Strategic vs. Nonstrategic Household Behaviour: An Analysis of U.S. Bankruptcy Filings*

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Abstract

This paper studies whether households filing for bankruptcy are strategic, i.e., they file when the financial benefit of filing exceeds the cost, or nonstrategic, i.e., they file when unable to repay their debt. These types differ in their likelihood of filing, hence the distribution of types affects the availability and pricing of consumer credit. I extend a standard heterogeneous agent life-cycle model of household bankruptcy to include both strategic and nonstrategic agents, where these types differ only in terms of their filing decision rule. The proportion of each type is estimated using household-level data from the Panel Study of Income Dynamics. The model enables us to quantify both strategic and nonstrategic bankruptcy filings, and infer the magnitude of the alleged 'abuse' of Chapter 7 bankruptcy policy by strategic households. It also provides insights into previous findings in both the structural and reduced-form bankruptcy literature, by estimating the model parameters using simulated method of moments, with target moments taken from previous studies. The main result is that a structural model without nonstrategic agents has difficulty matching key moments, and it generates a significantly larger number of bankruptcy filings where the agents could repay. Consequently, it overstates the extent that Chapter 7 is being 'abused', and leads to predictions that exaggerate the effect of the 2005 Bankruptcy Code reforms implemented to curtail abusive filings.

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1 Introduction

Evaluating the extent to which households behave strategically is crucial for understanding the impact of public policy. This requires inference regarding the motives of households using a given policy, and whether this use is consistent with the goals of the policy. In this paper I study U.S. bankruptcy policy with the goal of identifying strategic and nonstrategic filing behaviour by households. Bankruptcy policy is a suitable choice for such analysis, since there has been extensive disagreement about the motives of households filings for bankruptcy, and this debate has occurred concurrent to legislation proposed to eliminate 'abuse' of the policy by strategic households. Furthermore, bankruptcy policy reform has important implications for the availability and pricing of consumer credit.

Chapter 7 of the U.S. Bankruptcy Code allows filers to completely discharge most types of unsecured debt, hence providing indebted household with a 'fresh start'. This type of bankruptcy policy is unique to the US and considerably more lenient than bankruptcy policy in other developed countries. However, in 2005 the Bankruptcy Abuse Prevention and Consumer Protection Act (BAPCPA) was adopted, introducing eligibility criteria and several other measures aimed at increasing the cost of filing. The generosity with which debt is discharged, together with the lack of restrictions on eligibility (prior to BAPCPA), provided households with an incentive to file, even if they can afford to repay their debt. This type of filing behaviour has been referred to as 'strategic', since it entails households responding optimally to the costs and benefits of filing – regardless of whether they can afford to repay their debt. This is in contrast to 'nonstrategic' behaviour, which refers to households filing in response to an adverse event (e.g., job loss, divorce, health problems) that precludes the possibility of repayment. Although both types will potentially file in response to an adverse event, the key feature that distinguishes between types is that the nonstrategic households never file if they can afford to repay. While anecdotal evidence and descriptive studies suggest that some households exhibit strategic behaviour when filing for bankruptcy, it is unclear how pervasive this is since there has been no formal attempt to quantify it. And, without knowing the extent of this strategic behaviour, it is difficult to evaluate the economic implications of bankruptcy policy reforms.

To address this, I introduce nonstrategic agents into a structural model of bankruptcy, estimate the proportion of strategic and nonstrategic types, and use the estimated model to study how the composition of types affects interest rates, welfare and bankruptcy policy reforms. In the model, strategic households file when the benefit of filing exceeds the opportunity cost (i.e., repaying), while nonstrategic households file when they are sufficiently liquidity-constrained and thus cannot afford to repay. While both types of households can file in response to adverse events, nonstrategic households always repay in the absence of an adverse event. Therefore, agents are *ex-ante* heterogeneous in terms of their filing decision. The model parameters are estimated by simulated method of moments using moments on the aggregate filing rate, average borrowing rate, the average debt-to-income ratio of filers, and regression coefficient estimates obtained using the Panel Study of Income Dynamics (PSID). Additionally, in contrast to previous studies of strategic and nonstrategic behaviour, I use a dynamic model, which allows strategic households to take into account both dynamic (i.e., exclusion from credit markets and prohibition of repeat filings) and non-financial (i.e., stigma) costs of bankruptcy.

I show that introducing nonstrategic agents is necessary, not just for estimating the proportion of strategic and nonstrategic behaviour, but for matching key data moments for bankruptcy filers. In particular, I show that a model without nonstrategic agents is generally unable to match the average debt-to-income ratio of bankruptcy filers, a key characteristic of bankrupt households emphasized by Sullivan, Warren, and Westbrook (1989). I also demonstrate that introducing heterogeneity in the filing decision leads to a large dispersion in borrowing patterns across the strategic and nonstrategic agent types, even though both types face the same borrowing constraints. Furthermore, introducing a mass of nonstrategic types, which are not as responsive to the benefits offered by bankruptcy policy as strategic agents, moderate the interest rates offered by intermediaries, when intermediaries cannot identify the type of the agents. Consequently, once nonstrategic agents are present in the model, the subsequent reduction in interest rates is large enough to eliminate the need for an interest-rate ceiling, as in Livshits, MacGee, and Tertilt (2010).

Additionally, I use the simulated data from the model to replicate the statistical test in Fay, Hurst, and White (2002). This influential study tested for strategic and nonstrategic filing behaviour by using sign restrictions from a regression of debt and income on whether households file for bankruptcy. I show that inferring strategic and/or nonstrategic behaviour directly from regression coefficient estimates is not always valid, since it would lead us to infer a type of filing behaviour inconsistent with the model. For example, the model populated exclusively with nonstrategic agents can produce regression coefficient estimates that they would interpret as evidence of strategic behaviour. This motivates using a quantitative model to identify strategic and nonstrategic filing behaviour.

This paper contributes to several strands of the literature on household bankruptcy. The first relates to the filing behaviour of households, which are largely descriptive, pioneered by the influential Consumer Bankruptcy Project I and II, Sullivan, Warren, and Westbrook (1989) and Sullivan, Warren, and Westbrook (2000). This was followed by studies specifically addressing strategic and nonstrategic filing behaviour, in particular, Fay, Hurst, and White (2002), and, more recently, Zhang, Sabarwal, and Gan (2015) and Gan, Hernandez, and Zhang (2015). My paper departs from these previous studies by using a structural model of bankruptcy to study the motives and potentially heterogeneous filing behaviour of households. It enables us to quantify the proportion of strategic and nonstrategic households filing for bankruptcy, and determine what proportion of the filings by strategic households may be considered ‘abusive’. In contrast to previous studies, I do not assume that all strategic filings constitute ‘abuse’, since the model allows us to determine whether a strategic household that filed for bankruptcy could have repaid its debt.

The second group of related studies is comprised of economic models of bankruptcy. These are characterized by dynamic models with endogenous interest rates and default, following Chatterjee, Corbae, Nakajima, and Ríos-Rull (2007) and Livshits, MacGee, and Tertilt (2007). They have been applied to study the credit-card puzzle (Lopes (2008); Mankart (2014)), its interaction with social insurance policies (Athreya and Simpson (2006); Athreya (2008)), the household bankruptcy chapter choice (Li and Sarte (2006)), the role of durable goods (Pavan (2008)), the rising bankruptcy rate (Livshits, MacGee, and Tertilt (2010)), credit-market changes (Athreya, Tam, and Young (2012); Livshits, MacGee, and Tertilt (2016)), interaction with housing policy (Mitman (2016)), and cross-state policy variations (Hintermaier and Koeniger (2016)).[1]

These models have not been used to study heterogeneity in the filing decision, and its implications for borrowing rates and welfare. Therefore, I define nonstrategic filing behaviour in the model, following the descriptions provided by the literature on the filing behaviour of households. Specifically, the nonstrategic agents file when severely financially constrained, rather than filing in response to the benefits provided by the bankruptcy policy. Furthermore, I consider three specifications of the nonstrategic agent to reflect different financial constraints: income, disposable income, and consumption. The resulting dichotomy between strategic and nonstrategic agents is similar to that described in Haltiwanger and Waldman (1991), who define a particular form of heterogeneity across agents in terms of how they choose their actions: one type (responders) condition their actions on the actions of others, while the other type (non-responders) do not. Here, the strategic agents are responders in the sense that they condition their action (filing choice) on the benefits offered by the bankruptcy policy, while the nonstrategic agents do not. This is also consistent with Zhang, Sabarwal, and Gan (2015), who argue that nonstrategic types are characterised by being ‘rationally inattentive’ to the bankruptcy policy.

Finally, several studies have used economic models to study the effects of the BAPCPA reforms. These include the effect of the means test (Athreya (2002); Chatterjee, Corbae, Nakajima, and Ríos-Rull (2007)), its implications for the choice of bankruptcy chapter by households (Cornwell and Xu (2014)), and its impact on rates of foreclosure (Li, White, and Zhu (2011); Mitman (2016)). By studying the effect of this policy change with heterogeneous types, we obtain differential effects depending on the proportion of strategic and nonstrategic types in the

[1] For a more comprehensive summary of this literature, see Livshits (2015).

economy: as the proportion of nonstrategic types increases, the policy response is dampened. Specifically, I show that excluding nonstrategic agents leads to significantly overestimating the reduction in bankruptcy filings.

The remainder of the paper is structured as follows. In Section 2, I begin by describing the findings of previous studies regarding strategic and nonstrategic behaviour, and a brief legislative history of the U.S. Bankruptcy Code. Section 3 outlines the economic model used to study strategic and nonstrategic bankruptcy, while the corresponding quantitative model and data moments are described in Section 4. This is followed by the results of the model estimation and analysis in Section 5. Section 6 uses the estimated model to study the effect of the BAPCPA reforms, and Section 7 offers concluding remarks.

2 Background and Data

Many previous studies of household bankruptcy have focused on identifying the events, or triggers, that caused a household to file for bankruptcy. In particular, these are often referred to as 'adverse events' or 'bad luck', and entail either a large reduction in income for the household, or a large rise in their expenses. On the other hand, for decades there have been allegations of 'abuse' of the bankruptcy system, which has been fuelled by anecdotes of high-profile individuals filing, and the rise in bankruptcy filings since the Bankruptcy Reform Act of 1978.[2] This can be seen in Figure 1, which depicts the total number of annual non-business filings from 1980 to 2004. There has been a dramatic increase in filings from 287,570 in 1980, to more than one million by 1997.

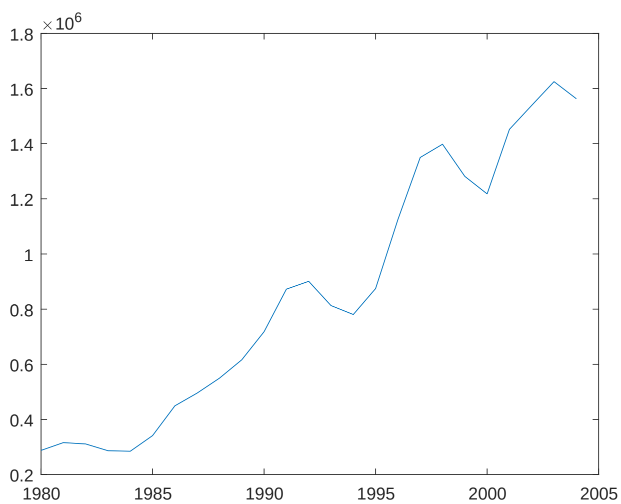


Figure 1: Annual non-business filings. (Source: American Bankruptcy Institute)

[2]See, for example, Sullivan, Warren, and Westbrook (1997) or White (2007).

Throughout this period there was significant attention devoted to whether the Bankruptcy Code needed revisions in response to the considerable rise in household filings. This includes reforms undertaken in 1984, the founding of the National Bankruptcy Review Commission (NBRC) in 1994 to recommend further reforms, a subsequent drafting of these reforms from 1996–1998, and a prolonged period of debate over these reforms until the eventual adoption of the Bankruptcy Abuse Prevention and Consumer Protection Act (BAPCPA) in 2005. Given the lack of detailed micro-data on bankruptcy filings throughout this period, it was difficult to determine whether these allegations of abuse were significantly widespread to warrant legislative reform.

This prompted a landmark study by Sullivan, Warren, and Westbrook (1989), called the Bankruptcy Project, which collected data from bankruptcy courts in Illinois, Pennsylvania and Texas in the early 1980s. While noting that some 'dishonest' bankruptcies were observed, the authors emphasized that these were the exceptions, rather than the rule. Overwhelmingly, households filing were in a dire financial situation caused by an adverse event, could not reasonably expect to repay their debt, and therefore were in desperate need of financial relief. This study was followed up a decade later by Sullivan, Warren, and Westbrook (2000), using data from the early 1990s, which reiterated the conclusions of the former study. The follow-up study occurred at the same time the NBRC was tasked with recommending changes to the Bankruptcy Code, largely to investigate these allegations of abuse.

During the time these reforms were being debated in the U.S. Congress, evidence appeared to support the notion that households were 'abusing' the bankruptcy system. In an influential study, Fay, Hurst, and White (2002) undertake a reduced-form analysis of bankruptcy using PSID data, finding evidence of strategic behaviour and "little support for the nonstrategic model of bankruptcy". This conclusion follows from the fact that they fail to find support for adverse events causing households to file, and nonstrategic households only file in response to adverse events. Specifically, in a regression with a binary variable indicating whether a household filed for bankruptcy, the adverse-event variables (unemployment spells, health problems and divorce) do not affect the bankruptcy decision, except for a marginally significant positive effect of divorce. This result is quite striking, since it conflicts with the reasons provided by households in the PSID, contained in Table 1.

The first four categories in Table 1 describe these so-called adverse events, which can broadly be described as either job loss, divorce, or medical expenses. Together these adverse events account for approximately 50% of primary responses.[3] The fifth category important, since it contains the largest proportion of responses (33%), but it is vague – 'debts too high' could be an outcome of an adverse event, and/or credit card misuse. Even if we assume it's entirely due

[3]The PSID allowed households to list multiple reasons. Table 1 contains the first response, which I assume is the most important factor. It should be noted that if we pool all responses, rather than consider only the first response, the composition across categories is largely unchanged.

Table 1: Self-reported reasons for bankruptcy.

Category	Reason	Frequency	Proportion
1	Loss of job; business failed	108	20.69
2	Divorce/separation; death of spouse	85	16.28
3	Illness/injury; unable to work	23	4.41
4	Medical/health care bills	60	11.49
5	Debts too high; credit card misuse	172	32.95
6	Lawsuit; creditor harassment	5	0.96
7	Other	65	12.45
8	DK	4	0.77
Total	–	522	100.00

Note: This table provides household responses to the 1997 PSID question, "What was your reason for filing for bankruptcy?", which was asked up to five times. Responses in category 0 (respondent is not household head, or never filed) and 9 (NA; refused) are excluded.

to credit card misuse, it's not clear whether this misuse is borrowing with no intention to repay, or simply irresponsible financial behaviour. Nevertheless, since this category is likely to contain the 'strategic' filers, it can be interpreted as *prima facie* evidence of 'abuse', and hence motivates further investigation.

