Difficulty controlling expenditure		
1=Very easy	5014	11.1	(18.1)
2	8872	19.7	(32)
3	4768	10.6	(17.2)
4	4380	9.7	(15.8)
5	3092	6.9	(11.2)
6	1249	2.8	(4.5)
7= Very difficult	309	0.7	(1.1)
Missing	17357	38.5	
	Consideration of future consequences		
(Mean) and (SD)	(4.075)	(0.678)	

Missing	17,093	38.0	
	Highest level of education achieved		
Primary	23965	53.2	(53.4)
Secondary	15837	35.2	(35.3)
University	5056	11.2	(11.3)
Missing	183	0.4	
	Employed		
No	22403	49.7	(49.8)
Yes	22627	50.2	(50.2)
Missing	11	0.02	
	Partner		
No	7576	16.8	(16.8)
Yes	37465	83.2	(83.2)
Missing	0	0.0	
	Number of children		
(Mean) and (SD)	(0.855)	(1.137)	
Missing	0	0	
	Homeowner		
No	5780	12.8	(29.0)
Yes	14178	31.5	(71.0)
Missing	25083	55.7	
	Sex		
Male	22538	50	(50.0)
Female	22503	50	(50.0)
Missing	0	0.0	
	Age		
(Mean) and (SD)	(51.3)	(16.6)	
Missing	492	1.1	
	Annual household net income (euros)		
(Mean) and (SD)	(38858)	(58143)	
Missing	20,445	45.4	

Notes: All observations for those persons aged 16 and over in households participating in three consecutive waves of the CentERpanel. In 2002, the guilder was replaced by the euro at an exchange rate of 2.20371 guilders = 1 €. All income values before 2003 are converted to € at this exchange rate.

Table 3.2: Structural equation model estimates of the effects of financial strain on self-reported health mediated by changes in health behaviours

Model of strain	
Lagged strain	1.217**
	(0.026)
Effects of strain at t-2 on health behaviours at t-1	
Smoking	
Lagged smoking	3.327**
	(0.057)
Lagged strain	0.004
	(0.057)
Age	-0.005**
	(0.001)
Female	-0.027
	(0.035)
Highest level of education completed-secondary	-0.148**
	(0.038)
Highest level of education completed- university	-0.170**
	(0.062)
Employed	0.098*
	(0.041)
Has partner	-0.119*
	(0.049)
No. of children	0.047
	(0.047)
Annual household net income (log)	-0.014
	(0.033)
Homeowner	-0.171**
	(0.05)
Heavy drinking	
Lagged heavy drinking	2.436**
	(0.054)
Lagged strain	0.156**
	(0.057)
Age	0.003
	(0.002)
Female	-0.345**
	(0.042)
Highest level of education completed-secondary	-0.022
	(0.04)
Highest level of education completed- university	0.051
	(0.061)
Employed	-0.017
	(0.042)
Has partner	-0.068
	(0.051)
No. of children	-0.042
	(0.049)
Annual household net income (log)	0.026
	(0.042)

Homeowner	0.029
	(0.05)
Overweight	
Lagged overweight	2.601**
	(0.027)
Lagged strain	0.053
	(0.038)
Age	0.004**
	(0.001)
Female	-0.025
	(0.023)
Highest level of education completed-secondary	-0.080**
	(0.026)
Highest level of education completed- university	-0.183**
	(0.038)
Employed	0.162**
	(0.03)
Has partner	0.027
	(0.033)
No. of children	-0.008
	(0.034)
Annual household net income (log)	-0.004
	(0.024)
Homeowner	-0.019
	(0.035)
Effects of health behaviours at t-1 on health at t	
Smoking	-0.114**
	(0.028)
Heavy drinking	-0.097*
	(0.047)
Overweight	-0.083**
	(0.022)
Lagged health	2.02**
	(0.025)
Age	-0.008**
	(0.001)
Female	-0.023
	(0.024)
Highest level of education completed-secondary	0.056*
	(0.025)
Highest level of education completed- university	0.155**
	(0.038)
Employed	0.164**
	(0.027)
Has partner	0.111**
	(0.031)
No. of children	0.086**
	(0.028)
Annual household net income (log)	0.055*
	(0.025)
Homeowner	0.029
	(0.031)

Direct effects of strain at t-2 on health at t	-0.106**
	(0.034)
Residual covariances	
Health with smoking	0.015
	(0.026)
Health with heavy drinking	0.038
	(0.029)
Health with overweight	-0.010
	(0.020)
Health with stress	-0.046*
	(0.019)
Stress with smoking	0.015
	(0.028)
Stress with heavy drinking	0.024
	(0.026)
Stress with overweight	0.008
	(0.020)
Smoking with heavy drinking	0.146**
	(0.036)
Smoking with overweight	-0.064*
	(0.025)
Heavy drinking with overweight	-0.014
	(0.028)
n	41533

Notes: Health is a dichotomous variable with 1=Excellent/Good self-reported health and 0 otherwise. Thresholds and residual variances vary by year.
* $p < 0.05$, ** $p < 0.01$

Table 3.3: Structural equation model estimates of the effects of financial strain on health behaviours mediated by changes in time preferences

	Smoking	Heavy drinking	Overweight
Model of strain			
Lagged strain	1.162**	1.162**	1.162**
	(0.026)	(0.026)	(0.026)
Effects of strain at t-2 on time preferences at t-1			
Time Horizons			
Lagged time horizons	0.438**	0.438**	0.438**
	(0.007)	(0.007)	(0.007)
Lagged strain	0.028	0.029	0.029
	(0.022)	(0.022)	(0.022)
Age	-0.002**	-0.002**	-0.002**
	(0.001)	(0.001)	(0.001)
Female	-0.019	-0.018	-0.019
	(0.014)	(0.014)	(0.014)
Highest level of education completed-secondary	-0.044**	-0.043**	-0.044**
	(0.015)	(0.015)	(0.016)
Highest level of education completed- university	-0.051*	-0.048*	-0.051*
	(0.022)	(0.022)	(0.022)
Employed	-0.090**	-0.092**	-0.091**
	(0.016)	(0.016)	(0.016)
Has partner	-0.026	-0.024	-0.024
	(0.020)	(0.020)	(0.020)
No. of children	0.040*	0.040*	0.040*
	(0.020)	(0.020)	(0.020)
Annual household net income (log)	-0.080**	-0.080**	-0.080**
	(0.014)	(0.014)	(0.014)
Homeowner	-0.134**	-0.131**	-0.131**
	(0.019)	(0.019)	(0.019)
Spending discretionary income			
Lagged spending discretionary income	0.563**	0.563**	0.563**
	(0.006)	(0.006)	(0.006)
Lagged strain	0.055**	0.056**	0.056**
	(0.021)	(0.021)	(0.021)
Age	-0.004**	-0.004**	-0.004**
	(0.001)	(0.001)	(0.001)
Female	-0.058**	-0.058**	-0.059**
	(0.013)	(0.014)	(0.013)
Highest level of education completed-secondary	0.053**	0.050**	0.050**
	(0.015)	(0.015)	(0.015)
Highest level of education completed- university	-0.002	-0.007	-0.005
	(0.022)	(0.022)	(0.022)
Employed	0.007	0.011	0.011
	(0.017)	(0.017)	(0.017)
Has partner	0.004	0.000	0.000
	(0.019)	(0.019)	(0.019)

No. of children	-0.005	-0.007	-0.007
	(0.018)	(0.018)	(0.018)
Annual household net income (log)	0.024	0.023	0.023
	(0.013)	(0.013)	(0.013)
Homeowner	-0.059**	-0.064**	-0.064**
	(0.022)	(0.022)	(0.022)
Difficulty controlling expenditure			
Lagged difficulty controlling expenditure	0.484**	0.484**	0.482**
	(0.005)	(0.005)	(0.005)
Lagged strain	0.171**	0.171**	0.170**
	(0.019)	(0.020)	(0.020)
Age	-0.007**	-0.007**	-0.007**
	(0.001)	(0.001)	(0.001)
Female	0.016	0.016	0.020
	(0.015)	(0.015)	(0.015)
Highest level of education completed-secondary	-0.045**	-0.047**	-0.042**
	(0.023)	(0.015)	(0.015)
Highest level of education completed- university	-0.044	-0.048*	-0.037
	(0.023)	(0.023)	(0.023)
Employed	0.034*	0.037*	0.031
	(0.016)	(0.016)	(0.017)
Has partner	0.071**	0.068**	0.068**
	(0.018)	(0.018)	(0.018)
No. of children	0.091**	0.089**	0.088**
	(0.017)	(0.017)	(0.017)
Annual household net income (log)	-0.082**	-0.083**	-0.084**
	(0.014)	(0.014)	(0.014)
Homeowner	-0.048*	-0.053**	-0.052**
	(0.019)	(0.019)	(0.020)
Consideration of future consequences			
Lagged consideration of future consequences	0.736**	0.737**	0.737**
	(0.005)	(0.005)	(0.005)
Lagged strain	-0.010	-0.010	-0.010
	(0.008)	(0.008)	(0.008)
Age	0.001**	0.001**	0.001**
	(0.000)	(0.000)	(0.000)
Female	0.013*	0.013*	0.013*
	(0.006)	(0.006)	(0.007)
Highest level of education completed-secondary	-0.013*	-0.014*	-0.014*
	(0.006)	(0.006)	(0.006)
Highest level of education completed- university	-0.065**	-0.067**	-0.066**
	(0.009)	(0.009)	(0.009)
Employed	-0.010	-0.009	-0.009
	(0.007)	(0.007)	(0.007)
Has partner	-0.001	-0.002	-0.002
	(0.008)	(0.008)	(0.008)
No. of children	0.003	0.002	0.002
	(0.008)	(0.008)	(0.008)