Following the findings of Fay, Hurst, and White (2002), subsequent studies focused on investigating the link between adverse events and the filing decision, rather than explicitly studying strategic vs. nonstrategic behaviour. In particular, many papers find evidence supporting the claim that adverse events trigger bankruptcy filings: in particular, job loss, medical expenses and divorce. Specifically, Zhang, Sabarwal, and Gan (2015) using data from the 1998 Survey of Consumer Finance (SCF), find a strongly significant and positive effect of divorce. Additionally, Keys (2010) repeats the analysis of Fay, Hurst, and White (2002) using PSID data, but expands the window for adverse events from 1-year to 3-years, finding that unemployment spells are significant. There is also a substantial literature on the link between medical expenses and household bankruptcy (see, e.g., Domowitz and Sartain (1999), Gross and Notowidigdo (2011) and Koch (2014)), which suggests that unanticipated medical expenses are a major factor contributing to bankruptcy filings in the US. Additionally, Keys (2017) uses data from the National Longitudinal Survey of Youth (NLSY) to study the dynamic effects of adverse events on the likelihood of filing for bankruptcy. The main results demonstrate that unemployment spells and disability have a significant positive effect on bankruptcy filings across a 2–4 year horizon. While these recent studies suggest that adverse events are an important factor in the filing decision, they do not reveal whether households behave in a strategic or nonstrategic manner, since both types can potentially file in response to an adverse event. This point – that strategic behaviour and adverse events are not mutually exclusive – is emphasized by Keys (2017). One of the benefits of using a structural model to explicitly model strategic and nonstrategic behaviour is that we can identify whether a strategic household is filing in response to an adverse event.

Several other studies have established that households exhibit strategic behaviour in their decision to obtain health insurance or file for divorce (see, e.g., Mahoney (2015) and Traczynski (2011), respectively), i.e., their decision is affected by the insurance offered by bankruptcy policy. Other studies, however, find little evidence in cross-state variations in bankruptcy filings to suggest households are optimally responding to cross-state variations in bankruptcy exemption laws (e.g., Lefgren and McIntyre (2009)).[4] The only recent studies that explicitly test for strategic vs. nonstrategic behaviour in the filing decision are Zhang, Sabarwal, and Gan (2015) and Gan, Hernandez, and Zhang (2015). The former paper asserts that both strategic and nonstrategic behaviour produce a positive coefficient on financial benefit, which was the basis for Fay, Hurst, and White (2002) determining the presence of strategic behaviour (in addition to the absence of evidence for adverse events). Additionally, using adverse events as an instrument, they conclude that financial benefit is exogenous to the filing decision, and hence reject strategic behaviour for both the PSID and SCF. The latter paper, builds on the conclusions of the former to identify heterogeneous behaviour in borrowing and filing decisions among U.S. households. Both papers conduct statistical tests, rather than using an economic model to infer strategic vs. nonstrategic behaviour, and thus should be considered complementary to this paper.

Despite the disagreement over the role played by adverse events, structural models of bankruptcy have included adverse events as sources of uncertainty ranging from shocks to employment (e.g., Athreya and Simpson (2006)), divorce and medical expenses (e.g., Chatterjee, Corbae, Nakajima, and Ríos-Rull (2007) and Livshits, MacGee, and Tertilt (2007)). These are particularly important in models with endogenous debt-pricing, since interest rates adjust to deter agents from borrowing amounts that make them (strategically) filing in subsequent periods. Therefore, unanticipated adverse events are necessary to generate filings consistent with the data. This is no longer the case once nonstrategic households are included in the model. Nevertheless, despite including adverse events in these models, agent filing behaviour is homogeneous, and hence there has been no attempt to distinguish between strategic and nonstrategic filing behaviour.

3 Model

I employ a heterogeneous-agent model with endogenous debt-pricing to study the household bankruptcy filing decision. The exposition is consistent with the approach outlined in Livshits,

[4]In recent quantitative work, however, Mankart (2014) and Hintermaier and Koeniger (2016) question whether state variations in exemption levels are economically relevant, since most unsecured debtors hold less assets than the exempt amount.

MacGee, and Tertilt (2007): i.e., households are finite-lived and in every period they inelastically supply labour, suffer low-probability shocks to expenses, face a borrowing/saving decision, and have the option to discharge (unsecured) debt à la Chapter 7 of the U.S. Bankruptcy Code. Additionally, the borrowing rate facing agents is endogenous, following Eaton and Gersovitz (1981), where agents receive an interest-rate schedule that is a function of their future likelihood of filing for bankruptcy. The main challenge we face is to define strategic and nonstrategic behaviour in the model, since this has not been explored in previous models of bankruptcy.

I begin in Section 3.1 with a model containing *ex-ante* homogeneous agents. This provides us with a link to previous models of bankruptcy, and explores to what extent we can use a model with *ex-ante* homogeneity in the filing decision to identify strategic and nonstrategic behaviour. While these models of bankruptcy have not explicitly considered modelling strategic vs. nonstrategic filing behaviour, the decision rule of agents in existing models (e.g., Athreya (2002), Chatterjee, Corbae, Nakajima, and Ríos-Rull (2007), and Livshits, MacGee, and Tertilt (2007)) is consistent with the description of strategic behaviour in Fay, Hurst, and White (2002).[5] This is because the agents in these models are aware of the costs and benefits of filing, and consequently make the decision to file optimally. Nevertheless, since agents file in response to adverse events, not all instances of bankruptcy constitute 'abuse'. Specifically, I will define a notion of 'voluntary' vs. 'involuntary' bankruptcies, based on whether repaying was a feasible action, and that will allow us to distinguish some strategic filings from 'abuse' of the policy.

In Section 3.2 the assumption of *ex-ante* homogeneity is relaxed when I introduce strategic and nonstrategic types of agents. Since previous models of bankruptcy have well-defined strategic agents, the focus is on introducing nonstrategic agents into this framework. This requires introducing *ex-ante* heterogeneity in terms of the bankruptcy filing rule. Furthermore, I consider a variety of nonstrategic behavioural types informed by descriptive studies of nonstrategic filing behaviour, namely Sullivan, Warren, and Westbrook (1989), Sullivan, Warren, and Westbrook (2000) and Fay, Hurst, and White (2002). These types will differ only in terms of the financial variable used to define their filing rule, i.e., income, disposable income, or consumption.

3.1 Homogeneous filing behaviour

In this section I will develop a life-cycle model with *ex-ante* identical households that live for J periods. There is no heterogeneity in terms of attitudes toward bankruptcy policy or filing behaviour. Households maximize discounted lifetime utility from consumption, and face idiosyncratic uncertainty through both labour earnings and expenses. Markets are incomplete, and

[5]Although these bankruptcy models involve dynamic decision making, whereas the analysis of Fay, Hurst, and White (2002) is static, the essence of strategic filing behaviour is consistent since, in both cases, agents file when the benefit of filing exceeds the cost. The only difference is that the dynamic models encompass expected future costs and benefits in addition to the immediate costs and benefits.

there is no aggregate uncertainty. In every period, households inelastically supply their labour endowment and earn stochastic income $y > 0$. They also have a financial portfolio comprised of one-period bonds, b, where $b > 0$ corresponds with lending/saving and $b < 0$ corresponds to borrowing. The households are subject to an iid stochastic expense shock $x \geq 0$, which captures adverse events in the form of expenses, e.g., medical expenses or divorce costs. Additionally, with access to financial markets, households have the option to file for bankruptcy and discharge their unsecured debt ($b < 0$). There is no secured debt in this model, hence we will explicitly model only Chapter 7 bankruptcy policy, rather than both Chapter 7 and Chapter 13. Therefore, this choice problem involves the household choosing a sequence of consumption and repay decisions, (c_j, I_j), given the state (y_j, b_j, x_j), at every age $j = 1, \ldots, J$.

The structure we impose on I_j, i.e., the decision-making process for filing for bankruptcy, is what will distinguish between strategic and nonstrategic households in this model. Note that this will have feedback effects on the borrowing/savings decision, and hence heterogeneity in the filing decision rule will lead to different patterns of borrowing/saving across the strategic and nonstrategic types. For the remainder of this section, however, I_j will be identical for all agents.

Households. We will proceed by stating the recursive problem associated with these decision rules. The state for the recursive problem is defined as a vector, $\boldsymbol{s} = (y, b, x, j)$, where y, b, and x, denote income, wealth and expenses, respectively. Given a state $\boldsymbol{s}$, the value function is,

$$v(\boldsymbol{s}) = \max_{b', I} \{u(c) - (1 - I)\psi + \beta E_{\boldsymbol{s}'|\boldsymbol{s}}[I v(y', b', x', j+1) + (1 - I)v^A(y', 0, x', j+1)]\}, \tag{1}$$

$$c = y + I[b - x - q(y, b', j)b'] - (1 - I)\Gamma y, \tag{2}$$

where $v(\boldsymbol{s})|_{I=1}$ represents the value of repaying debt obligation $b < 0$ (or being repaid $b > 0$), and $v(\boldsymbol{s})|_{I=0}$ represents the value of filing for bankruptcy; and it is implicitly understood that the decision to repay, $I(\boldsymbol{s})$, is a function of the state. The filing decision of the household, therefore, is

$$I(\boldsymbol{s}) = \begin{cases} 1 & \text{if } v(\boldsymbol{s})|_{I=1} \geq v(\boldsymbol{s})|_{I=0} \\ 0 & \text{if } v(\boldsymbol{s})|_{I=1} < v(\boldsymbol{s})|_{I=0} \end{cases}$$

i.e., the household files for bankruptcy when the value of filing $v(\boldsymbol{s})|_{I=0}$ is strictly greater than the value of repaying $v(\boldsymbol{s})|_{I=1}$. Of course if the household is not borrowing, i.e., $b \geq 0$, they have no incentive to file for bankruptcy. As usual, $c > 0$ is current period consumption, and $\beta < 1$ captures future discounting. Note that $q(y, b')b'$ is what the household receives by promising to pay b' in the following period, hence the one-period interest rate on borrowing $q(y, b')b'$ is $q(y, b')^{-1}$. The determination of $q(\cdot)$ occurs in equilibrium, and will be discussed later in this section. Additionally, I impose the terminal condition of no borrowing in the final period of life, i.e., $b_{J+1} \geq 0$.

There are both static and dynamic costs of filing for bankruptcy. In the period the household files, it must pay a utility cost $\psi \geq 0$ and a fraction of income $\Gamma \in [0,1]$ is transferred to the lender. It is then forced into 'financial autarky' for subsequent periods, where access to financial markets is restricted and thus the household is prevented from borrowing to smooth consumption. Additionally, when market access is restricted, the household is unable to file for Chapter 7 bankruptcy again. Although the household cannot borrow in autarky it may want to file again, if permitted, since it is still subject to expense shocks. There is an important difference between ψ and Γ regarding the effect on interest rates. While the utility cost of filing ψ can capture both financial and non-financial costs of filing, e.g., legal costs and 'stigma' costs, it does not compensate the lender. The fraction of income Γ transferred to the lender directly affects the equilibrium interest-rate schedule $q(\cdot)$.

Losing market access has two consequences: the household cannot borrow, and they cannot file for bankruptcy again in response to expense shocks experienced in autarky. Therefore, the value of autarky is given by,

$$v^A(\boldsymbol{s}) = \max_{b' \geq 0}\{u(c) + \beta E_{\boldsymbol{s}'|\boldsymbol{s}}[\lambda v(y', b', x', j+1) + (1-\lambda)v^A(y', b', x', j+1)]\}, \tag{3}$$

where $\lambda \in [0,1]$ is the probability of leaving autarky. Since this parameter determines the expected duration of a household being restricted from credit access, λ measures the severity, in terms of longevity, of the punishment imposed by the bankruptcy rules or credit markets on the household in terms of their post-bankruptcy credit rating.[6] A possible interpretation of autarky is that it corresponds to the period in which households have the bankruptcy flag on their credit reports, as in Chatterjee, Corbae, Nakajima, and Ríos-Rull (2007). In Section 4 I will discuss how the value of λ is set in order to capture the joint restriction on borrowing and repeat filings.

Once the household leaves financial autarky, it regains the ability to borrow and file (Chapter 7) bankruptcy again. However, if a household obtains a sufficiently large expense shock in autarky, since it cannot borrow or discharge debt, repaying may not be feasible; i.e., $c \leq y + b - x < 0$. We overcome this by allowing households to repay expense shocks over several periods, as in Livshits, MacGee, and Tertilt (2010) and Mankart (2014). Instead, in each period the household repays some fixed fraction of income, given by $\delta > 0$, and the remaining expenses are rolled over at an interest rate $\overline{R} > 1$. This assumption is justified by appealing to Chapter 13 of the U.S. Bankruptcy Code, where households enter into a debt-repayment plan; i.e., the

[6] This is a limitation of using a stochastic autarky exit-process: it conflates the duration of the explicit bankruptcy punishment of precluding repeat filings with the duration of the implicit punishment of restricted credit access. Nevertheless, it is commonly employed due to the additional computational burden of keeping track of the duration spent in autarky under deterministic exit (e.g., Chatterjee, Corbae, Nakajima, and Ríos-Rull (2007); Mitman (2016)).

household repays a substantial amount of its outstanding unsecured debt over a 3 to 5-year period by making regular payments out of income. Therefore, we have several cases depending on whether it is feasible to repay the expense shock. Let $\hat{c}^A(y,b,x,j)$ denote the maximum possible consumption in autarky, given (y,b,x,j); i.e., $\hat{c}^A(y,b,x,j) = \max_{b'\geq 0}\{y+Rb-x-b'\} = y+Rb-x$. Autarky consumption and debt dynamics depend on $\hat{c}^A$ in the following way:

$$c = y+Rb-x-b', \text{ and } b' = c+x-y-Rb \geq 0, \qquad (\hat{c}^A > 0)$$
$$c = \max\{(1-\delta)y, y-x\}+Rb, \text{ and } b' = \min\{-x+\delta y, 0\} \leq 0, \qquad (\hat{c}^A \leq 0, b \geq 0)$$
$$c = \max\{(1-\delta)y, y-x+\overline{R}b\}, \text{ and } b' = \min\{-x+\overline{R}b+\delta y, 0\} \leq 0. \qquad (\hat{c}^A \leq 0, b < 0)$$

In the first case, $(\hat{c}^A > 0)$, the household has sufficient income and savings to repay the expense shock in the period, and can potentially save $b' \geq 0$. If the household cannot afford to repay the expense shock $(\hat{c}^A \leq 0, b \geq 0)$, it repays up to a fraction $\delta > 0$ of its income in each period while in autarky, and it consumes any savings $Rb \geq 0$ in the period of the expense shock. If the amount of debt outstanding is less than δy, the household pays the amount owed rather than δy. When the amount of expenses unpaid is rolled over, $(\hat{c}^A \leq 0, b < 0)$, the debt that is rolled over is subject to a roll-over interest rate $\overline{R} > R$.[7]

Intermediaries. The operation of financial markets is undertaken by intermediaries that borrow from, and lend to, households. Intermediaries are assumed to be risk-neutral and the market for intermediaries competitive, where they face an outside option generating a return of R. Additionally, the intermediaries incur a transaction cost of $\tau > 0$. Given a set of observable household characteristics $\mathbf{s}$, together with the borrowing choice b', intermediaries set the price of debt $q(\mathbf{s}, b')$, such that, in expectation, there is no arbitrage:

$$q(\mathbf{s}, b') = \frac{1}{R+\tau} E_{\mathbf{s}'|\mathbf{s}} \left[p(\mathbf{s}') + (1-p(\mathbf{s}')) \tfrac{\Gamma y}{b'+x'} \right]. \tag{4}$$

where $p(\mathbf{s}')$ is the probability of repayment in state $\mathbf{s}' = (y', b', x', j+1)$. It is the probability that a household that borrowed $q(\mathbf{s}, b')b'$ will repay b' in the following period. While we have written $q(\cdot)$ as a function of $\mathbf{s}$, strictly speaking, it does not depend on the current debt level b or expenses x, but it does depend on (y, j).[8] The right side of (4) is the expected fraction of debt received when lending: with probability $p(\mathbf{s}')$ the lender receives the full amount, and with probability $1-p(\mathbf{s}')$ the lender receives $\frac{\Gamma y}{b'+x'}$, which is less than 1, in equilibrium. This fraction is determined by following the convention, in Livshits, MacGee, and Tertilt (2007), that

[7] We can appeal to the existence of 'payday' loans, for example, to justify household access to credit after filing and the associated high interest rate. For more on this, see Han and Li (2011) and Bhutta, Skiba, and Tobacman (2015).