Annual household net income (log)	-0.005	-0.005	-0.005
	(0.006)	(0.006)	(0.006)
Homeowner	-0.015*	-0.017*	-0.017*
	(0.007)	(0.007)	(0.007)
Effects of time preferences at t-1 on health behaviour at t			
Time horizons	-0.024	-0.009	0.006
	(0.016)	(0.019)	(0.012)
Spending discretionary income	0.025	0.025	0.004
	(0.015)	(0.017)	(0.010)
Difficulty controlling expenditure	0.017	-0.011	0.040**
	(0.014)	(0.014)	(0.010)
Consideration of future consequences	0.069*	0.017	0.021
	(0.028)	(0.030)	(0.018)
Lagged health behaviour	3.351**	2.509**	2.606**
	(0.057)	(0.053)	(0.027)
Age	-0.005**	0.002	0.005**
	(0.002)	(0.002)	(0.001)
Female	-0.041	-0.321**	-0.031
	(0.034)	(0.042)	(0.023)
Highest level of education completed-secondary	-0.137**	-0.047	-0.071**
	(0.039)	(0.040)	(0.026)
Highest level of education completed-university	-0.135*	0.012	-0.167**
	(0.063)	(0.062)	(0.038)
Employed	0.075	-0.009	0.141**
	(0.042)	(0.042)	(0.029)
Has partner	-0.134**	-0.092	0.014
	(0.049)	(0.051)	(0.032)
No. of children	0.044	-0.050	-0.017
	(0.048)	(0.048)	(0.034)
Annual household net income (log)	-0.015	0.008	0.002
	(0.032)	(0.041)	(0.024)
Homeowner	-0.158**	-0.006	0.000
	(0.051)	(0.050)	(0.035)
Direct effects of strain at t-2 on health behaviour at t	0.045	-0.080	0.038
	(0.061)	(0.065)	(0.038)
Residual covariances			
Health behaviour with			
Strain	0.010	0.032	0.000
	(0.028)	(0.027)	(0.020)
Time horizons	-0.023	-0.033	-0.005
	(0.022)	(0.018)	(0.013)
Spending discretionary income	0.010	0.019	0.013
	(0.017)	(0.018)	(0.013)
Difficulty controlling expenditure	0.014	0.019	0.027*
	(0.018)	(0.018)	(0.013)

Consideration of future consequences	-0.005	0.004	0.002
	(0.007)	(0.008)	(0.004)
Strain with			
Time horizons	0.069**	0.069**	0.069**
	(0.012)	(0.012)	(0.012)
Spending discretionary income	0.048**	0.048**	0.049**
	(0.009)	(0.009)	(0.009)
Difficulty controlling expenditure	0.186**	0.186**	0.185**
	(0.011)	(0.011)	(0.011)
Consideration of future consequences	-0.005	-0.005	-0.005
	(0.004)	(0.004)	(0.004)
Time horizons with			
Spending discretionary income	0.078**	0.078**	0.078**
	(0.008)	(0.008)	(0.008)
Difficulty controlling expenditure	0.042**	0.042**	0.042**
	(0.007)	(0.007)	(0.007)
Consideration of future consequences	0.045**	0.045**	0.045**
	(0.004)	(0.004)	(0.004)
Spending discretionary income with			
Difficulty controlling expenditure	0.135**	0.136**	0.136**
	(0.006)	(0.006)	(0.006)
Consideration of future consequences	0.018	0.018	0.018
	(0.011)	(0.011)	(0.011)
Difficulty controlling expenditure with			
Consideration of future consequences	-0.005	-0.005	-0.005
	(0.003)	(0.003)	(0.003)
n	41533	41533	41533

Notes: Thresholds and residual variances vary by year. *p<0.05, ** p<0.01

Table 3.4: Structural equation model estimates of the effects of financial strain on self-reported health mediated by changes in health behaviours and moderated by gender

Model of strain	
Lagged strain	1.191**
	(0.037)
Effects of strain at t-2 on health behaviours at t-1	
Smoking	
Lagged smoking	3.096**
	(0.047)
Lagged strain	0.012
	(0.063)
Age	-0.006**
	(0.002)
Female	-0.207**
	(0.060)
Highest level of education completed-secondary	-0.153**
	(0.042)
Highest level of education completed- university	-0.181**
	(0.066)
Employed	0.071
	(0.047)
Has partner	-0.133*
	(0.052)
No. of children	0.054
	(0.048)
Annual household net income (log)	-0.018
	(0.036)
Homeowner	-0.158**
	(0.059)
Interaction= Female x lagged strain	0.018
	(0.838)
Heavy drinking	
Lagged heavy drinking	2.386**
	(0.055)
Lagged strain	0.177**
	(0.068)
Age	0.003
	(0.002)
Female	-0.408**
	(0.073)
Highest level of education completed-secondary	-0.032
	(0.047)
Highest level of education completed- university	0.047
	(0.063)
Employed	-0.023
	(0.046)
Has partner	-0.071
	(0.054)

No. of children	-0.044
	(0.053)
Annual household net income (log)	0.032
	(0.043)
Homeowner	0.022
	(0.056)
Interaction= Female x lagged strain	-0.043
	(0.113)
Overweight	
Lagged overweight	2.442**
	(0.033)
Lagged strain	0.058
	(0.048)
Age	0.004**
	(0.001)
Female	-0.152**
	(0.035)
Highest level of education completed-secondary	-0.082**
	(0.027)
Highest level of education completed- university	-0.189**
	(0.037)
Employed	0.156**
	(0.028)
Has partner	0.033
	(0.033)
No. of children	-0.007
	(0.032)
Annual household net income (log)	-0.003
	(0.025)
Homeowner	-0.028
	(0.033)
Interaction= Female x lagged strain	0.001
	(0.064)
Effects of health behaviours at t-1 on health at t	
Smoking	-0.116**
	(0.038)
Heavy drinking	-0.106*
	(0.053)
Overweight	-0.099**
	(0.031)
Lagged health	2.025**
	(0.024)
Age	-0.008**
	(0.001)
Female	-0.042
	(0.040)
Highest level of education completed-secondary	0.053*
	(0.026)
Highest level of education completed- university	0.170**
	(0.029)

Employed	0.170**
	(0.029)
Has partner	0.107**
	(0.032)
No. of children	0.081*
	(0.032)
Annual household net income (log)	0.055*
	(0.026)
Homeowner	0.024
	(0.034)
Direct effects of strain at t-2 on health at t	-0.107*
	(0.042)
Interaction= Female X Lagged Overweight	0.027
	(0.042)
Interaction= Female x Lagged Heavy drinking	0.026
	(0.102)
Interaction= Female X Smoking	-0.012
	(0.051)
Interaction= Female X Lagged t-2 strain	-0.011
	(0.059)
Residual covariances	
Health with smoking	0.022
	(0.027)
Health with heavy drinking	0.036
	(0.026)
Health with overweight	-0.010
	(0.018)
Health with stress	-0.049*
	(0.019)
Stress with smoking	0.014
	(0.029)
Stress with heavy drinking	0.026
	(0.033)
Stress with overweight	0.009
	(0.019)
Smoking with heavy drinking	0.148**
	(0.033)
Smoking with overweight	-0.076**
	(0.027)
Heavy drinking with overweight	-0.017
	(0.031)
n	41533

Notes: Health is a dichotomous variable with 1=Excellent/Good self-reported health and 0 otherwise. Thresholds and residual variances vary by year.
* $p < 0.05$, ** $p < 0.01$

Table 3.5: Structural equation model estimates of the effects of financial strain on self-reported health mediated by changes in health behaviours and moderated by employment status

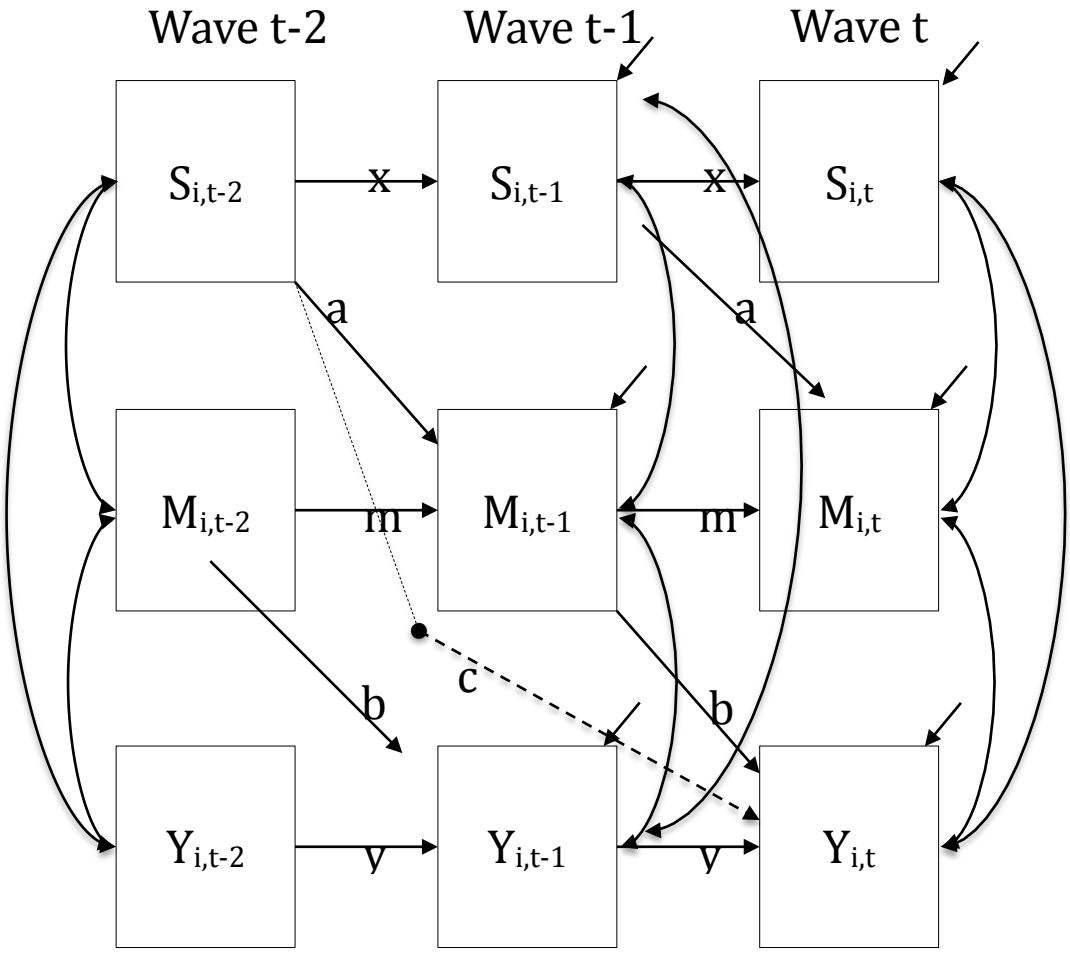
Model of strain	
Lagged strain	1.222**
	(0.036)
Effects of strain at t-2 on health behaviours at t-1	
Smoking	
Lagged smoking	3.136**
	(0.048)
Lagged strain	-0.010
	(0.073)
Age	-0.006**
	(0.001)
Female	-0.042
	(0.037)
Highest level of education completed-secondary	-0.156**
	(0.041)
Highest level of education completed- university	-0.185**
	(0.066)
Employed	-0.068
	(0.067)
Has partner	-0.137**
	(0.052)
No. of children	0.056
	(0.047)
Annual household net income (log)	-0.020
	(0.036)
Homeowner	-0.157*
	(0.061)
Interaction=Employed x lagged strain	0.036
	(0.089)
Heavy drinking	
Lagged heavy drinking	2.322**
	(0.061)
Lagged strain	0.168*
	(0.078)
Age	0.003
	(0.002)
Female	-0.352**
	(0.042)
Highest level of education completed-secondary	-0.031
	(0.047)
Highest level of education completed- university	0.043
	(0.064)
Employed	-0.013
	(0.075)
Has partner	-0.072
	(0.053)

No. of children	-0.044
	(0.052)
Annual household net income (log)	0.043
	(0.043)
Homeowner	0.025
	(0.055)
Interaction= Employed x lagged strain	-0.012
	(0.105)
Overweight	
Lagged overweight	2.459**
	(0.031)
Lagged strain	0.049
	(0.047)
Age	0.004**
	(0.001)
Female	-0.031
	(0.024)
Highest level of education completed-secondary	-0.084**
	(0.027)
Highest level of education completed- university	-0.182**
	(0.037)
Employed	0.058
	(0.038)
Has partner	0.028
	(0.032)
No. of children	-0.005
	(0.032)
Annual household net income (log)	-0.008
	(0.026)
Homeowner	-0.030
	(0.032)
Interaction= Employed x lagged strain	0.024
	(0.060)
Effects of health behaviours at t-1 on health at t	
Smoking	-0.126**
	(0.040)
Heavy drinking	-0.110
	(0.063)
Overweight	-0.066*
	(0.031)
Lagged health	2.026**
	(0.024)
Age	-0.008**
	(0.001)
Female	-0.030
	(0.026)
Highest level of education completed-secondary	0.053*
	(0.026)
Highest level of education completed- university	0.148**
	(0.039)

Employed	0.205**
	(0.045)
Has partner	0.107**
	(0.032)
No. of children	0.082*
	(0.032)
Annual household net income (log)	0.054*
	(0.026)
Homeowner	0.023
	(0.034)
Direct effects of strain at t-2 on health at t	-0.087*
	(0.042)
Interaction= Emp X Lagged Overweight	-0.046
	(0.042)
Interaction= Emp x Lagged Heavy drinking	0.010
	(0.085)
Interaction= Emp X Smoking	0.010
	(0.050)
Interaction= Emp X Lagged t-2 strain	-0.053
	(0.057)
Residual covariances	
Health with smoking	0.023
	(0.027)
Health with heavy drinking	0.038
	(0.026)
Health with overweight	-0.010
	(0.018)
Health with stress	-0.050*
	(0.019)
Stress with smoking	0.012
	(0.028)
Stress with heavy drinking	0.025
	(0.032)
Stress with overweight	0.010
	(0.019)
Smoking with heavy drinking	0.150**
	(0.033)
Smoking with overweight	-0.079**
	(0.027)
Heavy drinking with overweight	-0.015
	(0.030)
n	41533

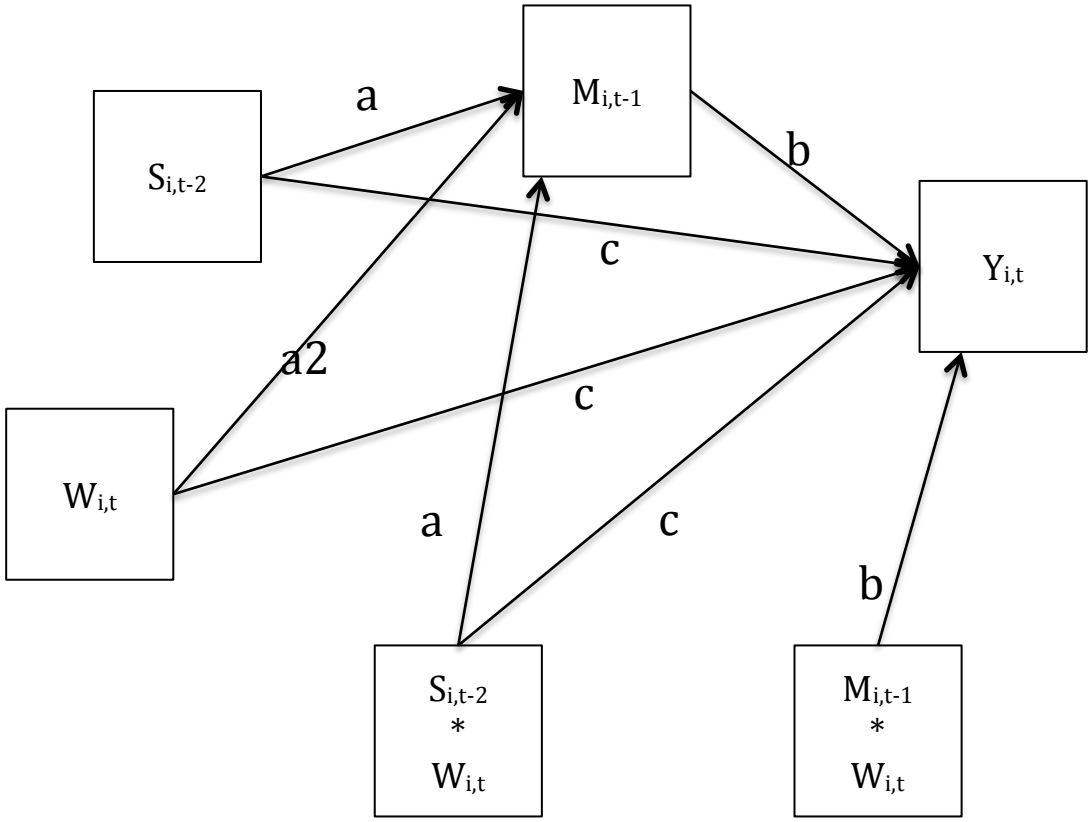
Notes: Health is a dichotomous variable with 1=Excellent/Good self-reported health and 0 otherwise. Thresholds and residual variances vary by year.
* $p < 0.05$, ** $p < 0.01$

Figure 3.1: Three wave autoregressive model of the effect of financial strain ($S_{i,t-2}$) on health outcome ($Y_{i,t}$) mediated by changes in $M_{i,t-1}$.



Notes: Financial strain, $S_{i,t}$, is governed by a simple autoregressive model where the only explanatory variable is its own lag $S_{i,t-1}$. The mediating variable, $M_{i,t}$, is also autoregressive but is additionally affected by demographic and household controls and lagged financial strain $S_{i,t-1}$. Health outcomes, $Y_{i,t}$, are autoregressive, affected by controls and also affected by financial strain from two periods before ($S_{i,t-2}$) both directly and indirectly through changes in the mediator $M_{i,t-1}$. Single headed arrows at corners are variance terms. Double-headed arrows are covariance terms.

Figure 3.2: Statistical diagram of the total effect moderation model examining the effect of financial strain ($S_{i,t-2}$) on health outcome ($Y_{i,t}$) mediated by changes in $M_{i,t-1}$ and moderated by $W_{i,t}$.



Notes: Figure 3.2 builds on the three-wave autoregressive mediation model in figure 3.1 and combines moderation of the direct effect with moderation of the first and second stages of the mediated effect, thereby moderating each path of the total effect of strain on health. This is known as a total effect moderation model. For simplicity, any autoregressive effects are not included in this model however are included in the calculation of the moderated mediation effect. $W_{i,t}$ represents the moderator variable, while the interaction term of strain and the moderator is represented by $S_{i,t-2} * W_{i,t}$ and the interaction term of the mediator and the moderator is shown by $M_{i,t-1} * W_{i,t}$. As before, financial strain, $S_{i,t}$, is governed by a simple autoregressive model where the only explanatory variable is its own lag $S_{i,t-1}$. The mediating variable, $M_{i,t-1}$, is also autoregressive but is additionally affected by the moderator $W_{i,t}$, the interaction term of strain and the moderator $S_{i,t-2} * W_{i,t}$, demographic and household controls and lagged financial strain $S_{i,t-1}$. Health outcomes, $Y_{i,t}$, are autoregressive, affected by the moderator $W_{i,t}$, the interaction term of strain and the moderator $S_{i,t-2} * W_{i,t}$, the interaction term of the mediator and the moderator $M_{i,t-1} * W_{i,t}$, controls and financial strain from two periods before ($S_{i,t-2}$).

Appendix

The following questions were used to calculate the Consideration of Future Consequences (CFC) scale. Questions 1,2,6,7 and 8 were recoded so that a higher score consistently indicated a more present focus.