[8] Generically, $p(\mathbf{s}) = \int_{\mathbf{s}\in S} I(\mathbf{s})dG(\mathbf{s})$, where $G(\cdot)$ is the distribution function governing the stochastic components of the state vector. In the quantitative model, in Section 4, income follows a Markov process, but expenses are iid.

the amount of earnings forfeited under bankruptcy is allocated proportionately to repaying debt b' and expenses x', hence the lender does not receive the full amount Γy. Strictly speaking, if the household does not have any assets beyond some threshold then the lender will not receive any compensation under a Chapter 7 bankruptcy. Since b represents wealth in the model, the household cannot concurrently hold assets and debt, and hence the intermediary should not be compensated. However, there are several reasons why we should expect a lender to receive something under bankruptcy in the model, e.g., time aggregation, or a legislative reason, such as the 'good faith' provision in the U.S. Bankruptcy Code. This is typically modelled by assuming that some fraction of income is transferred to the lender, e.g., Livshits, MacGee, and Tertilt (2007) and Mankart (2014), and it is justified by noting that households in default (i.e., missed payments) can legally have their income garnished by the lender. This is not ideal, however, since households can end garnishment by filing for bankruptcy. Therefore, even if we ignore the legal costs and uncertainty associated with attempting to garnish wages, the household should optimally respond by filing for bankruptcy as soon as they are notified that their wages will be garnished, which therefore undermines any benefit to the lender of seeking to garnish wages. In fact, in the PSID we observe that only a small fraction of bankrupt households had their wages garnished, and that *every household that had their wages garnished filed for bankruptcy*. For this reason it may be more appropriate to have a fraction of debt transferred to the lender, but this raises technical issues relating to feasibility.[9]

Regardless of how the transfer to the lender under bankruptcy is specified, it has important implications in this model through its effect on the interest-rate schedule in (4). If there is no transfer to the lender under bankruptcy, i.e., $\Gamma = 0$, then the lender will set $q(\cdot) = 0$ if the probability of repayment is zero – corresponding to an infinite interest rate. This creates substantial discontinuities in the interest-rate schedule, and constrains households to borrow amounts they will repay with a very high probability at an interest rate closely approximating the risk-free rate.

Another point of interest regards the need for an interest-rate ceiling: Livshits, MacGee, and Tertilt (2010) note that a small fraction of households may borrow at extraordinarily high interest rates with no intent to repay, i.e., borrowing at $q(\cdot)$ arbitrarily close to zero. This occurs when $\Gamma > 0$, since it ensures the intermediary receives some compensation under bankruptcy, and thus accordingly sets $q(\cdot) > 0$. Therefore we impose an interest-rate ceiling by adjusting the (inverse) interest rate set by the intermediary to

$$\hat{q}(\boldsymbol{s}, b') = \begin{cases} q(\boldsymbol{s}, b') & \text{if } q(\boldsymbol{s}, b') \geq \frac{1}{\bar{R}} \\ 0 & \text{otherwise} \end{cases}$$

[9] The role of the bankruptcy policy in the model is to provide agents with a consumption floor, which may be undermined depending on how we specify the filing costs.

where $\hat{R} > R$ is the interest rate ceiling, and $q(\boldsymbol{s}, b')$ is the unrestricted (inverse) interest rate from (4). When the quantitative model in Section 4 is estimated, this ceiling binds for a very small fraction of homogeneous agents when $\Gamma > 0$. However, once we introduce nonstrategic agents, the interest-rate ceiling never binds – when the lenders cannot identify the type of the agents, the existence of nonstrategic types increases the equilibrium $q(\cdot)$ offered to strategic agents, relative to the model without nonstrategic types.

Equilibrium. A recursive competitive equilibrium in this environment is characterised by the value functions $v(\boldsymbol{s})$, $v^A(\boldsymbol{s})$, policy functions for debt holdings $b'(\boldsymbol{s})$ and filing decisions $I(\boldsymbol{s})$, and debt price $q(y, b', j)$, such that, for $\boldsymbol{s} = (y, b, x, j)$ and $j = 1, \ldots, J$: (i) the value functions satisfy the functional equations, (1), (3), and $b'(\boldsymbol{s})$ and $I(\boldsymbol{s})$ are the associated optimal policy functions; (ii) the interest-rate schedule $q(y, b', j)$ is determined by the zero-profit, no-arbitrage condition given by (4); and (iii). the default probabilities are consistent, $p(y', b', x', j+1) = E_{y',x'|y} I(y', b', x', j+1)$, given a bankruptcy rule and risk-free return R.

We can solve for the equilibrium using backward induction. Beginning in age J, solve for the policy functions and hence the default probabilities. For each subsequent iteration, from $j = J-1, \ldots, 1$, solve for the interest-rate schedule $q(y, b, j)$, the policy functions and the default probabilities. There is no borrowing or lending at age J, and we require households to meet their debt obligations at age J. Although households can always file for bankruptcy in the final period to meet their debt obligations, this will not lead to excessive borrowing in $J-1$ since $q(y, d, J-1)$ implicitly takes this into account, and households have potentially accumulated precautionary savings by this age.

3.1.1 Involuntary bankruptcies

When agents are homogeneous, they behave identically regarding their attitude toward bankruptcy policy, i.e., all agents have the same policy function for filing. In this case, they are forward-looking and file when the benefit exceeds the cost of filing. Specifically, this decision is made in terms of value functions for repaying and filing, according to $I(\boldsymbol{s})$, hence all agents are strategic. However, repaying the debt instead of filing may not have been a feasible action for all households that filed. Therefore, following Chatterjee, Corbae, Nakajima, and Ríos-Rull (2007), I label bankruptcies as 'voluntary' or 'involuntary' depending on whether repaying is a feasible action. In the former case bankruptcy is the best option, while in the latter case bankruptcy is the only option. Separating bankruptcies into these cases is useful because it provides us with a starting point for identifying 'abusive' bankruptcy filings; i.e., those bankruptcies deemed inconsistent with the goals of lawmakers. Even in a framework where all agents file strategically, for sufficiently large expense shocks, some bankruptcies will not constitute 'abuse' of the bankruptcy system.

Let $\hat{c}^R(y,b,x,j)$ denote the maximum possible consumption, given (y,b,x,j), when the agent is not in autarky. This is the 'repay-state' analogue of the maximum feasible consumption in autarky, $\hat{c}^A(y,b,x,j)$. The object $\hat{c}^R$ and the 'voluntary'/'involuntary' filings are defined as:

$$y + b - x - q(y,b',j)\hat{b}' = \hat{c}^R(y,b,x,j|\hat{b}') > 0 \qquad \text{('voluntary')}$$

$$\hat{c}^R(y,b,x,j|\hat{b}') \leq 0 \qquad \text{('involuntary')}$$

where $\hat{b}'(y,b,x,j) = \arg\max\{q(y,b',j)b'\}$ represents the maximum possible borrowing amount in any state (y,b,x,j). Therefore, for an 'involuntary' bankruptcy, repaying was not feasible for any b' in the period the agent filed. Whereas, for a 'voluntary' bankruptcy, there exists a b' such that repaying was feasible in the period they filed. It is important to emphasize that this specification is consistent with previous models of bankruptcy, in the sense that there is no heterogeneity coming through agents' filing decisions. While all agents behave strategically in the sense that they know the bankruptcy policy and hence calculate the costs and benefits of filing, including being forward-looking and taking dynamic filing costs into account, not all of these agents are 'abusing' bankruptcy policy. However, it should be noted that since all agents have the same policy functions for borrowing and filing, the difference between a 'voluntary' and 'involuntary' bankruptcy is primarily driven by the exogenous expense shocks. This is somewhat limiting, since households are not making choices that determine whether they are 'abusing' the policy; i.e., we observe no difference between 'voluntary' and 'involuntary' bankruptcies in their borrowing and filing choices. However, this provides us with a motivation for introducing heterogeneity into this framework to generate different policy functions for strategic and nonstrategic households. This will lead to an outcome where only a fraction of strategic bankruptcies are 'involuntary', but all nonstrategic bankruptcies will be 'involuntary', by definition.

Nevertheless, this specification is a useful starting point for studying the alleged 'abuse' of the bankruptcy system. Furthermore it provides a direct link to previous models of bankruptcy, allowing us to use an established framework to study this issue. Additionally, we can argue that this setup provides us with an upper bound of 'abuse', since it assumes agents' have complete knowledge of the bankruptcy law and a lack of behavioural biases in engaging with the policy. However, since this setup assumes *ex-ante* homogeneity in terms of filing behaviour, that is, an agent only files if its benefit exceeds costs, which is in contrast to the description of nonstrategic filing behaviour in Fay, Hurst, and White (2002), we will introduce a nonstrategic agent to this model in the following section.

3.2 Heterogeneous filing behaviour

We can introduce heterogeneity in filing behaviour in the model so that agents use bankruptcy policy in different ways. Let $t \in \{S, NS\}$ denote the type of the agent, where S and NS refer to strategic and nonstrategic agents, respectively. The state vector $\boldsymbol{s}$ is now expanded to include the agent's type, hence we have $\boldsymbol{s} = (y, b, x, j, t)$, and the type does not change over the life cycle. Finally, I introduce a parameter $\alpha \in [0, 1]$, which reflects the proportion of strategic agents in the economy; thus, the proportion of nonstrategic types is given by $1 - \alpha$.

Households. The Bellman equation with heterogeneous agents is as in (1) with period consumption given by (2), except the state vector is now expanded to include the agent type, t, which exclusively enters the value function and budget constraint through the filing decision $I(y, b, x, j, t)$. While there are not explicit differences in consumption between the strategic and nonstrategic types, the differences in filing behaviour has feedback effects on borrowing/saving decisions b'. The value in autarky (3) remains unchanged since neither agent type can file while in financial autarky. The filing decision for strategic types is the same as that in Section 3.1,

$$I(y, b, x, j, S) = \begin{cases} 1 & \text{if } v(y, b, x, j, S)|_{I=1} \geq v(y, b, x, j, S)|_{I=0} \\ 0 & \text{if } v(y, b, x, j, S)|_{I=1} < v(y, b, x, j, S)|_{I=0} \end{cases}$$

since this takes into account all of the current and future costs and benefits of filing. This filing decision ensures that the model with heterogeneous agents nests the model with homogeneous agents: when all agents are strategic (i.e., when $\alpha = 1$) the agents behave identically to those in the homogeneous model. We will consider several variations of the nonstrategic type, and these are defined in Section 3.2.1.

Intermediaries. The existence of multiple types affects the determination of $q(\cdot)$. If the intermediaries can identify types and discriminate, they will optimally set an interest-rate schedule $\boldsymbol{q} = \{q^S, q^{NS}\}$, indexed by agent types, where q^t is set according to (4). Instead, I will assume that there is asymmetric information. Specifically, intermediaries cannot identify types, and hence set interest rates for pooled borrowers. In the pooling case, the equilibrium interest rate is a weighted average of the interest-rate schedule $\boldsymbol{q}$ set with types separated,

$$q(\boldsymbol{s}, b') = \alpha q^S + (1 - \alpha) q^{NS}, \tag{5}$$

where each type-specific interest rate q^t is weighted by the proportion of those types in the economy. We do not need to assume that the intermediaries know the proportion of types in the economy in order to correctly price debt, as in (5). For some fixed proportion of types and perfect competition among intermediaries, q will be driven to equal (5), in equilibrium, where the intermediaries earn zero excess-returns.[10] Finally, as discussed in Section 3.1, the interest-rate ceiling imposed with homogeneous agents is not necessary with heterogeneous agents; i.e., it never binds in equilibrium.

Equilibrium. A recursive competitive equilibrium in the environment with heterogeneous filing types is defined in the same way as the case with homogeneous filing types, with several notable differences. The state vector is expanded to include types, $t \in \{S, NS\}$, so that $\boldsymbol{s} = (y, b, x, j, t)$. Policy functions and default probabilities are now also indexed by type. Interest-rate schedules are determined assuming pooling of agent types, according to (5), which is determined according to the zero-profit, no-arbitrage condition (4).

3.2.1 Nonstrategic behaviour

I consider three specifications of nonstrategic behaviour, informed by descriptions in previous studies. In each case agents do not make the filing decision in response to the relative costs and benefits of bankruptcy. Instead, they file when they cannot afford to repay. Specifically, the nonstrategic household files when sufficiently constrained in terms of a particular financial variable, either (NS.1) income, (NS.2) disposable income, or (NS.3) consumption. Formally, for a given state (y, b, x, j) the nonstrategic household files in each case if

$$y \leq \underline{y}, \tag{NS.1}$$

$$y + b - x \leq \underline{b}, \tag{NS.2}$$

$$\hat{c}^R(\cdot) \leq \underline{c}, \tag{NS.3}$$

where $\underline{y} \geq 0$, $\underline{b} \leq 0$, $\underline{c} \geq 0$, and $\hat{c}^R(\cdot)$ is defined as in the homogeneous case, $\hat{c}^R(y, b, x, j|\hat{b}') = y + b - x - q(y, b', j)\hat{b}'$, with $\hat{b}' = \arg\max\{q(y, b', j)b'\}$.[11] Each case will be discussed in turn.

NS.1: Income. In the first specification, the nonstrategic type files when (exogenous) income falls below a threshold, reflecting that income is the primary source the household uses to repay debt. Hence, a sufficient reduction in household income corresponds to a reduction in their ability to repay outstanding debt. This approach is motivated by the assumptions of Fay, Hurst, and White (2002). For nonstrategic households, they stated that, "a strict interpretation of the nonstrategic model implies that income should be negatively and significantly related to the probability of filing for bankruptcy, because income measures ability to repay debt", and that "financial benefit should not be significantly related to the probability of filing, because households' financial benefit from filing depends only on their wealth and not on their incomes"

[10] See Appendix A for details.

[11] While I have not specified an upper bound for these cutoffs, in Section 5 the range of parameter values considered will be restricted to a range that ensures there does not exist a state where the nonstrategic household files but the strategic household does not.

This interpretation of the nonstrategic model of bankruptcy implies that it *only* depends on income, and not wealth or debt. We may, however, be inclined to think that debt is also an important factor in the filing decision of the nonstrategic household, and this is explored in the next specification.

NS.2: Disposable income. This formulation takes into account the current debt obligations and expense shock. It is a natural rule to consider, since it allows the filing decision to vary for different amounts of debt outstanding, unlike NS.1. This overcomes the restrictive assumption that debt affects the filing decision of the strategic agent (through financial benefit), but not the nonstrategic agent. The most obvious benefit this has over the former specification is that it allows adverse events, in the form of expenses, to trigger bankruptcy, which is consistent with the findings of literature on medical expenses and divorce triggering bankruptcy. With $\underline{b} \leq 0$, repayment of debt and expenses is not feasible *unless the agent borrows*. Borrowing, however, does not feature into the filing decision of this agent type.

NS.3: Consumption. This specification extends NS.2 to allow the agent to borrow to avoid filing for bankruptcy. It extends the notion of 'ability to repay' to include disposable income and new debt. Therefore, the decision to file is now in terms of current consumption; i.e., if consumption falls below a threshold, the nonstrategic agent files. The decision depends on the maximum possible amount an agent can borrow in a given period, $\hat{b}'$. Hence, for $\underline{c} = 0$, repaying is not feasible. This specification ensures the nonstrategic agent files if it is constrained in terms of current-period consumption.