Now we present you with some statements about the future. Please indicate on a scale from 1 to 7 to what extent you agree with the following statements. 1 means 'extremely uncharacteristic' 7 means 'extremely characteristic'

1. I think about how things can change in the future, and try to influence those things in my everyday life.
2. I often work on things that will only pay off in a couple of years.
3. I am only concerned about the present, because I trust that things will work themselves out in the future.
4. With everything I do, I am only concerned about the immediate consequences (say a period of a couple of days or weeks).
5. Whether something is convenient for me or not, to a large extent determines the decisions that I take or the actions that I undertake.
6. I am willing to sacrifice my well-being in the present to achieve certain goals in the future.
7. I think it is important to take warnings about negative consequences of my acts seriously, even if these negative consequences would only occur in the distant future.
8. I think it is more important to work on things that have important consequences in the future, than to work on things that have immediate but less important consequences.
9. In general, I ignore warnings about future problems because I think these problems will be solved before they get critical.
10. I think there is no need to sacrifice things now for problems that lie in the future, because it will always be possible to solve these future problems later.
11. I only respond to urgent problems, trusting that problems that come up later can be solved in a later stage.

CHAPTER 4

QUANTIFYING THE RELATIVE IMPORTANCE OF MEDIATING PATHWAYS FROM FINANCIAL STRAIN TO HEALTH

Abstract

Using data on retirees from the US Health and Retirement Study (HRS), I find evidence that the health impairment effect of a negative wealth shock is mediated not through changes in health behaviours but through biological changes in sensitive organ systems associated with exposure to stressors. My identification strategy relies on the temporal ordering of financial strain and health consequences thus preventing potential reverse causation. My cross-wave structure however may not capture effects of strain on health sooner than the four-year time lag tested in this paper. The empirical analysis is also limited by the level of missingness in the data.

Keywords: financial strain, health, mediation, allostatic load, wealth shocks, health behaviours.

4.1. Introduction

In this paper, we use negative shocks to the financial wealth of US retired households to explore the mediating pathways from shocks to worse health. Using data from the US Health and Retirement Study (HRS), we show that negative wealth shocks have statistically significant effects on the health of a sample of retired individuals. Understanding the causal links between economic resources and health presents challenges to the researcher (Deaton and Paxton, 1999; Marmot and Bobak, 2000), the novelty of this study is that I use a plausibly exogenous shock variable in the empirical analysis.

Financial strain not only negatively affects mental health but also worsens self-reported health and increases physical impairment. The response to strain and its subsequent impact on health can act both through behavioural and biological pathways, however a broader understanding and quantification of the relative importance of these pathways is required (French and Vigne, 2019). In previous analysis, Prentice et al. (2017) indicate the health-behavioural response to financial strain appears to be relatively minor indicating that the biological response to financial strain may be of more importance for health outcomes, however extensive work on how stress "gets under the skin" has yet to be carried out (Patel, 2019).

4.1.1 The concept of allostatic load

Allostatic load is a potentially useful conceptual framework through which to capture physiological dysregulation related to stress (McEwen and Lasley, 2003). Allostatic load refers to the effects of chronic and acute stress and is the process of wear-and-tear on the body and brain (Sterling and Eyer, 1988; McEwen and Stellar, 1993; McEwen, 1998, 2006; McEwen and Gianaros, 2010). When an individual is experiencing stress their physiological systems including the hypothalamic–pituitary–adrenal (HPA) axis, the sympathetic nervous system and the immune system are under challenge (Schulkin, 2004). The changes in metabolism and the impact of wear-and-tear on organs and tissues increases allostatic load which can subsequently predispose them to physiological, psychological, and psychosocial health conditions such as hypertension, coronary heart disease, stroke, obesity,

diabetes, arthritis, major depression, gastrointestinal disorders, chronic pain, and chronic fatigue syndrome (McEwen and Stellar, 1993; IOM of the National Academies, 2008).

In order to understand allostatic load, it is important to first understand the concept of homeostasis. Organisms must maintain their physiological parameters (e.g., temperature, blood pressure, glucose, and hormone concentrations in blood) within a certain range of values in order to survive and function correctly (known as homeostasis). Perturbations to homeostasis can occur as a result of the external environment or pathological processes, and as a result the individual makes adjustments in their physiological processes to bring them back into their normal range. One such example is blood pressure which fluctuates throughout the day, rising during exercise and decreasing at rest. This dynamic process through which an organism adjusts its physiological parameters and achieves stability in response to perturbations of homeostasis is referred to as allostasis (McEwen and Wingfield, 2003).

Short-term or infrequent regulation of physiological systems is both necessary and adaptive, however recurrent or continual responses may jeopardise healthy responses, causing organs to habituate to over or under-respond to stressors. Over time, the chemical fluctuations cause system dysregulation in metabolic, inflammatory and cardiovascular biomarkers because of excessive activation and subsequently result in disease. Accordingly, allostatic load is defined as "the strain on the body produced by repeated ups and downs of physiologic response, elevated activity of physiologic systems under challenge, changes in metabolism and wear and tear on a number of organs and tissues, [that] can predispose the organism to disease" (McEwen & Stellar, 1993).

McEwen (1998) suggests that repeated acute and/or chronic stressors have long-lasting effects on the neuroendocrine, cardiovascular, immune, and neural systems. Allostatic load, is a measure of the preclinical elevations in biomarkers across these sensitive organ systems caused by over exposure to stressors (Seeman et al., 1997). The concept of allostasis and allostatic load emphasize the measurement of dysregulation in multiple adaptive systems as a collective.

There are wide individual variations in biological reactions to stressful situations and it depends on genetic factors, gender, developmental stage, and physiologic and psychological history (McEwen and Stellar, 1993). Some individuals are highly resilient and cope with stress easily; others are highly vulnerable (Rutter, 1985).

To our knowledge, no previous study has examined the specific relationship between financial strain and allostatic load in a longitudinal setting. In one study by Gallo et al. (2011), it was found that greater stress in the domain of finances was related to higher AL scores, however this was cross sectional in nature prohibiting conclusions regarding the directionality of the observed associations. Furthermore, the focus of the study was on a specific segment of US female Latino residents, meaning the findings could not be assumed to be generalizable beyond the particular socio-demographic group.

Studies which have implicated stress exposure using allostatic load have typically focused on individual-level factors, such as socioeconomic status, poverty and adverse experiences (Gruenewald et al., 2012; Kakinami et al., 2013; Barboza Solís et al., 2015). Kirsch and Ryff (2016) using Midlife in the United States (MIDUS) Refresher Survey data (2012–2015), found that hardships experienced during the recessionary period were positively related to self-reported chronic conditions, physical health, acute somatic symptoms, and waist circumference. Therefore building on this work, we hypothesize economic hardships would be positively associated with allostatic load (Patel, 2019). Physiological stress from financial hardship could accumulate to negatively affect a variety of physiological systems, resulting in higher allostatic load. The allostatic load therefore provides a better picture of the physiological toll that financial hardships may have on the body.

There is a significant body of literature that suggests stress has considerable effects on health as a result of allostatic load. It has been shown to predict risk of incident cardiovascular disease, decline of physical and cognitive function, and all-cause mortality in high-functioning community-dwelling older men and women (McEwen and Stellar 1993; Seeman et al., 1997; 2001). In a cross sectional study of older people in Taiwan, Hu et al. (2007) found that higher allostatic load was associated with poorer self-rated health and severe physical activity difficulties. Furthermore,

using the MacArthur Study of Successful Ageing, Karlamangla et al. (2002) found that baseline allostatic load was associated with functional decline in a community-based cohort of elderly men and women over a 7-year follow up period. Other studies using the same data over the same period found links between allostatic load, cardiovascular disease and mortality (Seeman et al 1997; Seeman et al 2001). A study of London-based civil servants found that a number of biomarkers, particularly waist-to-hip ratio and high-density lipoprotein cholesterol among others, were associated with self-rated physical decline over a 3-year interval (Kumari et al. 2004; Read and Grundy, 2014).

Research on allostatic load and self-rated health is scarce (Goldman et al., 2004; Lekander et al., 2004). Much previous research has focused on single biomarkers and/or bodily systems, and less is known about the relationships between a set of biomarkers from different bodily systems and self-rated health. In their study of Women Working in Two Occupational Sectors, Hasson et al. (2009) found that a high AL was significantly association with poor self-rated health, particularly for those working within the health care sector.

Although these studies suggest that allostatic load may be used as an early sign of health risks, most have only used allostatic load at baseline as a predictive measure and have not tested reciprocal or longitudinal relationships (Read and Grundy, 2014). For example Goldman et al. (2006), in their study of baseline allostatic load and later life health outcomes, suggested the need for further work using repeated measures in their study, despite their finding that allostatic load could be a precursor for poorer health in later life.

4.2 Methodology

4.2.1 Data

Data from the Health and Retirement Study (HRS) were used in this paper, a nationally representative longitudinal study sponsored by the National Institute of Aging and conducted by the University of Michigan. The biennial study, which started in 1992, asks detailed questions on income, wealth, health and medical expenditures from adults aged 50 and older in the United States.

From 2006 onwards, HRS began collecting physical performance measures, anthropometric measures, blood-based biomarkers from fingersticks and dried blood spots (DBS), and salivary DNA as part of the enhanced face to face (EFTF) interview. These were collected on a rotating basis for half the sample at each wave through 2016. As a result, each half-sample has now had up to three opportunities for the biomarker interview over four- year intervals (Crimmins et al., 2017). In addition, a competing revision award allowed HRS to collect venous blood for the first time in 2016 from all panel respondents in a separate home visit in order to provide a substantially fuller picture of the health of a representative sample of older people (Crimmins et al., 2017).

The data used in this study come from waves 8 to 13 of the HRS covering the years 2006 to 2016.

The sample of this study is restricted to financial respondents, and their spouses if existent, who report wealth and nonzero retirement income in the previous wave summing to a lifetime wealth of at least $10,000. Further, I restrict the sample to singles and couples who were retired in the previous wave, i.e., either both financial respondent and spouse were neither working for pay (i.e., neither working, full or part-time working, nor partly retired) nor unemployed; or both considered themselves completely retired. Furthermore, only households with the most comprehensive biomarker measurements were included in the analyses. That is, households where at least one member had biomarker measurements in the current wave as well as the previous survey or, at a minimum, biomarker measurements in either the current wave or the previous survey.

4.2.2 Measurements

4.2.2.1 Wealth data

In this study, we make use of wealth data from the RAND HRS file which is cleaned and partly imputed. Responses to HRS financial questions are given in exact amounts however unfolding response brackets are offered if exact amounts are unknown.

Following the approach of Schwandt (2018), current household wealth ($A_{i,t}$) consists of net housing wealth, real estate wealth, vehicles, business wealth, individual retirement accounts (IRAs), stocks and mutual funds, checking and savings accounts, CDs, savings bonds and treasury bills, bonds, other savings, and debts.

Lifetime Wealth

The measure of lifetime wealth ($W_{i,t}$) consists of the sum of current wealth ($A_{i,t}$) and discounted expected future income.

$$W_{i,t} = A_{i,t} + E\left(\sum_{\tau=0}^{T-t} \frac{Y_{t+\tau}}{(1+r)^{t+\tau}}\right),$$

$Y_{i,t}$ represents income and r is the real annual interest rate. Pensions and annuities $(PAI_{i,t})$, old age social security $(SS_{i,t})$ and veteran benefits $(VetBen_{i,t})$ are used together as a proxy for a retired individual's expectations about future income as these can be assumed to stay constant (in real terms) if the retiree remains in retirement. We assume that interest rate expectations (set to 3 percent) also remain constant. In addition, the survival probability ($S_{t+\tau}$) is needed. Following Schwandt (2018), we calculated τ-year survival rates by age (t), gender (g), and ten-year birth cohort (c) using the SSA life tables.

$$W_{i,t} = A_{i,t} + (SS_{i,t} + PAI_{i,t} + VetBen_{i,t}) \sum_{\tau=1}^{T-t} \frac{E(S_{t+\tau}|t_i, g_i, c_i)}{(1+r)^{t+\tau}}$$

Further details about the construction of lifetime wealth are provided by Schwandt (2018) in the online Appendix Section B.

Stock Wealth

In order to construct a measure of wealth shock, details on the amount of stock holdings possessed by a participant are required. The HRS collects information on direct stock holdings in each wave but does not include stocks held in IRAs. Retired individuals often hold a large proportion of their wealth in IRAs therefore it is

essential to know the percentage of each IRA invested in stock to calculate the total amount of stock holdings. From 2006 onwards for each IRA, the percentage invested in "stocks and mutual funds" is reported. In the 2004 wave, three categories indicate whether IRAs are invested "mostly in stocks," "mostly in interest-earning assets," or "about evenly split." We translate these categories into 100 percent, 0 percent, and 50 percent invested in stocks, which results in roughly the same investment distribution in 2004 as for the exact information in the next wave - 2006. In Schwandt's (2018) paper, the assumption of a stable investment distribution between 2004 and 2006/2008 for US IRAs was checked with data from the Survey of Consumer Finances (SCF), a US representative triennial survey, and it was found that the cumulative distribution function did not change significantly between SCF 2004 and SCF 2007.

Wealth shock

$$\frac{S_{h(i),t-1}}{W_{h(i),t-1}} \frac{\Delta SP_{m(i,t)}}{SP_{m(i,t-1)}}$$

The measure of wealth shock is constructed by determining how much financial wealth (mutual funds, stocks & shares) in the previous period $S_{h(i),t-1}$ changes due to movement in Standard and Poor's 500 stock market index (S&P500) $\frac{\Delta SP_{m(i,t)}}{SP_{m(i,t-1)}}$. This was then rescaled by lifetime wealth $W_{h(i),t-1}$. We rescale by lifetime wealth as the effect of a wealth shock is likely to depend on the initial wealth level. A $50,000 loss would be felt differently by very rich individuals compared to those that are poor. Furthermore, expected future earnings are of importance as individuals with a high annual income and long life expectancy can easily override a wealth loss by dissaving.

Consideration of future income alongside current wealth is important for retired individuals as they usually have a relatively stable pension income and a limited time horizon of years to live. Furthermore, rescaling by lifetime wealth instead of current wealth is beneficial as lifetime wealth has fewer zeros or negative values which would usually not be included in the analysis (Schwandt, 2018).

4.2.2.2 Health data

The item we used to measure health is a self-reported change in health. The question asks, compared to the previous interview, my health is "much better" (1), "somewhat better" (2), "same" (3), "somewhat worse" (4), and "much worse" (5). Higher values therefore denote health deterioration. We measure the change over two periods in participants' responses to this item.

Smoking

The following question was asked to assess smoking status, "Do you smoke cigarettes now?" This was a yes no variable and subsequently respondents were classified as smokers or non-smokers.

Overweight

The survey provided a measure of body mass index, calculated as weight in kilograms over the square of height in metres. Individuals were then classified as being either a normal weight (BMI <25 kg/m2) or overweight (BMI >25 kg/m2).

Heavy drinking

Survey participants were asked about their typical alcohol consumption in the past few months (e.g., *In the last three months, on average, how many days per week have you had any alcohol to drink? On the days that you drink, about how many drinks do you have?*). From this, we constructed a measure of an individual's level of alcohol use: low drink level (defined as consuming an average of less than two drinks per day for men and an average of less than one drink per day for women, moderate drinking (defined as consuming an average of two or more drinks per day for men and an average of one or more drinks per day for women; (Nelson et al., 2009)) and heavy drinking (defined as five or more drinks on a single occasion; (Wechsler and Nelson, 2001)). According to Naimi et al. (2003), these categories are consistent with the U.S. Department of Agriculture nutritional guidelines. We only consider current drinkers in our analysis for a number of reasons (a) nondrinkers,

especially those in later life stages, are a heterogeneous group including both life-long abstainers and individuals who stopped drinking due to health concerns (including a history of problem drinking; Moos et al., 2004) and (b) only current drinkers are at risk for alcohol use problems (Mezuk et al., 2011).

Physical activity

Participants were asked about their level of participation in light, moderate, and vigorous physical activity. As with Colberg et al. (2010) we used only the moderate and vigorous items to come as close as possible to the ADA recommendation (i.e., a minimum of 150 min/week of at least moderate-intensity aerobic exercise over the course of 3 or more days per week).

In order to measure participation in physical activity, individuals were asked, "How often do you take part in sports or activities that are vigorous, such as running or jogging, swimming, cycling, aerobics or gym workout, tennis, or digging with a spade or shovel?" Followed by, "And how often do you take part in sports or activities that are moderately energetic such as, gardening, cleaning the car, walking at a moderate pace, dancing, floor or stretching exercises." Possible responses for both questions included more than once a week, once a week, one to three times a month, and hardly ever or never. We categorised those who reported engaging in either moderate or vigorous physical activity more than once a week as physically active. All others were categorised as being physically inactive.

Biomarkers

While allostatic load is well developed in theory (McEwen, 1998), there is controversy as to which indicators are necessary and sufficient for its measurement. The current most common approach to measuring allostatic load is through composite measures of a range of biomarkers, traits which are sensitive to changes in the biological state resulting from environmental exposure (Read and Grundy, 2012). They often involve the collection and subsequent analysis of biological specimens (e.g. blood, urine and saliva) but they also include physical and functional measures (e.g. blood pressure, anthropometry and grip strength). Biomarkers can shed light on

the multiple physiological pathways- neuroendocrine, cardiovascular, metabolic, immune/inflammatory- through which contextual factors exert their influence on health. Such knowledge facilitates our understanding of how financial strain "gets under the skin". According to Crimmins et al. (2013) biomarkers are not susceptible to many of the shortcomings associated with self-report health measures and may enhance the modelling of causal pathways to health by revealing health characteristics which are unknown to participants or not determined by self-reports.

Biomarkers are directly measured traits that provide insight into the functioning of biological systems. They often involve the collection and subsequent analysis of biological specimens (e.g., blood, saliva, urine), but they also include physical and functional measures (e.g., blood pressure, anthropometry, grip strength).

The eight biomarkers used in our calculation of allostatic load include glycosylated haemoglobin A1c, high-density lipoprotein (HDL) cholesterol, total cholesterol, Cystatin C and waist circumference, systolic blood pressure and diastolic blood pressure and C-reactive protein. Due to the skewed distribution for each blood biomarker, we took the natural log to normalize the distribution.

Three of the biomarkers were obtained from anthropometric measures (waist to hip ratio), blood pressure measures (**systolic and diastolic blood pressure**). From a sitting position, three blood pressure readings, 45 seconds apart, were taken using an Omron HEM-780 Intellisense Automated Blood Pressure Monitor on the participant's left arm. Systolic and diastolic blood pressure were recorded and averaged across the three measurements (mmHg). Elevated blood pressure levels increase the risk of atrial fibrillation and are a major risk factor for stroke, myocardial infarction, heart failure, chronic kidney disease, cognitive decline and premature death. Participants with at least one valid measure were included in the present sample.

To measure **waist circumference**, participants were asked to stand up, remove any bulky clothing, point to their navel, and place a tape measure around their waist at the level of their navel. Waist circumference in inches was recorded. The independent associations of high waist circumference with increased risks of diabetes

(Folsom et al. 2000), cardiovascular disease (Dey and Lissner, 2003), mobility limitations (LaCroix et al., 1993) and pain (Heim et al., 2008) and a number of other health conditions have all been previously established.