In every case the nonstrategic agent is myopic, since filing only depends on current-period variables and not future consumption or bankruptcy costs. Additionally, while filing for bankruptcy is a choice in reality, this is not true in the model. The filing decision is based on exogenous variables only, and hence it is not endogenous. Even in NS.3, which allows for borrowing, the filing decision is based on $\hat{b}'$, not b'. Consequently, the nonstrategic agent is not optimally filing.[12] This, however, is consistent with the notion that agents are sufficiently constrained (or illiquid) and have no choice other than to file – see, for example, Sullivan, Warren, and Westbrook (2000). It is also reflective of the fact that these agents are not strategic, and hence they are not optimally filing. The cutoff that determines when the nonstrategic agent files can be interpreted as the point where the household seeks a remedy for its indebtedness, e.g., legal advice. In such a case the household would be advised that filing is in its best interests, and hence files. An alternative explanation for nonstrategic behaviour is provided by Zhang, Sabarwal, and Gan (2015), who describe these types as being 'rationally inattentive' to the benefits offered by bankruptcy policy. They argue that, given the low probability of suffering an adverse

[12] The nonstrategic type will abstain from filing in states where it is the optimal action, unlike the strategic type. However, whenever we observe a nonstrategic type filing, filing was the optimal action in that state, i.e., the strategic type will also file in that state.

event, and the legal costs required to accurately determine the benefits of filing (prior to experiencing an adverse event), it is rational to not be informed. This explanation is broadly consistent with the above descriptions of nonstrategic behaviour, where the trigger for a nonstrategic agent filing is when they are sufficiently financially constrained, rather than when the benefit of filing exceeds the cost.

3.2.2 Alternative specifications of nonstrategic behaviour

There are several other ways we might consider to model nonstrategic behaviour. Specifically, by introducing heterogeneity into the model through either discounting (β) or stigma costs (ψ). I will briefly describe how these approaches differ from that outlined above, and why these approaches are not chosen.

Heterogeneous discounting. It is important to emphasize that while nonstrategic agents are myopic in this model, the difference between strategic and nonstrategic agents is not simply due to differences in discounting; i.e., this setup is not equivalent to one where strategic and nonstrategic agents are *ex-ante* heterogeneous only in terms of their discounting preference, where nonstrategic agents are myopic $\beta^{NS} < \beta^{S} < 1$. The crucial difference is generated from the bankruptcy filing decision in terms of period payoffs. This can be illustrated with a simple example: suppose we have a nonstrategic agent with $\beta^{NS} = 0$, i.e., nonstrategic agent only considers the period consumption when making decisions. It will not take into account dynamic costs of bankruptcy, but it will file even if it can afford to repay if the period payoff for bankruptcy exceeds repaying. The extremely impatient agent is discounting the dynamic costs of bankruptcy, but none of the benefits of bankruptcy (since they occur within the period of filing); hence the impatient agent is more likely to file, in contrast to descriptions of nonstrategic behaviour. Not only will this agent exhibit very different borrowing behaviour from the nonstrategic agent defined in the previous section, it will still file in a 'static' strategic sense; i.e., it ignores dynamic costs and benefits of filing, but behaves strategically given the immediate costs and benefits.

Heterogeneous stigma. It may seem as though the nonstrategic agents behave identically to strategic agents with high stigma costs. This, however, is only true for certain values of ψ and the nonstrategic cutoff. Consider the nonstrategic consumption type (NS.3) with a cutoff $\underline{c} = 0$. In this extreme case, the nonstrategic agent will only file when it is not feasible to repay. This agent will behave identically to a strategic agent with a very large but finite ψ, since this agent will also only file when repaying is not feasible. Now suppose we reduce ψ and increase $\underline{c}$ so that both types of agents file in some states where repaying is a feasible action. These states may differ, since the nonstrategic agent makes its filing decision solely on current period consumption when repaying, while the strategic agent considers both current and future expected consumption under repaying vs. filing. In other words, this is a special case for the strategic agents, since it leads to a filing decision that does not depend on future consumption.

4 Quantitative model and data

The model from Section 3 needs some additional structure in order to be estimated. This involves specifying preferences, stochastic processes for earnings and expenses, and parameters. The households have a period utility function with constant relative risk aversion (CRRA), parameterised by γ; i.e., $u(c) = c^{1-\gamma}/(1-\gamma)$. Agents live for a total of $J = 50$ years, and spend $J_W = 40$ of those years working from age 25 to 64 before exogenous retirement at age 65, followed by an additional 10 years of post-retirement, from age 65 to 74.

Stochastic processes. During working years, the earnings of an agent follows a Markov process, which is comprised of both transitory and persistent components, in addition to a deterministic age-profile. That is, the state variable for income is now a vector, $\boldsymbol{y} = [y_\eta, y_u]$, where η and u index to the persistent and transitory component, respectively. The parameters governing the deterministic and stochastic processes are estimated using data from the Panel Study of Income Dynamics (PSID) for 1984-1996, the range of years considered in the analysis of Fay, Hurst, and White (2002), and they are contained in Table 2.

Table 2: Estimated parameters for stochastic component of income.

parameter	value	description
ρ_y	0.94741	persistence of *net* labour earnings
σ_{y_η}	0.15612	standard deviation of persistent *net* labour earnings shock
σ_{y_u}	0.16186	standard deviation of transitory *net* labour earnings shock

Note: Estimating using PSID data using household labour earnings; net earnings were generated on earnings data minus income tax estimated using NBER Taxsim. For further details, see Appendix B.1.

These estimates are broadly in the range found previously: estimates of σ_{y_η} include 0.14–0.16 (Hubbard, Skinner, and Zeldes (1995)), 0.15–0.17 (Gourinchas and Parker (2002)), 0.17 (weighted average) with a general range of 0.12–0.21 (depending on aggregate condition) (Storesletten, Telmer, and Yaron (2004)); while estimates of σ_{y_u} include 0.17 (Hubbard, Skinner, and Zeldes (1995)), 0.21 (Gourinchas and Parker (2002)), 0.235–257 (Storesletten, Telmer, and Yaron (2004), over-identified estimates).[13] The stochastic processes for the transitory and persistent component of income are discretised into 11 states, the latter following Rouwenhorst (1995). Wealth, i.e., debt and savings, is discretised into an unevenly-spaced grid with 291 states.

The exogenous process for the expense shocks follows that defined in Livshits, MacGee, and Tertilt (2007). These, however, are stated for a model with a period of three years. The an-

[13]The estimate for σ_{y_u} is marginally lower than the range of previous estimates, since it is for labour earnings net of taxes: the corresponding parameter estimate for gross labour earnings was within the range of previous estimates.

nual values of the expense shock are taken from Mankart (2014), and converted to 1996 dollars, to give magnitudes of $\$1,191$ and \$37,085, with associated probabilities 2.369 percent and 0.153 percent. These values incorporate unanticipated expenses associated with the major causes of bankruptcy in the US: medical expenses, divorce and unplanned pregnancies. See Livshits, MacGee, and Tertilt (2003) for details on how these were estimated. The stochastic income and expense process thus represent the multiple sources of uncertainty responsible for bankrupt households filings in the PSID, from Table 1.

Retirement. At the age of retirement, income becomes deterministic and the agents are no longer subject to expense shocks. This assumption is largely made for convenience: the expense shocks are the primary force causing bankruptcy in the model, and post-retirement bankruptcy is not observed in the data for this time period. However, there is some validity to this assumption beyond convenience. The expense shock formulated by Livshits, MacGee, and Tertilt (2007) captures the financial risks associated with divorce, catastrophic medical expenses, and unplanned pregnancies. Clearly the incidence of the latter event is extremely unlikely to occur post-retirement, and the same argument can be made about divorce – at least in terms of the reduction in labour earnings that comes from separating the household, since the household has no labour earnings. Medical expenses, however, generally rise post-retirement (see, for example, DeNardi, French, and Jones (2010)), but it is not clear whether the same applies to catastrophic medical expenses. Furthermore, the rise in out-of-pocket medical expenses is mitigated to some extent by Medicare, and hence it is not clear whether their risk of bankruptcy caused by medical expenses rises in line with post-retirement medical expenses. Although the household is not subjected to expense shocks post-retirement, the household still can file for bankruptcy, but this will only occur when a household exits autarky with a stock of debt incurred due to an expense shock. Post-retirement income is equal to 57.9% of the deterministic and persistent component of earnings in the final year of work (i.e., it excludes the transitory component). This fraction is calibrated to ensure the mean post-retirement income matches the average sum of income and public transfers in the PSID for households with a household head at least 65 years old.

Parameters. The set of parameters that will be estimated includes β, γ, Γ, ψ, and, depending on the specification of the nonstrategic types, one of $\underline{y}$, $\underline{b}$, $\underline{c}$. These are the key parameters governing the borrowing and filing behaviour of households. The remaining parameters, λ, R, $\overline{R}$, reflect features of the economy and institutional policy, rather than behavioural parameters. The probability of exiting financial autarky is set to $\lambda = 0.20$ so that the expected duration a household remains in autarky is five years. This is consistent with the (pre-BAPCPA) Bankruptcy Code, which restricts repeat Chapter 7 filings for six years. This is a shorter duration than that implied by the Fair Credit Reporting Act, which states that Chapter 7 bankruptcy filings cannot remain on a household's record for more than 10 years, corresponding to $\lambda = 0.10$, which was the target used by Chatterjee, Corbae, Nakajima, and Ríos-Rull (2007). However, as in Mitman (2016), I set a higher value of λ to reflect the findings of Han and Li (2011), that households obtain access to credit before the removal of the bankruptcy flag. This enables us to match the legislative aspect of Chapter 7 regarding restricted repeat filings, and better approximate the duration without access to credit than we would with a lower value of λ corresponding to the 10-year bankruptcy flag. Additionally, it means that I can reduce the value of this parameter in Section 6 to reflect the aspect of the BAPCPA reforms that increased the duration of restricted repeat filings. The risk-free rate is set to $R = 1.0344$ (Gourinchas and Parker (2002)), with an intermediation cost of $\tau = 0.04$ (Evans and Schmalensee (1999)), and a roll-over interest rate of $\overline{R} = 1.20$ (Livshits, MacGee, and Tertilt (2010)). Additionally, I set the interest rate ceiling $\hat{R} = 75$ (Livshits, MacGee, and Tertilt (2010)), but emphasize that this is only applicable for the model with homogeneous agents. The parameters will be estimated using simulated method of moments, with target moments taken from household-level survey data from the PSID. The model moments are generated using a $N \times J_W$ simulated panel of life-cycle income, wealth (savings or debt), consumption, and bankruptcy filings, for $N = 100,000$ households. Note that only the pre-retirement lifespan is simulated, since this corresponds with the sample period used to obtain the data moments. This generates $4,000,000$ observations for the simulated sample. The parameters are estimated to minimise the percent deviations of the model moments from the data moments; i.e., the distance between the model and data moments using a diagonal weighting matrix, with weights equal to the inverse of the data moment.

4.1 Data sources and moments

The data moments used to estimate the model come from two different sources. First, I use a series of moments that are typically used to calibrate bankruptcy models. These notably include the average filing rate and the average borrowing rate. Additionally, I target the average debt-income ratio for bankruptcy filers – a moment emphasized by Sullivan, Warren, and Westbrook (1989). Given our interest is primarily in the household decision problem, rather than macroeconomic aggregates, I chose these moments instead of data aggregates for the economy, such as the charge-off rate and total debt-to-earnings ratio. Second, I use coefficient estimates from the regression in Fay, Hurst, and White (2002) as moments. These moments, generated using PSID data, enable us to address two important points. First, we can determine whether a standard life-cycle model of bankruptcy generates behaviour consistent with the households that filed for bankruptcy in the PSID data. Second, we can use the model to assess the validity of the inference in Fay, Hurst, and White (2002) – which was brought into question by Zhang, Sabarwal, and Gan (2015).

The PSID moments are obtained by regressing the bankruptcy filing decision on a set of financial and demographic covariates. These can be partitioned into those that will appear in the model, and those that will not. The former set is comprised of debt, debt^2, income, income^2, Δincome, age, age^2; while the latter set contains state fixed-effects (to control for state variation in bankruptcy laws), year fixed-effects (to control for aggregate fluctuations over time), self-employment, and education variables.[14] While most of these variables are self-explanatory, Δincome needs some clarification. It measures the reduction in income from one year to the next, rather than the change in income, and is defined in this way so that it corresponds to the variable "reduction in income" in Table 4 of Fay, Hurst, and White (2002). Therefore, $\Delta\text{income}_t = \min\{y_t - y_{t-1}, 0\}$ measures the drop in income from year $t-1$ to year t (henceforth I will refer to this variable as 'income drop'). Thus, a negative coefficient on Δincome_t indicates that a reduction in income increases the likelihood of filing for bankruptcy. The subset of PSID regression coefficient estimates that will be used as target moments are contained in Table 3.

Table 3: Target moments from the regression using PSID data.

debt	debt^2	income	income^2	Δincome
1.43×10^{-7}	-2.77×10^{-13}	-3.86×10^{-8}	3.32×10^{-14}	-3.55×10^{-8}
(3.98×10^{-8})	(8.43×10^{-14})	(7.52×10^{-9})	(8.19×10^{-15})	(1.72×10^{-8})

Note: The year range for the PSID is 1984–1996, with variables in 1996 dollars, which yielded a sample size of $N = 61,735$. Standard errors are in parenthesis.

Fay, Hurst, and White (2002) contend that the sign on the coefficients of debt and income are indicative of strategic and nonstrategic behaviour. Specifically, if households are strategic they file for bankruptcy in response to changes in financial benefit (debt) but not income, and, conversely, if they are nonstrategic they file in response to adverse events that reduce their ability to repay (income) but not changes in financial benefit (debt) offered by bankruptcy policy.[15] The hypotheses are stated such that they can be tested via coefficient restrictions in a regression of income and financial benefit on whether households file for bankruptcy: a positive coefficient on debt is interpreted as evidence of strategic behaviour (while a zero coefficient is evidence of nonstrategic behaviour), and a negative coefficient on income is interpreted as evidence of nonstrategic behaviour (while a zero coefficient is evidence of strategic behaviour). Zhang, Sabarwal, and Gan (2015), on the other hand, argue that we should observe a positive sign on debt regardless of whether households are strategic or nonstrategic. I will demonstrate in the following section that the model supports the latter claim: in a model populated solely with nonstrategic agents, we obtain a positive coefficient on debt. Furthermore, in a model populated solely with strategic agents we can obtain a negative coefficient on income. This suggests that we

[14] For further details on this approach, and variable definitions from the PSID, see Appendix B.2.

[15] The equivalent of financial benefit in the model is debt ($\min\{b, 0\}$), since households that file do not concurrently hold assets. The implications of this difference will be discussed further in Section 5.

cannot infer strategic or nonstrategic behaviour simply from the signs of coefficient estimates. Nevertheless, the moments in Table 3 do contain information that enables us to estimate the proportion of strategic and nonstrategic types. In particular, the income-drop variable conveys useful information about whether the household filed in response to an income or an expense shock.

5 Estimation and analysis

In this section I estimate the parameters of the quantitative model from Section 4, and show that (1) adding nonstrategic agents to the standard model enables us to match key data moments, (2) the model with nonstrategic agents generates substantially different borrowing and filing behaviour by strategic agents, which is caused by changes to the interest-rate profile offered by intermediaries, and (3) inferring strategic and nonstrategic behaviour using the sign of regression coefficient estimates on debt and income may lead to conclusions inconsistent with the underlying behaviour.

5.1 Homogeneous agents

I begin by studying the two special cases of the model with heterogeneous agents: where all agents are strategic ($\alpha = 1$), and where all agents are nonstrategic ($\alpha = 0$). The purpose of this section is threefold. First, I demonstrate that the model with only strategic agents generates outcomes consistent with previous models of bankruptcy: this involves fixing β and γ at values set in previous studies and calibrating Γ to match the aggregate filing rate. The model can match several data moments targeted in previous studies, in addition to some of the moments from the regression using PSID data. This model, however, has difficulty matching the debt-income ratio of agents filing for bankruptcy. Second, I illustrate the shortcomings of the homogeneous agents model populated solely with strategic agents, by estimating β, γ and Γ using simulated method of moments to match the filing rate, the borrowing rate and the debt-income ratio. This motivates the inclusion of both strategic and nonstrategic agents into the model, which is undertaken in the Section 5.2. Finally, before including both types in the model concurrently, I use the results of the special cases $\alpha = 1$ and $\alpha = 0$ to evaluate the inference of Fay, Hurst, and White (2002). By studying the signs of the coefficient estimates on debt and income from the bankruptcy regression, in a model where we know all the agents are either strategic or nonstrategic, we can determine whether this is a valid approach to inferring strategic and/or nonstrategic behaviour.