In order to eliminate daily fluctuations in measurements, **glycosylated haemoglobin (HbA1C)** is used to measure blood glucose. This summary measure covers about 120 days and is most commonly used to monitor the level of control in diabetics (Reynolds et al., 2006). It is also considered a risk factor for diabetes-related conditions such as cardiovascular disease, and can be used a screening tool for diabetes and as a general indicator of anything that can potentially disrupt blood glucose over time, such as different diets, other diseases and drugs (Khaw and Wareham, 2006; Crimmins et al., 2013).

Cholesterol does not circulate by itself in the blood, but is rather bound to proteins and real lipids, to form particles known as lipoproteins (Crimmins et al., 2013). The dried blood spot samples taken in the HRS have been analysed for Total Cholesterol (TC) and High-Density-Lipoprotein Cholesterol (HDL). TC is positively associated with the onset of atherosclerotic cardiovascular disease and predicts myocardial infarction, stroke, vascular kidney disease, peripheral artery disease and many other related conditions (Evered, 2007; Crimmins et al., 2013). HDL, conversely, is the "good cholesterol," and higher blood levels are associated with lower incidence of vascular conditions generally (Ashen and Blumenthal, 2005).

Cystatin C is a protein produced by cells in the body and serves as a measure of kidney function. Levels of Cystatin C appear to increase with healthy aging (Sarnak et al., 2008), but raised levels can also indicate serious cardiovascular disease and impending mortality (Crimmins et al., 2013; Muslimovic et al., 2015).

C-reactive protein (CRP) is a blood protein that indicates levels of inflammation associated with a range of conditions including acute and chronic conditions, and these can be infectious or non-infectious in etiology (Nehring and Patel, 2018). Elevation of this protein is part of healthy immune response however chronic elevation is associated with an increased risk of diabetes, hypertension and cardiovascular disease (Crimmins et al., 2013).

Construction of allostatic load score and allostatic load descriptive statistics

There is evidence that AL has a stronger relationship with physical health than its individual components. Therefore, following McEwen (2000), we used the group-based method and summed the number of parameters for which the individual fell into the top quartile indicating high risk (except HDL cholesterol for which membership in the lowest quartile corresponds to highest risk). The allostatic load index is measured as the total number of biomarkers categorized as high risk for an individual. The possible values for the allostatic load index range from 0 to 8. Higher values indicate higher multisystem physiological dysregulation. Other methods of summarising the data, including averaging z-scores and use of other criterion cutpoints (Seeman et al., 1997) were examined in earlier analyses and produced similar results.[8]

Table 4.2 provides summary statistics for the biomarkers used in the construction of our allostatic load measure and the high risk cut off points for each.

4.2.2.3 Covariates

A number of covariates were used as control variables including gender, dummy for age, race, census region, lagged marital status, education level, household income, financial wealth, household debt, non-financial wealth, health insurance, change in S&P 500 Index and a dummy for stock holdings.

4.2.3 Statistical analysis

This paper seeks to examine the direct effect of negative wealth shocks on a change in self-reported health, and the indirect associations via changes in health behaviours in the first instance and secondly changes in allostatic load.

[8] There are a number of issues with this measure. HRS lacks measurement of hormones produced by the HPA and SAMA, two key endocrine pathways mediating the impact of stress on health. Addition of these measures would allow for the construction of a measure of allostatic load and to make comparisons with the growing number of studies using this concept (McDade, 2013). Further, measuring biomarkers/mediators e.g. cortisol accurately is an issue. Using different approaches to measuring allostatic load emerged in a review of 26 studies done on the relationship between SES and biomarkers of multiple physiological systems (Dowd, Simanek, & Aiello, 2009).

The use of longitudinal data in this study will address some previous shortcomings in other papers where mediation analysis did not explicitly consider the role of time, despite the fact that it takes time for meditational effects to evolve (Maxwell et al., 2011) and furthermore, previous levels of the variables need to be included or the paths in the models may be over or underestimated relative to their true values (Selig and Preacher, 2009). [9] To estimate the effects of negative wealth shocks on a change in health via our mediators (health behaviours and allostatic load), we use a structural equation model with multiple time points for each variable which allows time for causes to have their effects, supports stronger inference about the direction of causation compared to models using cross sectional data, and reduces the probable parameter bias that occurs when using cross sectional data (Selig and Preacher, 2009).

The model can be expressed by the following equations:

$$\Delta M_{i,t} = \alpha + \beta^{a} \frac{S_{h(i),t-1}}{W_{h(i),t-1}} \frac{\Delta SP_{m(i,t)}}{SP_{m(i,t-1)}} + \epsilon_{i,t}^{\Delta M}$$

$$\Delta Y_{it} = \alpha + \beta^{b} \Delta M_{i,t} + \beta^{c} \frac{S_{h(i),t-1}}{W_{h(i),t-1}} \frac{\Delta SP_{m(i,t)}}{SP_{m(i,t-1)}} + \gamma^{\Delta Y\prime} X_{it} + \epsilon_{it}^{\Delta Y} \quad (1)$$

The mediating variable $\Delta M_{i,t}$ represents a change in the mediator between this wave and two waves previous. A change in health status, ΔY_{it} (measured over two waves), is affected by our negative wealth shock measure both directly and indirectly through changes in the mediator(s) $\Delta M_{i,t}$. A vector of demographic controls (X_{it}) and household characteristics further affects health changes.

Changes in different health measures are regressed via Structural Equation Modelling on the constructed negative wealth shocks. Full Information Maximum Likelihood is used to take account of missing values. Joint normality of all variables is assumed and missing values are assumed to be missing at random. The first

[9] Kraemer et al. (2008) stated "the necessity of using longitudinal studies with at least two and usually three time points to establish moderators and mediators" (p. 106). Gollob and Reichardt (1987) discuss the problems of using cross sectional data in detail.

difference specification cleans the dependent variable of unexplainable variation i.e. it absorbs time invariant health status changes, behavioural differences or allostatic load changes that exist across individuals (while it does not reduce the number of observations since the construction of wealth shocks already requires a lag). [10]

To account for item level missing data and obtain the maximum number of cases, multiple imputation (MI) was employed in MPlus for both continuous and categorical variables (Asparouhov and Muthen, 2010).

4.3. Results

Descriptive statistics of all variables from the year 2006 to 2014 are presented in Table 4.1. It can be seen that the majority of respondents report that they have not experienced a change in health from the previous wave (60.5%). The majority of the sample are overweight with mean BMI being 27.5, 8.9% smoke currently, 9.3% are moderate or heavy drinkers. The mean allostatic load score is 1.74.

Our sample has more females (67.1%) than males (32.9%), the mean age is 51 years and the mean annual total household net income is €38858.

I first estimate the model in (1) without the mediating variable to confirm results found elsewhere. Results shown in Table 4.3 indicate clearly, just as in Schwandt (2018), that the exogenous negative wealth shock has a large and statistically significant effect on self-reported health among retirees causing health to deteriorate across waves ($\beta^c = 9.089$)[11]. Estimates for the coefficients on other controls are as expected – income and wealth reduce health deterioration as does education and marriage.

In the next set of results in Table 4.4, I use the structural equation model in (1) with allostatic load as a single mediating variable to determine whether the effect of the wealth shock on health is completely mediated through increases in allostatic load. With the same set of controls as before, an increase in allostatic load is seen to have a

[10] This specification also has an efficiency advantage over an alternative fixed effects specification (Wooldridge 2010) if the mediators follow a random walk rather than a white noise process. French and Jones (2004) show that within individuals health shocks are highly persistent.
[11] This model is estimated over a gap of two waves or four years.

large and significant effect on worse health ($\beta^b = 0.124$) but the evidence for negative wealth shocks causing the increase in allostatic load is weak. The coefficient is seen to be positive as expected but only statistically significant at the marginal 10% level of significance ($\beta^a = 3.142$). On the other hand, the negative health effect of the wealth shock is still apparent but now acting directly on self-reported health and not mediated through allostatic load ($\beta^c = 8.936$). In the second column of estimates, I follow Stephan (2016) in calculating an alternative composite allostatic load measure based on computing Z scores for each biomarker and averaging the result. Higher values therefore indicate higher multi-system physiological dysregulation as in the group-based method used for the composite allostatic load measure in the first column but values are now continuous rather than ordinal. The evidence for a mediating effect of allostatic load is even weaker in this set of estimates. There is neither an effect of the negative wealth shock on allostatic load nor, more surprisingly, evidence of a relationship between increases in allostatic load and health deterioration.

I repeat this analysis in Table 4.5 replacing changes in allostatic load as mediator by changes in a number of health behaviours related to financial stress. The evidence for a statistically significant mediated effect is much weaker here. The negative wealth shock has no clear effect on changes in any of the health-related behaviours. Estimates in the lower panel also show no clear effect of these behaviours on changes in self-reported health. The one counterintuitive relationship observable is increased overweightedness being associated with health improvement. However, this can be explained by the observation that, due to the prevalence of adiposity (obesity) in the USA, 'normal' BMI can be an indication of health abnormalities in older adults rather than an indication of a healthy weight (Batsis et al., 2016). The effect of the negative wealth shock is still apparent in the direct effect estimate ($\beta^c = 8.936$) but unmediated by health behaviours.

When I test all potential mediating pathways together in Table 4.6 it is clear that the evidence for allostatic load as mediator of the effect of negative wealth shocks on health deterioration is much stronger than for health behaviours. The negative wealth shock has no statistically significant effect on health behaviours as in Table 4.5 whereas the effect of allostatic load is in the hypothesized direction and is

significant albeit at the marginal 10% level of significance as in Table 4.4. The effects of these mediating variables on health deterioration is unchanged from previous estimates. Increases in allostatic load cause health to worsen whereas becoming overweight improves health as observed before. There is still a large direct effect that I have not managed to capture with the estimated mediated pathways ($\beta^c = 9.160$).

In the last set of estimates (Table 4.7), I decompose the allostatic load measure into its constituent parts to examine the reaction of each biomarker to negative wealth shocks. Changes in the allostatic load components generally have the expected relationship when examined individually in the lower panel of results. Increases in systolic and diastolic blood pressure as well as cystatin C are associated with health deterioration while increases in HDL (the "good cholesterol") are associated with health improvements. The negative coefficient on glycosylated haemoglobin (HbA1C) is however anomalous. The upper panel of results in contrast shows no clear association with the negative wealth shock. I take this as confirmation of evidence found elsewhere that the composite AL measure has a stronger relationship with physical health than its individual components.

4.4. Conclusions

Using data on retirees from the US Health and Retirement Study (HRS), I have found some evidence that the health impairment effect of a negative wealth shock observed by Schwandt (2018) is mediated not through changes in health behaviours but through biological changes in sensitive organ systems associated with exposure to stressors. This then confirms the conclusion of Prentice et al. (2017) who indicate the health-behavioural response to financial strain appears to be relatively minor for health outcomes compared to the biological response to financial strain.

Although the strength of our study design is that the temporal ordering of financial strain and health consequences in our model controls for potential reverse causation, the cross wave structure may not capture short term periods of financial strain which can also impact on health i.e. strain may affect health sooner than the four-year time lag that we are testing in this paper. This is a limitation of the data available to us.

The data analysis is also limited by the level of missingness in the data. The panel structure required repeated observations on household members which are often not available as is typical in studies of older populations.

Tables

Table 4.1: Descriptive statistics for all waves from 2006-2014 (N=11144)

	n	%	(% non-missing)
Negative wealth shock			
(Mean) and (SD)	(0.00)	(0.01)	
Self rated change in health (Missing 0.2%)			
Somewhat better	952	8.5%	8.6%
Same	6747	60.5%	60.7%
Somewhat worse	3421	30.7%	30.8%
Frequent moderate physical activity (Missing 0.4%)			
Every day	851	7.6%	7.7%
> Once per week	3792	34.0%	34.2%
Once per week	1811	16.3%	16.3%
1-3 times per week	1286	11.5%	11.6%
Never	3361	30.2%	30.3%
Frequent vigorous physical activity (Missing 0.4%)			
Every day	242	2.2%	2.2%
> Once per week	1872	16.8%	16.9%
Once per week	921	8.3%	8.3%
1-3 times per week	757	6.8%	6.8%
Never	7304	65.5%	65.8%
Smoker (Missing 0.8%)			
No	10062	90.3%	91.0%
Drink level (Missing 0.2%)			
Non drinker	7768	69.7%	69.9%
Light	2316	20.8%	20.8%
Moderate	946	8.5%	8.5%
Heavy	89	0.8%	0.8%
BMI (Missing 0.01%)			
(Mean) and (SD)	(27.5)	(5.77)	
Allostatic load (Missing 0.1%)			
(Mean) and (SD)	(1.74)	(1.38)	
Education			
Lt high-school	2082	18.7%	18.7%
GED	601	4.5%	4.5%
High-school graduate	3830	34.4%	34.4%
Some college	2552	22.9%	22.9%
College and above	2177	19.5%	19.5%
Gender			
Male	3661		32.9%
Female	7483		67.1%
Age dummy (Missing 0.1%)			
50+	43.0	0.4%	0.4%
55+	955	8.6%	8.6%
65+	1178	10.6%	10.6%

70+	1966	17.6%	17.7%
75+	6993	62.8%	62.8%
(Lagged) Marital Status (Missing 0.2%)			
Married	4641	41.7%	41.7%
Married, spouse absent	79	0.7%	0.7%
Partnered	207	1.9%	1.9%
Separated	118	1.1%	1.1%
Divorced	1371	12.3%	12.3%
Separated/divorced	3	0.0%	0.0%
Widowed	4246	38.1%	38.1%
Never married	474	4.3%	4.3%
Race			
White/Caucasian	9205	82.6%	82.6%
Black/African American	1513	13.6%	13.6%
Other	425	3.8%	3.8%
Census region			
North East	1606	14.4%	14.4%
Mid West	2845	25.5%	25.5%
South	4646	41.7%	41.7%
West	2045	18.4%	18.4%
Other	1	0.0%	0.0%
Household income (log $)			
(Mean) and (SD)	(10.14)	(1.31)	
Lifetime wealth ($)			
(Mean) and (SD)	(172363)	(596545)	
Financial wealth (log $)			
(Mean) and (SD)	(8.03)	(4.87)	
Household debt (log $)			
(Mean) and (SD)	(1.89)	(3.49)	
Non-financial wealth (log $)			
(Mean) and (SD)	(10.89)	(3.43)	
S&P 500 index			
(Mean) and (SD)	(1697.6)	(410.1)	
Stocks and mutual funds			
0	7798		70%
1	3346		30%
N	11144		

Notes: No missing data unless indicated.

Table 4.2: Criterion cut-points for individual biological components of allostatic load index in HRS

	Biological Parameters	N	Mean (SD)	High risk cut off values
Cardiovascular	High systolic BP (mmHg)	8090	132.2 (20.6)	≥144.5
	High diastolic BP (mmHg)	8090	76.5 (11.5)	≥83.5
Metabolic Indicators	High glycosylated haemoglobin (HbA1c) (%)	8690	37.6 (52.9)	≥86
	Low HDL cholesterol (mg/dl)	8475	55.7 (17.2)	≤43.25
	High total cholesterol (mg/dl)	8649	188.1(42.7)	≥214.49
	High cystatin C (μg/ml)	8602	1.3 (0.6)	≥1.47
	High waist measurement (inches)	8025	39.7 (6.3)	≥43
Inflammation marker	High C-reactive protein (μg/ml)	8641	4.4 (11.0)	≥4.26

Table 4.3: Regression of a negative wealth shock on self-reported change in health using a sample of retired households

	coef./s.e.
Negative wealth shock	9.089**
	(1.434)
Gender	0.043
	(0.031)
Age dummy	0.019**
	(0.002)
Race	-0.108**
	(0.030)
Census region	-0.009
	(0.015)
(Lagged) Marital Status	-0.019**
	(0.005)
Education level	-0.073**
	(0.012)
Household income	-0.070**
	(0.012)
Financial Wealth	0.009*
	(0.004)
Household debt	0.000
	(0.004)
Non-financial wealth	-0.021**
	(0.007)
Health insurance	0.039
	(0.036)
S&P 500 index	0.000**
	(0.000)
Stocks and mutual funds	0.097**
	(0.036)
n	11144

Table 4.4: Structural equation model estimates of the effects of a negative wealth shock on a self-reported change in health mediated by a change in allostatic load

	coef./s.e.	
	AL1	AL2
Effects of a negative wealth shock on a change in allostatic load		
Negative wealth shock	3.142*	0.393
	(1.534)	(-0.459)
Effect of a change in allostatic load on a change in self-reported health		
Allostatic load	0.124**	-0.021
	(0.011)	(-0.037)
Gender	0.043	0.043
	(0.031)	(-0.031)
Age dummy	0.019**	0.019**
	(0.002)	(0.002)
Race	-0.109**	-0.109**
	(0.030)	(0.030)
Census region	-0.009	-0.009
	(0.015)	(0.015)
Lagged marital status	-0.018**	-0.019**
	(0.005)	(0.005)
Education level	-0.072**	-0.073**
	(0.012)	(0.012)
Household income	-0.069**	-0.070**
	(0.012)	(0.012)
Financial Wealth	0.008	0.009*
	(0.004)	(0.004)
Household debt	-0.001	0.000
	(0.004)	(0.004)
Non financial wealth	-0.022**	-0.020**
	(0.007)	(0.007)
Health insurance	0.036	0.037
	(0.036)	(0.036)
S&P 500 index	0.000**	0.000**
	(0.000)	(0.000)
Stocks and mutual funds	0.093**	0.097**
	(0.036)	(0.036)
Direct effect of negative wealth shock on health	8.936**	9.094**
	(1.423)	(1.434)
n	11144	11144

Table 4.5: Structural equation model estimates of the effects of a negative wealth shock on a self-reported change in health mediated by changes in health behaviours

	coef./s.e.
Effect of a negative wealth shock on a change in health behaviours	
Physical activity	0.338
	(2.085)
Overweight	-0.030
	(1.491)
Heavy drinking	-2.553
	(3.073)
Smoking	0.248
	(0.676)
Effect of a change in health behaviours on a change in health	
Physical activity	-0.082
	(0.058)
Overweight	-0.198**
	(0.067)
Heavy drinking	0.063
	(0.116)
Smoking	-0.170
	(0.160)
Direct effect of negative wealth shock on health	9.374**
	(1.549)
n	11144

Notes: Other controls include Gender, Age, Race, Census region, (Lagged) marital status, Education, household income, Financial Wealth, Household debt, Non financial wealth, Health insurance, S&P 500 index, Stocks and mutual funds.

Table 4.6: Structural equation model estimates of the effects of a negative wealth shock on a self-reported change in health mediated by changes in health behaviours and allostatic load

	coef./s.e.
Effect of a negative wealth shock on a change in health behaviours and allostatic load	
Physical activity	0.338
	(2.085)
Overweight	-0.030
	(1.491)
Heavy drinking	-2.553
	(3.073)
Smoking	0.248
	(0.676)
Allostatic load	3.142*
	(1.534)
Effect of a change in health behaviours and allostatic load on a change in health	
Physical activity	-0.065
	(0.059)
Overweight	-0.216**
	(0.065)
Heavy drinking	0.047
	(0.117)
Smoking	-0.157
	(0.160)
Allostatic load	0.125**
	(0.011)
Direct effect of negative wealth shock on health	9.160**
	(1.536)
n	11144

Notes: Other controls include Gender, Age, Race, Census region, (Lagged) marital status, Education, household income, Financial Wealth, Household debt, Non financial wealth, Health insurance, S&P 500 index, Stocks and mutual funds.