Strategic agents only. First we want to demonstrate that this model is compatible with previous (3-year) life-cycle models of bankruptcy, e.g., Livshits, MacGee, and Tertilt (2007), Livshits, MacGee, and Tertilt (2010) and Mankart (2014). Therefore we fix β and γ at the values set in these studies (0.95 and 2.0, respectively) and calibrate the model to match the aggregate filing rate (0.493%). This yields an estimate of $\Gamma = 0.0496$, which means that approximately 5% of household annual income is transferred to the lender under bankruptcy – a somewhat smaller amount than the 30–35% of 3-year income transferred in the aforementioned models. The model moments associated with this calibration are contained in Table 4.

Table 4: Calibration results, with homogeneous agents ($\alpha = 1$).

Moments	Target	Model	Data	Source
Filing rate	Y	0.496%	0.493%	SWW (2000)
Interest rate	N	11.3%	$10.9 - 12.8\%$	LMT (2010)
Debt/income	N	0.40	1.87	SWW (2000)
Debt coef.	N	3.32×10^{-06}	1.43×10^{-07}	Table 3 (PSID)
Debt-sq. coef.	N	-3.32×10^{-12}	-2.77×10^{-13}	Table 3 (PSID)
Income coef.	N	-7.36×10^{-07}	-3.86×10^{-08}	Table 3 (PSID)
Income-sq. coef.	N	5.54×10^{-12}	3.32×10^{-14}	Table 3 (PSID)
Income drop coef.	N	6.81×10^{-08}	-3.55×10^{-08}	Table 3 (PSID)

Note: The filing rate and debt-income ratio targets were taken from Sullivan, Warren, and Westbrook (2000) (SWW), while the borrowing interest rate is taken from Livshits, MacGee, and Tertilt (2010) (LMT).

From Table 4 we can see that the homogeneous agents model with Γ calibrated to match the aggregate filing rate generally does a good job of matching data moments not targeted. Specifically, it is able to match the borrowing rate, however it does a poor job matching the debt-to-income ratio. Furthermore, it does a reasonable job matching the coefficient estimates from Table 3 – it generates estimates with correct signs for all except one variable (income drop), therefore the shape of the debt and income profiles of filers are concave, as in the PSID data. However, missing the coefficient sign on income drop reflects the fact that reductions in income are not associated with bankruptcy filings. The reason is that, consistent with the intuition provided in Fay, Hurst, and White (2002), changes in income should not affect the financial benefit of filing for strategic agents. Therefore, we can interpret the positive coefficient on income drop as reflecting the fact that strategic bankruptcies are primarily driven by expense shocks, rather than reductions in income. This is not surprising, since it can be difficult to generate bankruptcies using endogenous interest rates proportional to the likelihood of filing, since the interest rate (and probability of default) is directly tied to current income, but not expenses (since they are iid). Hence bankruptcies are primarily driven by expense shocks in this model.

Note that there is no role for ψ in the homogeneous agents model. This is due to the fact that a model with $\Gamma = 0$ and $\psi = 0$ generates too few bankruptcies to match the filing rate. Table 11 in Appendix D.1 demonstrates that (1) the model with Γ clearly outperforms the model with ψ –

which is due to the feedback effect on interest rates, which enables greater borrowing, (2) there is little gain to include both parameters in the model – this requires a reduction in Γ to facilitate a positive ψ, but Γ is already quite low, and agents are very responsive to small changes in ψ, (3) both models fail to match the debt-income ratio, and the coefficient on income drop.

We may be tempted to interpret the failure to match the coefficient on income drop as a deficiency of the model or the parameterisation of the income process; i.e., agents are not filing in response income fluctuations. However, a reduction in β will enable us to match the sign on the coefficient on 'income drop' – e.g., with $\beta = 0.93$ and $\gamma = 2.0$, the filing rate can be matched with a calibrated value of $\Gamma = 0.094$, which produces a coefficient on income drop of -1.02×10^{-08}, compared to the data moment of -3.55×10^{-08}. Therefore we will focus on evaluating whether different parameter values for β and γ can enable us to match the debt-income ratio using the homogeneous agents model. To determine which values of β and γ are required to match the data moment on the debt-income ratio, and the implications for other moments, I use simulated method of moments to estimate Γ together with β and/or γ to match both the aggregate filing rate and the debt-income ratio. These parameter estimates can be found in Table 5.

Table 5: Parameter estimates and model moments for homogeneous strategic agents ($\alpha = 1$).

Estimated Parameter(s)	β	Γ	ψ	Filing rate	Debt/ income	Interest rate
Γ	0.950	**0.050**	0.00000	**0.496**%	0.40	11.3%
β, Γ	**0.841**	**0.512**	0.00000	**0.493**%	**1.87**	7.9%
β, Γ, ψ	**0.854**	**0.008**	**0.00008**	**0.493**%	**1.87**	**8.1**%
Data targets	–	–	–	0.493%	1.87	11.5%

Note: Estimated parameters and moments targeted are indicated by **bold** entries.

In the second row of Table 5, β and Γ are jointly estimated – we find a significant reduction in β (from 0.950 to 0.841) and increase in Γ (from 0.050 to 0.512) is required to generate a sufficiently high debt-income ratio. This value of Γ means that over 50% of household income is transferred to the lender under bankruptcy – a substantially higher figure than those usually found in the literature.

To illustrate the effect of Γ on the filing rate and debt-income ratio, consider the second row of Table 5, where $\beta = 0.841$, $\gamma = 2.00$ and $\Gamma = 0.512$. At these values, the average earnings of filers is $18,030 and the average amount discharged is $30,367. If we reduce Γ to the value in the first row of Table 5 (0.050), the average earnings of filers and amount discharged becomes $19,902 and $5,501, respectively. Additionally, we significantly overestimate the filing rate and underestimate the debt-income ratio. Therefore, increasing the transfer to the lender (Γ) has a marginal effect in terms of deterring high-income types from filing, but has a substantial effect on the magnitude of the debt discharged.

The parameter estimates reveal that, for an acceptable range of parameter values, the model fails to produce a debt-income ratio for filers consistent with the data. This result can be interpreted in a couple of ways; (1) interest rates adjust to ensure strategic agents do not borrow 'too much', i.e., an amount that would allow them to discharge larger amounts under bankruptcy; and (2) strategic agents are too 'quick' to file, i.e., they prefer to file today (and discharge a relatively small amount of debt) than borrow to finance current consumption and repay outstanding debt holdings (or potentially discharge a larger amount of debt in the future).

In Section 5.2 I will show that introducing heterogeneity in the filing behaviour generates dispersion across types in terms of the amount borrowed, and hence the amount discharged. This dispersion enables us to match the debt-income ratio, and improves the interest-rate schedules offered to both types of agents.

Nonstrategic agents only. I now consider the other special case of the heterogeneous agents model, where all agents are nonstrategic in their filing decision, i.e., $\alpha = 0$. The purpose of this exercise is to use a model solely populated with nonstrategic agents, together with the results from the model populated solely by strategic agents, to evaluate the inference by Fay, Hurst, and White (2002). Specifically, to determine if coefficient estimates from a regression of debt and income on whether households file for bankruptcy are indicative of strategic and/or nonstrategic behaviour. In particular, they seek to test the strategic hypothesis, that households file in response to changes in financial benefit (debt), and the nonstrategic hypothesis, that households file in response to adverse events that reduce their ability to repay (income). In our model, since we do not allow households to concurrently hold assets and debt, there is an equivalence between financial benefit and debt which is not present in Fay, Hurst, and White (2002). However, this is unlikely to affect the results, since bankrupt households hold few seizable assets – this is reflected in the PSID, where the correlation between financial benefit and debt is 0.97.[16]

I test the strategic and nonstrategic hypothesis using the two special cases of the homogeneous agents model: $\alpha = 1$ (strategic agents only), and $\alpha = 0$ (nonstrategic agents only). In the former case, all agents are behaving strategically, by construction, therefore we should expect a positive coefficient on debt and a zero coefficient on income. In the latter case, all agents are filing nonstrategically, by construction, hence we should expect a zero coefficient on debt and a negative coefficient on income. These parameter estimates and model moments generated by this exercise can be found in Table 6.

[16]While Fay, Hurst, and White (2002) emphasize the importance of financial benefit, since we do not allow households to concurrently hold assets and debt in the model in Section 3, the corresponding definition of financial benefit in this model is simply debt: $\min\{b, 0\}$. This departure occurs because we do not have assets in the model, and hence asset exemptions have no role.

Table 6: Parameter estimates and model moments for homogeneous agents.

–	Strategic only	Nonstrategic only (NS.1)	Nonstrategic only (NS.2)	Nonstrategic only (NS.3)
Parameters				
α	1	0	0	0
Γ	**0.050**	**0.188**	**0.010**	**0.208**
cutoff	–	**9812**	**−720**	**6775**
Moments				
Filing rate	**0.495**%	**0.450**%	**0.483**%	**0.471**%
Interest rate	11.33%	**13.29**%	**9.92**%	**11.56**%
Debt/income	0.40	**2.20**	**1.36**	**2.60**
Regression coef.				
Debt	3.33×10^{-06}	2.13×10^{-06}	6.62×10^{-06}	2.81×10^{-06}
Debt-sq.	-3.33×10^{-10}	-2.14×10^{-12}	-6.89×10^{-12}	-1.70×10^{-12}
Income	-7.37×10^{-07}	-8.87×10^{-07}	-2.24×10^{-09}	-2.41×10^{-07}
Income-sq.	5.55×10^{-12}	7.88×10^{-12}	9.72×10^{-13}	2.92×10^{-12}
Income drop	6.82×10^{-08}	-2.73×10^{-07}	-6.92×10^{-07}	-4.61×10^{-07}

Note: Estimated parameters and moments targeted are indicated by **bold** entries.

Table 6 demonstrates that none of the four models of homogeneous agents are able to match the filing rate, interest rate and debt-income ratio. The estimated cutoffs are $\underline{y} = 9812$, $\underline{b} = -720$, and $\underline{c} = 6775$; i.e., NS.1 agents file when annual income falls below \$9,812, NS.2 agents file when debt exceeds annual income by \$720, and NS.3 agents file when annual consumption falls below \$6,775. All models obtain the same signs on the regression coefficients. In contrast to the model with strategic agents only, these models can match the sign on income drop, reflecting the role that reductions in income play in the filing decision for nonstrategic agents. Additionally, the models of nonstrategic agents obtain debt-income ratios substantially higher than the model with strategic agents. This is due to the fact that nonstrategic agents accumulate more debt before the filing decision is triggered by the cutoff, relative to the strategic agents.

The most important result in this table is the sign on the regression coefficients for debt and income, and how these relate to the inference in Fay, Hurst, and White (2002). In all cases the sign of the coefficient on debt is positive, and the sign on the coefficient of income is negative – consistent with the PSID coefficients, *even though these were not used as target moments*. Specifically, the model only populated with strategic agents produces a coefficient estimate on income consistent with nonstrategic behaviour, and all three versions of the model only populated with nonstrategic agents produces a coefficient estimate on debt consistent with strategic behaviour. This finding suggests that caution should be used when attempting to directly infer strategic or nonstrategic behaviour from the signs of these regression coefficients. These results are consistent with the argument made by Zhang, Sabarwal, and Gan (2015): that a positive coefficient will be obtained regardless of the behaviour of agents. Nevertheless, these moments do contain useful information, particularly the income-drop variable, since it is the only sign difference between the models. Hence, in the next section I will also target the regression moments in order to estimate the proportion of types and the nonstrategic cutoff.

5.2 Heterogeneous agents

This section estimates the model with heterogeneous agents (i.e., $\alpha \in (0, 1)$). As in the previous section, I proceed by maintaining $\beta = 0.95$ and $\gamma = 2.0$, and estimating Γ, ψ and α to match the filing rate, the borrowing rate, and the debt-income ratio. Unlike the model with homogeneous agents, ψ plays an important role. Perhaps somewhat counter-intuitively, introducing nonstrategic agents into the model actually leads to an increase in the filing rate – holding all other parameters fixed. This occurs because nonstrategic agents file for bankruptcy in less states than strategic agents (for the range of nonstrategic cutoffs considered), and since intermediaries cannot discriminate between types this causes interest rates to reduce, relative to the model populated only by strategic agents ($\alpha = 1$). To some extent, nonstrategic agents substitute for the role played by the transfer to the lender under bankruptcy, Γ; i.e., they smooth the equilibrium interest-rate schedule $q(\cdot)$ offered by intermediaries across states. This causes a significant increase in borrowing and filing by strategic agents, which leads to dispersion across types which helps us to match the data moment on the debt-income ratio and interest rates. Specifically, when $\alpha < 1$, holding all other parameters fixed, the filing rate increases despite the number of strategic agents reducing. Hence $\psi > 0$ can potentially decrease the filing rate for strategic types, which was unnecessary in the homogeneous agents model. Furthermore, as α declines and the economy is populated with relatively more nonstrategic agents, intermediaries offer lower interest rates to agents borrowing. This effect, however, does not necessarily affect the target moment on the average borrowing interest rate in the same manner, since agents choose the amount they borrow, and this choice is also affected by changes in α.

I demonstrate that the model with both strategic and nonstrategic agents is able to match the debt-income ratio for reasonable parameter values, in contrast to the homogeneous agents model, as well as key moments from the regression using PSID data. The proportion of types is identified by noting a tension between the debt-income ratio and the borrowing interest rate: on average, the nonstrategic types borrow at a lower interest rate than the strategic types – which implies they borrow less, on average, since intermediaries offer both types the same interest-rate schedule. The dispersion between the amount of debt discharged by the two types depends on the proportion of types (α), and the bankruptcy costs (Γ; ψ). The proportion of types influences the interest-rate schedule offered to agents (more nonstrategic types result it lower interest rates), and hence it directly affects borrowing constraints and the amount of debt discharged under bankruptcy. Higher costs of bankruptcy result in more debt being discharged by strategic agents, relative to nonstrategic agents – since the higher costs require a higher benefit (larger debt discharge) for the strategic agents to file. For example, with low bankruptcy costs and tight borrowing constraints (possibly due to a large fraction of strategic types), strategic households will discharge less debt, on average, than nonstrategic households. On the other hand, if there is a small fraction of strategic types, borrowing constraints will be loose, and strategic agents will discharge more debt, on average, than nonstrategic households.

I proceed by exclusively considering the nonstrategic consumption type (NS.3) for the remainder of this section, since it provides the best fit with the target moments.[17] There are two particular cases that I will analyse: (1) where I fix the cutoff at $\underline{c} = 0$, and (2) where I estimate the level of the cutoff. The former case allows us to directly compare the results the homogeneous agents model. For a sufficiently low cutoff (e.g., $\underline{c} = 0$) the nonstrategic agents will only file if repaying is not feasible.[18] This corresponds to the 'involuntary' filings in the homogeneous agents model with $\alpha = 1$. The latter case, where I estimate the level of the cutoff $\underline{c}$, will be used to study the effect of the BAPCPA reforms, in Section 6. The parameter estimates and model moments for these two cases are presented in Table 7.

First, consider the case where $\underline{c} = 0$. The model estimates $\alpha = 0.345$, i.e., 34.5% of agents are strategic, and the bankruptcy costs Γ and ψ are 0.023 and 0.000041, respectively. This specification exactly matches the filing rate and the debt-income ratio, but significantly underestimates the interest rate. Furthermore, it fails to match the negative coefficient on income from the PSID moments. Interestingly, although only 34.5% of agents are strategic, they account for 95.7% of total bankruptcies. Additionally, 14.6% of total bankruptcies are 'involuntary', i.e., repaying was not feasible, which reveals that approximately 11% of strategic bankruptcies were involuntary. On average, the strategic agents discharge a significantly smaller amount of debt ($26,563) than the nonstrategic agents ($42,618), but they typically borrow more – since their average borrowing rate is 11.24% compared to 7.62% for nonstrategic agents. Consequently the debt-income ratio is much smaller for strategic agents (1.80) than nonstrategic agents (3.46).

The specification with $\underline{c} = 0$ is quite restrictive: nonstrategic agents only file when positive consumption is not feasible, including the potential for borrowing. Therefore, I estimate the cutoff in addition to the proportion of types. In order to do this, I expand the set of target moments to include the regression coefficients, which enable us to identify the cutoff separately from the proportion of types. In this case, we obtain an estimate of $\underline{c} = 6042$ (column '$\underline{c}$ est.' in Table 7), which means that an indebted nonstrategic household will file if its maximum possible annual consumption (i.e., including borrowing the largest possible amount) falls below $6,042. For ref-

[17] Additional results for the other nonstrategic types are contained in Appendix D.2.

[18] Note that when the cutoff is determined based strictly on feasibility, there is no difference between NS.1, NS.2 and NS.3.

Table 7: Parameter estimates and model moments for homogeneous and heterogeneous agents.

–	Strategic only	Both types ($\underline{c} = 0$)	Both types ($\underline{c}$ est.)	Data target
Parameters				
α	1.000	**0.345**	**0.101**	–
Γ	**0.050**	**0.023**	**0.048**	–
ψ	0.000000	**0.000041**	**0.000032**	–
$\underline{c}$	0	0	**6042**	–
Moments				
Filing rate	**0.495%**	**0.493%**	**0.493%**	0.493%
Interest rate	11.33%	**8.75%**	**11.00%**	11.50%
Debt/income	0.40	**1.87**	**1.87**	1.87
Regression coef.				
Debt	3.33×10^{-06}	6.84×10^{-06}	$\mathbf{6.44 \times 10^{-06}}$	1.43×10^{-07}
Debt-sq.	-3.33×10^{-10}	-6.66×10^{-12}	$\mathbf{-6.04 \times 10^{-12}}$	-2.77×10^{-13}
Income	-7.37×10^{-07}	1.49×10^{-07}	$\mathbf{1.79 \times 10^{-07}}$	-3.86×10^{-08}
Income-sq.	5.55×10^{-12}	-4.32×10^{-13}	$\mathbf{3.35 \times 10^{-14}}$	3.32×10^{-14}
Income drop	6.82×10^{-08}	-2.69×10^{-07}	$\mathbf{-4.70 \times 10^{-07}}$	-3.55×10^{-08}
Statistics				
Prop. BR (S)	1.000	0.957	0.674	–
Borrowing rate (S)	11.33%	11.24%	39.00%	–
Debt/income (S)	0.40	1.80	1.93	–
Discharge (S)	\$5,816	\$26,563	\$41,204	–
Earnings|File (S)	\$14,381	\$15,521	\$21,592	–
Prop. BR (NS)	–	0.043	0.326	–
Borrowing rate (NS)	–	7.62%	8.22%	–
Debt/income (NS)	–	3.46	1.75	–
Discharge (NS)	–	\$42,618	\$18,142	–
Earnings|File (NS)	–	\$14,329	\$9,805	–
Prop. Involuntary BR	0.108	0.146	0.387	–

Note: Estimated parameters and moments targeted are indicated by **bold** entries. (S) refers to strategic types and (NS) refers to nonstrategic types. The column 'strategic only' refers to the model without nonstrategic agents, i.e., $\alpha = 1$, while the columns 'both types' refer to the model with both strategic and nonstrategic agents: the first column has $\underline{c}$ fixed at 0, and is estimated using the exactly identified model not including PSID regression coefficients; the second column estimates the cutoff $\underline{c}$ using the over-identified model including the PSID regression coefficients.

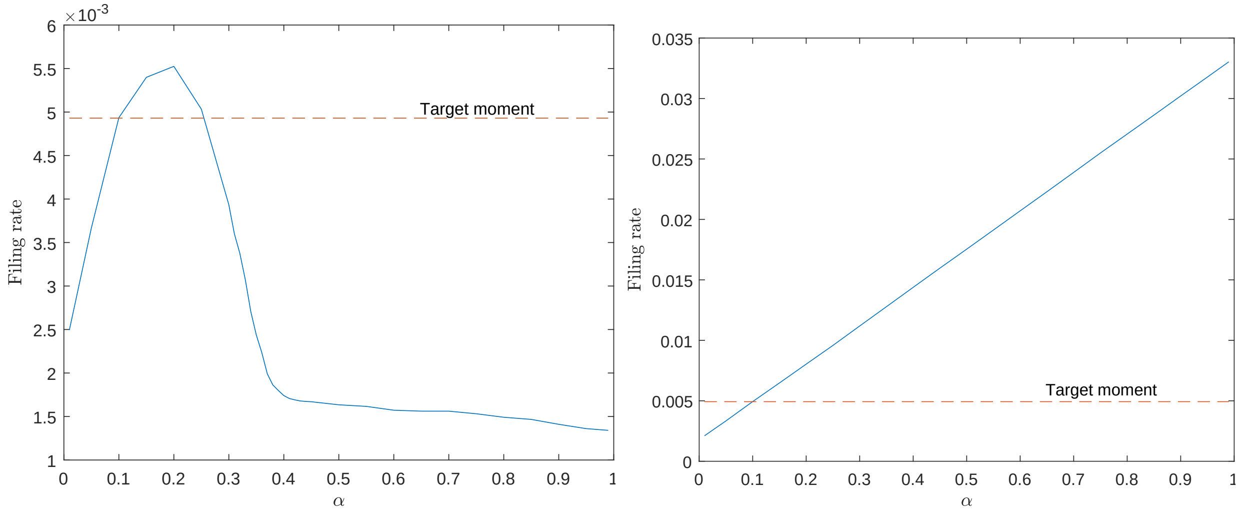
erence, the 1996 poverty level in the U.S. was $7,740 (annual income, averaged across states) for a family unit of size 1.[19] This is broadly consistent with studies of household bankruptcy that contend most households file out of desperation, rather than opportunity. Once we estimate the cutoff, the proportion of strategic types falls to 10.1% and the stigma cost (ψ) declines significantly. The transfer to the lender (Γ) returns to a level (4.8%) closely approximating that in the homogeneous model with strategic agents only (5.0%). The decline in stigma leads to

[19]Source: Federal Register, Vol. 61, No. 43, March 4, 1996, pp. 8286-8288.

increased borrowing by the strategic types, reflected in the significant increase in the average borrowing rates for strategic types (39%), which causes the interest rate moment to rise to 11%, better approximating the target than when $\underline{c} = 0$. The filing rate and the debt-income ratio exactly match their corresponding target levels. Finally, note that the ordering of average amount discharged between strategic and nonstrategic types has reversed relative to the case with $\underline{c} = 0$. The improved interest-rate schedule, due to the fall in α, has facilitated increased borrowing by strategic types, causing a higher average discharge. This, in turn, increases the average earnings of strategic filers, leading to dispersion between the strategic and nonstrategic types, relative to the case when $\underline{c} = 0$. Conversely, as $\underline{c}$ rises, households file with lower levels of debt, relative to $\underline{c} = 0$, hence the reduction in the average discharge for nonstrategic types. Interesting, we see a fall in the average earnings of nonstrategic filers. This indicates that, when $\underline{c} = 0$, the majority of nonstrategic filings were driven primarily by expense shocks, which are independent of income. As the cutoff increases, income plays a greater role in determining when the nonstrategic households file, consistent with the description of nonstrategic behaviour in Fay, Hurst, and White (2002).

Identification. The filing rate is clearly decreasing in Γ and ψ, but the case for α is not as clear. When there is a substantial fraction of nonstrategic agents (i.e., for low values of α), increasing α will increase the filing rate since strategic agents are more likely to file than nonstrategic agents. However, if the value of α increases to such an extent that there is a sufficiently large fraction of strategic agents in the economy, the interest-rate schedule offered to agents shifts up, tightening borrowing constraints, which reduces the likelihood of filing. This can be observed in panel (a) of Figure 2, which displays the effect of variations in α on the filing rate in the model where both α and $\underline{c}$ are estimated. When at least 20% of agents are strategic, any further increases in α decrease the filing rate. And, if more than $35 - 40\%$ of agents are strategic, the filing rate drops to levels observed in the homogeneous model with only strategic agents and a positive value of ψ (see Table 11 in Appendix D.1). Panel (b) of Figure 2 demonstrates the effect of a change in α on the filing rate, when the interest-rate schedule *does not* adjust. If interest rates did not adjust when the proportion of strategic agents increases, the filing rate would monotonically increase.

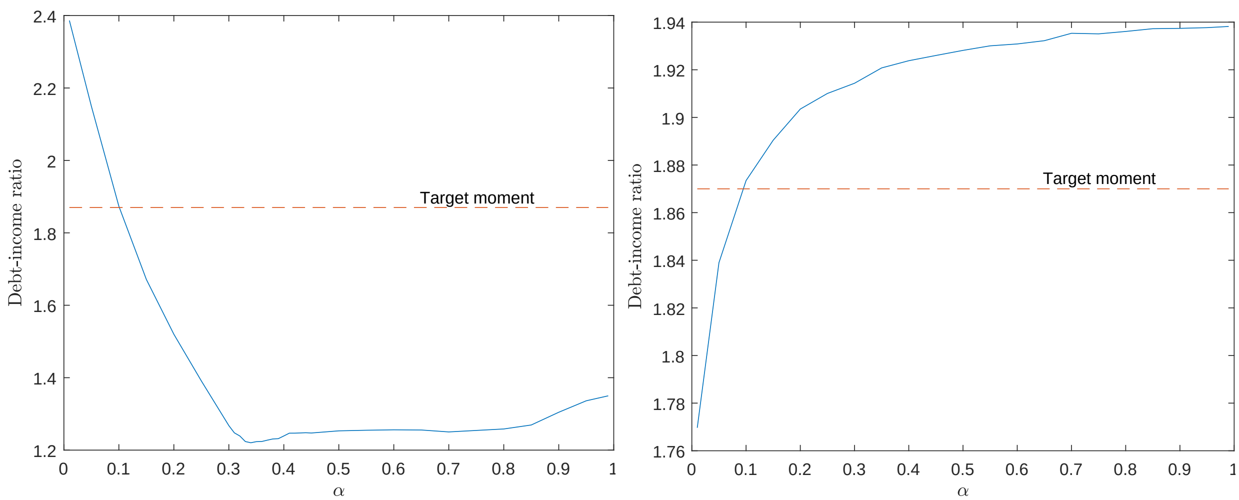
The debt-income ratio is increasing in both Γ and ψ, since these raise the cost of bankruptcy, and hence strategic agents require a larger benefit in order to file. This corresponds to discharging more debt, on average. Note that neither of these parameters directly affects the debt-income ratio for nonstrategic agents, but they will indirectly through the interest-rate schedule. Specifically, less filing by strategic types improves interest-rate schedules, leading to increased borrowing by nonstrategic types, and hence a marginal increase in the debt-income ratio. While this indirect effect is also true for strategic agents, it is dominated by the direct effect. A larger



(a) Flexible $q(\cdot)$ (b) Fixed $q(\cdot)$

Figure 2: Filing rate variation with α.

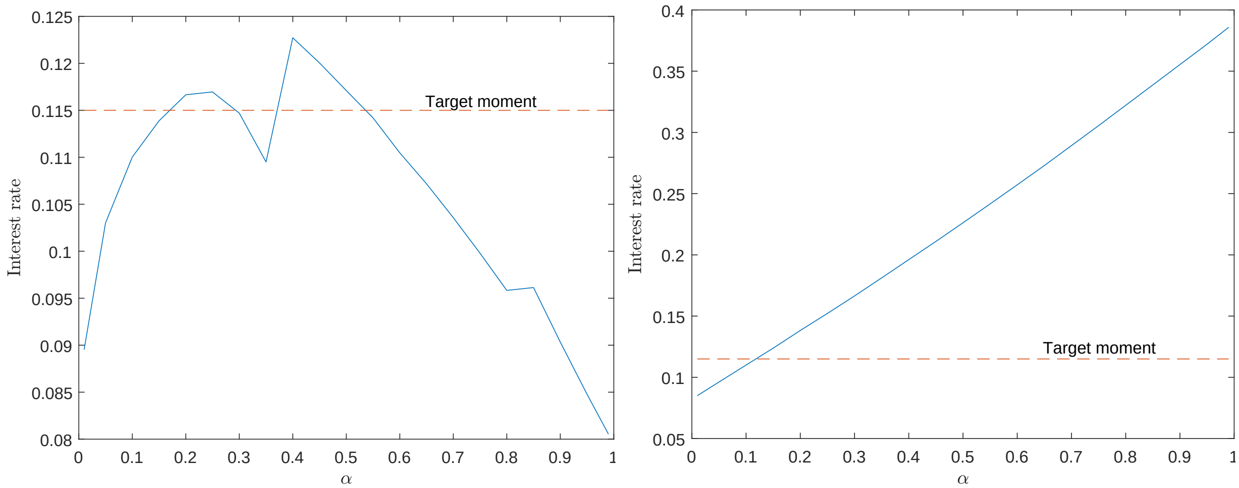
α corresponds to tighter borrowing constraints, which reduces the debt-income ratio. This is demonstrated in panel (a) of Figure 3. However, if we do not allow interest rates to adjust, the effect is the opposite, as shown in panel (b) of Figure 3.



(a) Flexible $q(\cdot)$ (b) Fixed $q(\cdot)$

Figure 3: Debt-income ratio variation with α.

Although we can easily identify the effect on the interest-rate schedule, the effect on average borrowing rates depends on the amount borrowed by agents. As was discussed above, a decrease in either Γ or ψ and an increase in α will tighten borrowing constraints. Note that, in the face of tightening borrowing constraints, agents may choose to borrow the same amount (at a higher interest rate), or borrow a lesser amount (at the same interest rate). Therefore, the net effect of a change in these parameters is not always clear. This is demonstrated in panel (a) of Figure 4. We see this function is highly nonlinear, as opposed to when the interest-rate schedule is fixed, which is depicted in panel (b) of Figure 4.



(a) Flexible $q(\cdot)$

(b) Fixed $q(\cdot)$

Figure 4: Interest rate variation with α.