Table 4.7: Structural equation model estimates of the effects of a negative wealth shock on a self-reported change in health mediated by a change in individual allostatic load components

	Systolic BP	Diastolic BP	Waist circumference	Glycosylated haemoglobin (HbA1C)	High-Density-Lipoprotein Cholesterol (HDL)	Total Cholesterol (TC)	Cystatin C	C-reactive protein (CRP)
Effects of a negative wealth shock on a change in allostatic load component	coef./s.e.	coef./s.e.	coef./s.e.	coef./s.e.	coef./s.e.	coef./s.e.	coef./s.e.	coef./s.e.
Negative wealth shock	19.825	12.089	3.552	-0.049**	-10.223	29.831	-0.136	-5.269
	(20.553)	(12.178)	(3.845)	(0.010)	(23.087)	(48.469)	(0.449)	(17.440)
Effect of a change in allostatic load component on a change in self-reported health								
Allostatic load component	0.004**	0.008**	-0.008	-0.494**	-0.003**	0.000	0.243**	-0.003*
	(0.001)	(0.002)	(0.012	(0.009)	(0.001)	(0.000)	(0.041)	(0.001)
Direct effect on health	8.999**	9.013**	9.091**	0.065**	9.139**	6.764**	9.153	9.108**
	(1.433)	(1.432)	(1.433)	(0.008)	(1.434)	(1.421)	(1.431)	(1.435)
n	11144	11144	11144	11144	11144	11144	11144	11144

Notes: Other controls include Gender, Age, Race, Census region, (Lagged) marital status, Education, household income, Financial Wealth, Household debt, Non financial wealth, Health insurance, S&P 500 index, Stocks and mutual funds.

CHAPTER 5

CONCLUSIONS

Introduction

The focus of my research is the association between financial strain (as a particular stress) and mental and physical health and health related behaviours. Financial stress is often caused by unexpected circumstances beyond our control for example shocks or changes in the wider political, economic and social environments or at the household level. Households, even those that are income rich or liquidity unconstrained, can be disrupted by unexpected financial shocks subsequently leaving them experiencing financial strain. Financial stress can lead to poor psychological states such as depression or anxiety which in turn are thought to influence health, either directly via physiological processes that influence disease pathogenesis or through behavioural patterns which can then contribute to disease or mortality. My research offers a greater breadth of understanding than the extant literature. Not only do I consider the direct impact of financial stress on health, but go beyond the black box view of causality and consider potential mediating variables in order to explain how this connection might occur. My research also offers insight into the effect of wealth shocks on health and health behaviours, subject matter now thrown into sharp relief by the emerging consequences of the COVID-19 pandemic.

My papers

In my first paper, the effect of financial strain on physical health and health related behaviours is examined, and in particular, the extent to which changes in the rate of time discounting mediates the association between financial strain and health. The data used is drawn from the nationally representative Dutch National Bank (DNB) Household Survey. The period considered is 1997 to 2002 as the time discounting questions of interest are only available for these dates. Estimation is by way of a cross lagged panel model. The central hypothesis is

that financial stress works against an individual's typical impulse control patterns to shift from a more long-term focus on distal goals (saving money and health optimising behaviour) to a short-term focus on immediate rewards (spending immediately, smoking, alcohol consumption and eating unhealthy foods) as represented by an increased rate of time discounting. Concerns, previously highlighted in the literature, about reverse causation and unmeasured confounders are addressed by carrying out sophisticated mediation analysis controlling for individual heterogeneity. Non-experimental data is used to examine the links in the chain of causation, in contrast to previous studies that relied on experimental data or cross sectional studies.

The analysis reveals that financial stress has a significant and sizeable direct effect on self-rated health, being overweight, smoking and excessive alcohol consumption. Individuals experiencing financial stress report a lower level of self-rated health, are more likely to be overweight, smoke and drink alcohol to excess. This link between financial stress and self-rated health is noteworthy as many studies relating financial difficulties and health do not clearly establish the direction of causation nor do they fully account for confounders. There is, however, lack of a mediating pathway as financial stress is not found to influence time discounting, nor did time discounting have any effect on self-rated health. This result is a surprise given the extensive literature indicating the significance of this behavioural pathway. A number of explanations as to why this might be the case are given including problems with the measures for the rate of time discounting, hypothetical versus real monetary rewards, and the use of exponential discounting as opposed to hyperbolic discounting.

In my second paper the behavioural pathway from financial strain to poor health is re-visited to further explore the causal mechanisms. Data is drawn from the DNB Household Survey, in this instance for 1997 to 2017. Initially, causal mediation analysis is conducted to examine the direct effect of financial stress on health, and the indirect associations via health behaviours. Secondly, I build on the first paper and re-analyse the links between financial strain, present biases and changes in health behaviours to better understand the lack of behavioural response to strain in our data given the extensive literature indicating the

significance of this pathway. Although the DNB Survey does not now contain a time preference question providing a discount rate it does offer four suitable proxies which each capture an aspect of impulsivity. Finally, a total effects moderation analysis is carried out to test if gender and employment situation moderate the direct effect of financial strain on ill health or the indirect mediated effect of changes in health behaviours. Few studies have investigated whether the relationship between economic stress and health differs by gender or by employment status.

The analysis reveals that financial strain has a significant and sizeable direct effect on self-rated health and health behaviours including smoking, heavy drinking and being overweight. However, health behaviours do not significantly mediate the relationship between financial strain and self-reported health. There is evidence that financial strain causes greater impulsivity but this does not result in worse health behaviours. I suggest that the lack of a link between time discounting and health may be caused by the influence of the force of present biases increasing demand for each unhealthy consumption good being outweighed by the reduction in demand due to the lack of disposable income available to the financially stressed. The assessment of moderation by gender finds that the indirect effect of health behaviours in the financial strain-health pathway is larger for men although not statistically significant. I suggest that societal views place inherent constraints on the types of behaviours women use to cope with strain which may explain the smaller indirect effect. The moderated mediation analysis using employment status finds that the indirect effect of those not in employment is slightly stronger relative to those that are, although again statistically insignificant. An issue for this aspect of the analysis is the dichotomous nature of the employment variable with the non-employed category encompassing, students, retired, home keepers or volunteers and those looking for work.

My third paper examines the direct effect of wealth shocks (constructed from plausibly exogenous movements in US equity markets) on a change in self-reported health, and the indirect associations via changes in allostatic load in the first instance and secondly via changes in health behaviours. Allostatic load is

captured by way of composite measures constructed from biomarkers. These biomarkers are not susceptible to many of the shortcomings associated with self-reported health measures and may enhance the modelling of causal pathways to health by revealing health characteristics which are unknown to participants. A structural equation model with multiple time points for each variable is implemented based on data (2006 to 2016) from the US Health and Retirement Study (HRS). The HRS dataset is used as it provides a rich collection of biomarkers that enable the construction of an allostatic load index. Initially, the structural equation model is estimated without the mediating variable to confirm results elsewhere in the literature. Thereafter, the model is estimated with allostatic load as a single mediating variable, then re-estimated with changes in health behaviours as mediator with the empirical analysis concluding with the decomposition of the allostatic load measure into its constituent parts to examine the reaction of each biomarker to negative wealth shocks.

The analysis demonstrates the negative wealth shock as having a large and statistically significant effect on self-reported health causing health to deteriorate across waves. The meditation analysis provides some evidence that this effect is mediated not through changes in health behaviours but through biological changes in sensitive organ systems associated with exposure to stressors. This helps to confirm my prior work suggesting that the health-behavioural response to financial strain is relatively minor for health outcomes compared to the biological response to financial strain. The evidence in the empirical analysis is, however, at marginal levels of statistical significance. This may well reflect the data limitations in my methodological approach. Although my study design controlled for potential reverse causation by using panel data as well as exogenous wealth shocks, the four-year time lag between observations attenuates any data signal. The data analysis is also limited by the level of missingness in the data. The panel structure required repeated observations on household members which are often not available as is typical in studies of older populations.

Further research

As already observed, there are a number of significant gaps in the research

literature that future research projects could tackle. The current interdisciplinary literature on household financial strain often repeats obvious findings; is methodologically simple and lacks a sound theoretical basis.

Studies have found that household financial strain is persistent but this work lacks sound theory and only allows for simple dynamics over time. We still know little about how households become financially fragile nor do we understand why households remain distressed beyond that they lack savings, income or diversified assets. The Dynamic Random Coefficients (DRCP) model (Bhuller et al, 2017) allows for (i) the joint estimation of separate models for entry into and persistence of strain and (ii) higher order dynamics to explore the effect of previous occasions when the household was strained and the length of the current episode.

More work could also be done to examine whether households have a 'pecking order' of coping methods to deal with financial crises and why they may vary. Standard economic theory presumes that households deal with shocks by selling assets or storing up savings as a precaution. But survey work indicates that households use a variety of strategies when coping with shocks. They may for example reduce consumption; draw on savings; rely on family/friends; take on extra work or sell off household assets. Drawing on ideas in corporate finance, each household may have a 'pecking order' of most preferred to least preferred coping method determined by direct or perhaps social costs. Empirical evidence demonstrates that some ordering exists but research is needed to provide a consistent theoretical grounding and new testable predictions that follow from this theory.

The COVID-19 pandemic has emphasised the differential effect of economic shocks on indebtedness levels between income groups in the UK (and in other wealthy countries). While the general trend (so far) is one of a rise in household savings and a reduction in debt, evidence is also emerging that some households, particularly those with low incomes, renters, people from minority ethnic groups, parents and carers, disabled people, those who are shielding, and young people have run down savings and increased debt (Francis-Devine, 2021; Romei and Strauss, 2021). From April 2020, respondents to the UK Understanding Society

survey have been asked to complete a short web-survey on the changing impact of COVID-19. This survey was repeated monthly and then bi-monthly from July 2020 onwards. The pandemic represents a major unexpected economic shock to the livelihoods of a large proportion of UK households which has played out in real-time across this succession of surveys. This data could be explored to examine whether UK households have pecking orders and determine the speed at which households move through these mechanisms and what determines the move at each stage to a new coping mechanism.

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