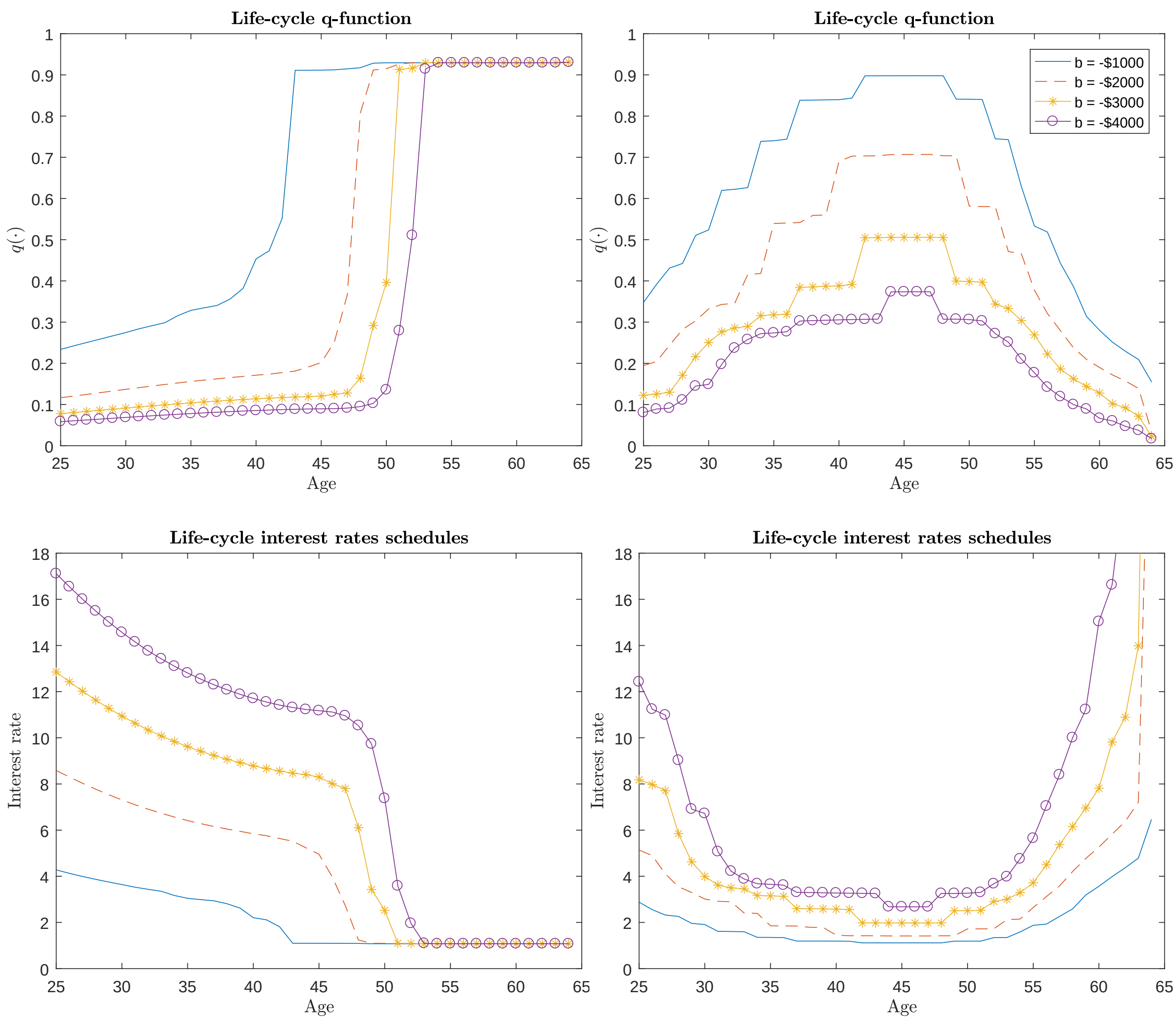
If the $q(\cdot)$ function was held fixed, and did not vary as the composition of types changes is the economy, increasing the proportion of strategic types would increase all three moments. However, given the feedback effect through the interest-rate schedule, we can see the tension between the filing rate, debt-income ratio and interest rate for low values of α. On the one hand, we need a low value of α to ensure that borrowing rates are loose enough to allow agents to accumulate a sufficient amount of debt to match the debt-income ratio. However, for sufficiently low values of α, strategic agents borrow very large amounts at high interest rates, overshooting both the debt-income ratio and the interest-rate target. At a given level of α, ψ adjusts to match the filing rate, and Γ (albeit to a lesser extent than α) adjusts to match the interest rate through its transfer to the lender, and the filing rate.

The regression coefficients, particularly income, are helpful for identifying the level of the cutoff in addition to the proportion of types. For all specifications of the nonstrategic type, as we increase the level of the cutoff, the coefficient on income decreases and eventually switches signs.[20] This indicates that, as more nonstrategic households file, we obtain a negative correlation between income and the likelihood of filing – which is not the case if the majority of bankruptcies are by strategic households. This is not substitutable for varying the proportion of types, α, since, even for very low values of α, if the cutoff is too low there will be an insufficient amount of nonstrategic bankruptcies to generate this relationship between income and the

[20] See Tables 13, 14, and 15 in Appendix D.2.

likelihood of filing. In fact, as we increase the proportion of nonstrategic types in the economy, if there are not many filings (due to a low cutoff), the sign on the coefficient of income will increase, since there is an increasingly large number of low-income nonstrategic types not filing (compared to the relatively high-income strategic types filing).

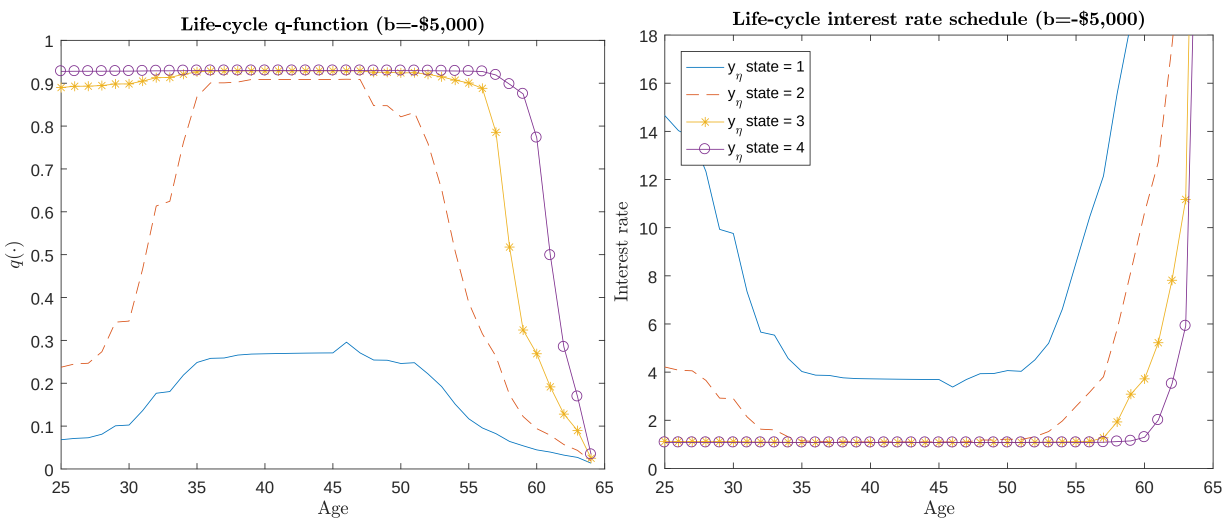
Interest rates. Figure 5 contains the $q(\cdot)$ function offered by intermediaries, and the corresponding interest-rate schedules, for agents in the lowest (persistent) income state for the homogeneous agents model ($\alpha = 1$) in panel (a), and the heterogeneous agents model in panel (b). The lowest state of the persistent income shock was chosen to illustrate how the interest-rate schedule varies depending on the amount borrowed, over the life cycle.



(a) Homogeneous agents ($\alpha = 1$) (b) Heterogeneous agents

Figure 5: Comparison of life-cycle interest-rate schedules across models.

We can see from observing panel (a), that in the model without nonstrategic agents the agent is offered very high interest rates early in the life cycle, but very low interest rates nearing retirement. This is in contrast to panel (b), where the interest rates have a U-shape over the life cycle; i.e., the agent faces borrowing constraints early and late in life, at the times when income is at its lowest. This is due to the fact that the majority of agents are nonstrategic (90%), and they are more likely to file when consumption is low. Hence this function is the inverse of the hump shape in life-cycle income. Note that, for agents in higher persistent income states, this function flattens, approaching the risk-free rate. This is depicted in panel (b) of Figure 6 for a household borrowing $5,000.



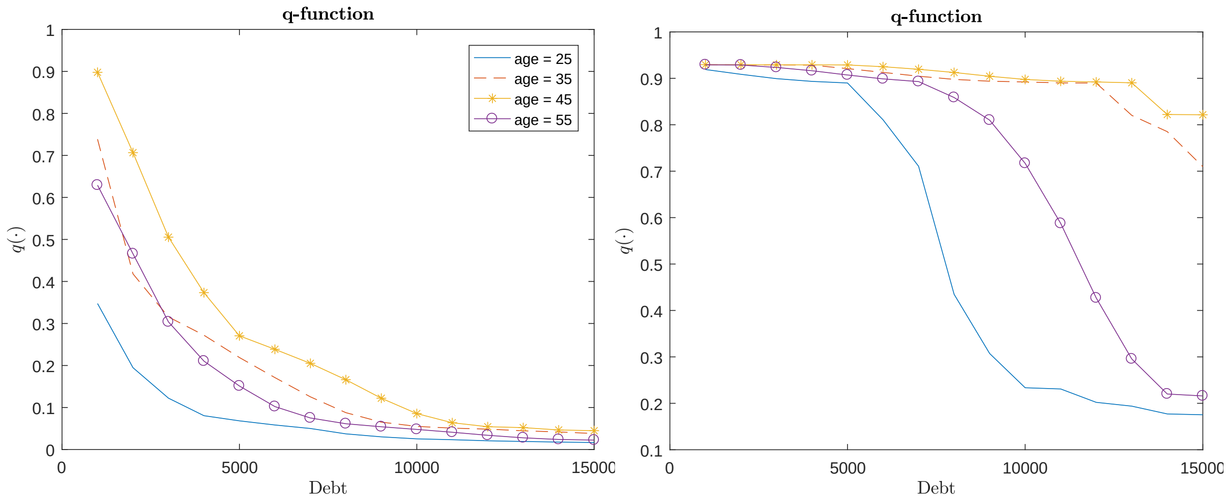
(a) $q(\cdot)$ function (b) Interest-rate schedule

Figure 6: Life-cycle interest-rate schedules, with heterogeneous agents.

As the persistent income state increases from 1 to 4 (which corresponds to an increase in income), the interest-rate schedule flattens to equal the risk-free rate and the intermediation cost from age 25-60.[21] Beyond 60, the rate drastically increases, reflecting the high likelihood of the nonstrategic agent filing to discharge this debt.

We can also evaluate how the shape of the $q(\cdot)$ function depends on the income level of the household. Figure 7 depicts the equilibrium $q(\cdot)$ function for the model with heterogeneous agents, where panel (a) is for a household with the lowest state of persistent income, and panel (b) is for a household with persistent income in the fourth state. The $q(\cdot)$ function appears to be convex for low income households, but concave for richer households, and it is lowest in both cases for relatively young and old households.

[21] See Figure 11 in Appendix D.3 for a comparison of the life-cycle interest-rate schedules offered in the homogeneous and heterogeneous model as the persistent income state changes.



(a) Persistent income state 1 (b) Persistent income state 4

Figure 7: $q(\cdot)$ by amount borrowed, with heterogeneous agents.

6 Application: bankruptcy policy reform

In this section I use the models estimated in Section 4 to evaluate the effect of the Bankruptcy Abuse Prevention and Consumer Protection Act (BAPCPA) on the borrowing and filing behaviour of households, interest rates and welfare. The purpose of this exercise is to determine whether nonstrategic agents affect the standard model predictions of the BAPCPA reforms. The changes in BAPCPA featured in this experiment involve (1) the implementation of eligibility criteria (a means test), and (2) an increased duration of restricting repeat filings (an increase in λ).[22] Additionally, after presenting baseline results with no change in the fixed cost of filing, I study the additional effect of an increase in the fixed cost of filing under BAPCPA (an increase in ψ).

The means test implemented in BAPCPA requires households to have an annual household income below the state median. Therefore, we require households to have income below the median level in the simulated data, \$26,327. Additionally, I decrease λ from 0.20 to 0.14 to capture the increased length of time for no repeat filings, from 6 years to 8 years.[23] Table 8 contains the baseline results of the simulation with BAPCPA imposed.

We can see from the model with homogeneous strategic agents ($\alpha = 1$) that implementing BAPCPA reduces the filing rate from 0.495% to 0.393%. This is quite a significant reduction, especially considering we have held the filing cost (ψ) fixed. Additionally, both the interest rate and the debt-income ratio have risen substantially, from 11.33% to 24.54% and 0.40 to 3.23,

[22] For a useful summary of changes under BAPCPA, see White (2007).

[23] Note that this also increases the duration the household is prevented from borrowing. This is a limitation that we cannot avoid without changing the specification of financial autarky. Therefore, we may interpret the effect of a decrease in ψ as an upper bound.

Table 8: BAPCPA simulation results.

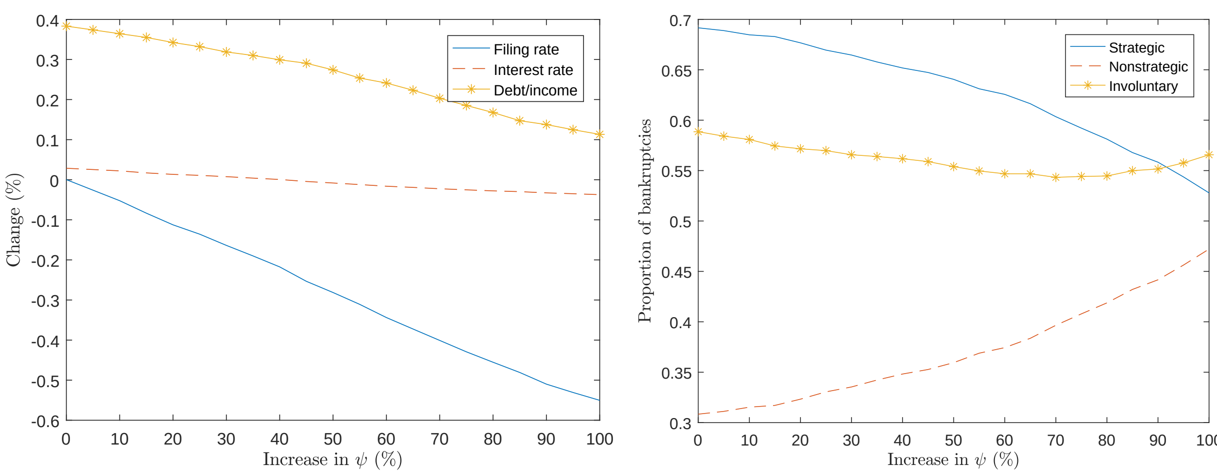
–	pre-BAPCPA ($\alpha = 1$)	post-BAPCPA ($\alpha = 1$)	pre-BAPCPA ($\alpha = 0.10$)	post-BAPCPA ($\alpha = 0.10$)
Moments				
Filing rate	0.495%	0.393%	0.493%	0.493%
Interest rate	11.33%	24.54%	11.00%	11.32%
Debt/income	0.40	3.23	1.87	2.59
Regression coef.				
Debt	3.33×10^{-06}	2.34×10^{-06}	6.44×10^{-06}	1.90×10^{-06}
Debt-sq.	-3.33×10^{-10}	-6.32×10^{-12}	-6.04×10^{-12}	-3.37×10^{-12}
Income	-7.37×10^{-07}	-3.53×10^{-06}	1.79×10^{-07}	-5.55×10^{-07}
Income-sq.	5.55×10^{-12}	1.38×10^{-11}	3.35×10^{-14}	3.86×10^{-12}
Income drop	6.82×10^{-08}	-6.16×10^{-06}	-4.70×10^{-07}	-4.56×10^{-07}
Statistics				
Prop. BR (S)	1.000	1.000	0.674	0.692
Borrowing rate (S)	11.33%	23.46%	39.00%	35.60%
Debt/income (S)	0.40	3.28	1.93	2.95
Discharge (S)	\$5,816	\$97,949	\$41,204	\$76,074
Earnings|File (S)	\$14,381	\$28,130	\$21,592	\$23,519
Prop. BR (NS)	–	–	0.326	0.308
Borrowing rate (NS)	–	–	8.22%	8.18%
Debt/income (NS)	–	–	1.75	1.79
Discharge (NS)	–	–	\$18,142	\$18,615
Earnings|File (NS)	–	–	\$9,805	\$9,801
Prop. Involuntary BR	0.108	0.793	0.387	0.589

Note: The pre-BAPCPA results are taken from Section 4. The post-BAPCPA results are obtained by imposing the means-test with median income \$26,327, $\lambda = 0.14$, and ψ fixed at the pre-BAPCPA level ($\psi = 0.0$ for homogeneous types, and $\psi = 0.000032$ for heterogeneous types).

respectively. This coincides with an enormous increase in the average amount of debt discharged (from \$5,816 to \$97,949) and the average earnings of filers doubling. Interestingly the coefficient on income drop is now negative, reflecting the fact that reductions in income now play a greater role in the filing decision, relative to expense shocks. The most striking result, however, is that the proportion of ‘involuntary’ bankruptcies has now risen from 10.8% to 79.3%, suggesting that the policy has worked as intended, i.e., to curtail ‘abusive’ filings. While the average borrowing rate has substantially increased, the interest-rate schedule decreased with the introduction of BAPCPA. Since households are prevented from filing in a larger set of states, due to the means test, intermediaries respond by offering lower rates, which prompted strategic households to dramatically increase their borrowing. This effect will be demonstrated more clearly later in this section, when I separate the effect of the means test from the reduction in λ.

The model with heterogeneous agents generates vastly different predictions: the filing rate remains unchanged, interest rates marginally increase (from 11% to 11.32%), and the debt-income ratio increases from 1.87 to 2.59. The key difference is that nonstrategic agents are largely unaffected by the policy change: there is a slight increase in the debt-income ratio, the average debt discharged, and a slight decrease in average borrowing interest rates. This is consistent with the definition of these types. In fact, it provides validation that they are specified correctly: the nonstrategic types should be unaffected by BAPCPA, since the policy was designed to target households 'abusing' the policy. Interestingly, the existence of the nonstrategic types also limits the response to the policy by strategic agents. We now observe much smaller increases in the borrowing, discharge and earnings of strategic filers. Most importantly, though, is the increase in 'involuntary' bankruptcies from 38.7% to 58.9%. Again, this reveals that the policy is working as intended, however, the increase is substantially less than that predicted by the model with only strategic agents.

Increased filing costs. An important aspect of the changes under BAPCPA is the increase in the fixed cost of filing. This increase is not transferred to the lender, therefore we must incorporate it through changes to ψ, rather than Γ. This is difficult, since an increase in, say, the cost of filing to the bankruptcy courts cannot be mapped directly into a value of ψ. Therefore, I proceed by demonstrating the effect of a percentage increase in ψ on the filing rate, interest rates and debt-income ratio. This is contained in panel (a) of Figure 8. In all cases, increasing ψ reduces the key moments. In particular, beyond a 40–45% increase in ψ, the net effect on the interest rate is negative.

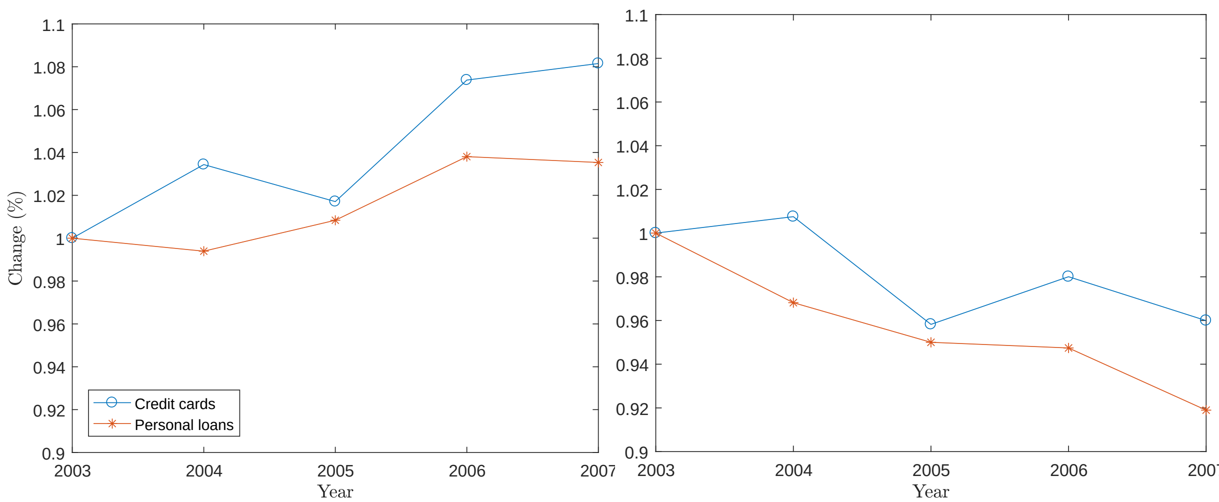


(a) Key moments

(b) Proportion of filings, by type

Figure 8: Effect of increase in ψ under BAPCPA, with heterogeneous agents.

We can use data on interest rates to provide some insight into what percentage increase in filing costs is required to generate interest rates moving in the right direction post-BAPCPA. Figure 9 shows the average borrowing rates before and after BAPCPA, from 2003 to 2007. These measures, taken from the Federal Reserve, measure average borrowing rates for credit cards and (24-month) personal loans. They are useful indicators of borrowing rates for unsecured loans. Panel (a) contains the nominal borrowing rate, while panel (b) depicts the real rate, i.e., nominal deflated by annual CPI. The figure reveals that, on average, nominal rates were rising during this period (between approximately 3–8%), but real rates were falling (between approximately 4–8%).



(a) Nominal rates (b) Real rates

Figure 9: Percentage change in average borrowing interest rates, before and after BAPCPA.

Irrespective of whether we consider real or nominal rates, it is clear that the prediction of the baseline model, which predicted a 100% increase in the average borrowing interest rate, is inconsistent with these findings. The model with nonstrategic agents, however, predicts an increase of up to 2.87% (for no change in ψ) and a decrease of up to 3.72% (for a 100% increase in ψ). While these appear to underestimate the changes in the average interest rate, we can use the fact that the real interest rate declined during this period to infer that ψ increased by at least $40-45\%$, the lowest increase in ψ that generated a decline in interest rates. Additionally, in Appendix C I perform a simple exercise using aggregate filing data to approximate the reduction in the filing rate caused by the BAPCPA reforms. The result of this exercise suggests that filings reduced by approximately 46%, which corresponds to a 70% increase in filing costs. Although it is difficult to directly compare ψ to actual filing costs, since it also encompasses non-financial 'stigma' costs of filing, White (2007) notes that BAPCPA increased the "typical cost of bankruptcy to debtors" from \$600 to \$1,800–\$2,800, plus the cost of educational mandates and tax preparation.

Finally, we can consider how increased filing costs affects the proportion of filings by each type. This effect is demonstrated in panel (b) of Figure 8. The figure reveals that, as we increase the filing cost, the proportion of strategic filings falls, and the proportion of nonstrategic filings increases. This is expected, since only strategic households should respond to changes in ψ. Interesting, the proportion of bankruptcies that are 'involuntary' is non-monotonic in ψ: it declines for an increase in ψ up to approximately 70%, then rises. This occurs because the proportion of strategic filings that are 'involuntary' is monotonically declining as ψ increases, but eventually the proportion of total filings done by nonstrategic households becomes sufficiently large to overcome this effect.

Welfare. The purpose of the means test is to prevent high-income households from filing under Chapter 7, but these households still have access to Chapter 13. Therefore, this change is equivalent to one where a fraction of households with incomes above the median are moved from a 'fresh start' system to a fixed repayment scheme, e.g., Chapter 13. This is similar to the case considered by Livshits, MacGee, and Tertilt (2007), who show that removing the 'fresh start' option for households and replacing it with a repayment scheme (e.g., Chapter 13) leads to a reduction in welfare when households are subject to large expense shocks. Therefore, we may expect that implementing a means test should reduce welfare. In fact, we may anticipate that the welfare loss is greater in this model, since agents do not have the option to file under Chapter 13. Despite this, for the baseline model with no change to ψ, the welfare effect of introducing BAPCPA improves welfare in the homogeneous agents model, but has a negligible effect in the heterogeneous agents model. This is because the gains from introducing BAPCPA accrue to the strategic types, and they account for a small proportion of households in the model with nonstrategic types. On the other hand, nonstrategic types suffer a small welfare loss: they are largely unaffected by the introduction of the means test, since they are not filing in high-income states and are not as constrained when borrowing relative to strategic types, but suffer a welfare loss from the decrease in λ.

Decomposition. We can decompose the effects into (1) the introduction of the means test, and (2) the restriction on repeat filings. For the first case, households with income above the median level are restricted from filing and I fix λ at the pre-BAPCPA level of 0.20, ensuring a bankrupt household's expected duration of being restricted from a repeat filing is 6 years. This is indicated by the column 'means-test' in Table 9. For the second case, there is no restriction on eligibility for households filing, but λ is reduced to 0.14, reflecting the increase in duration of no repeat filings. This case is represented by the column '$\downarrow \lambda$' in Table 9. Finally, the stigma cost of bankruptcy (ψ) is fixed at the pre-BAPCPA level of this decomposition.

If we fix $\lambda = 0.20$ and impose the means test, we observe a rise in bankruptcy filings, interest rates and the debt-income ratio. The only notable change in regression coefficients is that we now observe a switch in sign for the coefficient on income from positive to negative, reflecting the fact that high income individuals are now restricted from filing for bankruptcy. Additionally the statistics for strategic types reveal that the introduction of the means test has reduced the average

Table 9: Decomposition of BAPCPA effects, with heterogeneous types ($\alpha = 0.10$).

–	pre-BAPCPA	Means-test	$\downarrow \lambda$	Total effect
Moments				
Filing rate	0.493%	0.583%	0.418%	0.493%
Interest rate	11.00%	11.50%	10.91%	11.32%
Debt/income	1.87	2.57	1.89	2.59
Regression coef.				
Debt	6.44×10^{-06}	2.06×10^{-06}	5.77×10^{-06}	1.90×10^{-06}
Debt-sq.	-6.04×10^{-12}	-4.16×10^{-12}	-5.68×10^{-12}	-3.37×10^{-12}
Income	1.79×10^{-07}	-6.66×10^{-07}	1.55×10^{-07}	-5.55×10^{-07}
Income-sq.	3.35×10^{-14}	4.63×10^{-12}	5.55×10^{-14}	3.86×10^{-12}
Income drop	-4.70×10^{-07}	-5.36×10^{-07}	-4.13×10^{-07}	-4.56×10^{-07}
Statistics				
Prop. BR (S)	0.674	0.715	0.644	0.692
Borrowing rate (S)	39.00%	33.79%	41.30%	35.60%
Debt/income (S)	1.93	2.89	1.96	2.95
Discharge (S)	\$41,204	\$74,092	\$40,991	\$76,074
Earnings|File (S)	\$21,592	\$23,390	\$21,234	\$23,519
Prop. BR (NS)	0.326	0.285	0.356	0.308
Borrowing rate (NS)	8.22%	8.25%	8.17%	8.18%
Debt/income (NS)	1.75	1.77	1.78	1.79
Discharge (NS)	\$18,142	\$18,499	\$18,318	\$18,615
Earnings|File (NS)	\$9,805	\$9,908	\$9,718	\$9,801
Prop. Involuntary BR	0.387	0.570	0.417	0.589

Note: The column 'means-test' refers to the case where households with income above the median level were restricted from filing and λ is fixed at the baseline level (0.20), while the column '$\downarrow \lambda$' imposes no restriction on filing and the probability of exiting financial autarky is reduced to 0.14. (S) refers to strategic types and (NS) refers to nonstrategic types.

borrowing rate from 39% to approximately 33%, while the average amount discharge has risen significantly from approximately \$41,000 to \$74,000. This reveals that strategic households are borrowing more, *at better rates*, which is due to the fact that these households are restricted from filing in more states. Despite this, these households file for more, which is reflected in the rise in proportion of strategic bankruptcies (from 67.4% to 71.5%) – however, it is important to note that more of these filings are now 'involuntary' (an increase from 38.7% to 57.0%), which indicates that more bankruptcies are now caused by expense shocks, rather than income shocks. Finally, the means test is welfare improving for both the strategic and nonstrategic type, however it is the strategic agents that experience the larger welfare gain while the welfare gain for nonstrategic types is almost negligible. This effect on interest-rate schedules and welfare is consistent with the findings of Chatterjee, Corbae, Nakajima, and Ríos-Rull (2007), who study the effect of implementing a means test without any corresponding change in λ. Specifically, introducing the means test improves the interest-rate scheduled offered by intermediaries, leading to increased borrowing and no significant reduction in the filing rate.

On the other hand, when λ is reduced and there is no means test, we see a significant reduction in the filing rate, but only a marginal decrease in the interest rate and a marginal increase in the debt-income ratio. The reduction in bankruptcies is disproportionately experienced by the strategic types, reflected by the 3% decrease in proportion of strategic filings. In this case there is no significant changes to the average borrowing rate or amount of debt discharged by the strategic types. Decreasing λ hurts both the strategic and nonstrategic type, however, as before, the strategic types experience the larger welfare loss, while the change in welfare for nonstrategic types is negligible.

When there is no increase in the stigma cost (ψ) the net effect on the filing rate is zero – the increase caused by the means test and the decrease by the change in λ offset. However, the effect of the means test dominates for the interest rate, since the net effect is positive. Finally, since both effects increase the debt-income ratio, its net effect is positive. The net effect on welfare is negligible: while there is both a marginal gain for strategic agents and a marginal loss for nonstrategic agents, the resulting net effect is approximately zero.

7 Conclusion

This paper introduced nonstrategic agents into a life-cycle model of household bankruptcy with endogenous interest rates. These types differ from the standard strategic agents in terms of their filing rule: they do not file when the benefit of filing exceeds the cost, rather, they file when sufficiently financially constrained. This type of heterogeneity is motivated by previous descriptive studies, which contend that the majority of households are 'rationally inattentive' to the details of bankruptcy law, and hence the benefits of filing.

Introducing these agents into the model allows us to match key data moments, notably the debt-income ratio of filers and average borrowing interest rate, which the model with homogeneous strategic agents has difficulty matching. The key mechanism that generates this outcome results from the interest-rate schedules offered by intermediaries, which depends on the proportion of strategic and nonstrategic types in the economy. Specifically, when lenders cannot identify the type of the household, they offer a more generous interest-rate schedule to strategic households than they would otherwise obtain in an economy without nonstrategic types. This leads to greater borrowing by strategic agents, and debt discharged under bankruptcy.

Furthermore, the nonstrategic types play an important role in the analysis of policy changes, as illustrated by considering the effects of the BAPCPA reforms on interest rates, filing rates and welfare. The nonstrategic agents are largely unaffected by the policy change, and consequently mitigate counter-factual changes in interest rates predicted by the standard model without heterogeneous filing behaviour. This provides evidence that having a pool of non-responders to the policy, which is consistent with descriptive studies, is important for accurately modelling the implications of policy reform.

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Appendix A Debt pricing with heterogeneous types

This section contains additional details for the pricing of debt with heterogeneous types of households. When there exists multiple types of households, indexed by t, and the lender can identify the household's type, the debt-pricing equation in (4) becomes

$$q^t(s, b') = \frac{1}{R+\tau} E_{s'|s} \left[p^t(s') + (1 - p^t(s')) \tfrac{\Gamma y}{b'+x'} \right],$$

where the probability of repayment $p^t(\cdot)$ is now indexed by the household type, $t \in \{S, NS\}$. Therefore, with strategic and nonstrategic types, the intermediary will offer $q^S(\cdot)$ to strategic households, and $q^{NS}(\cdot)$ to nonstrategic households. These functions are given by

$$q^S(s, b') = \frac{1}{R+\tau} E_{s'|s} \left[p^S(s') + (1 - p^S(s')) \tfrac{\Gamma y}{b'+x'} \right], \text{ and} \tag{6}$$

$$q^{NS}(s, b') = \frac{1}{R+\tau} E_{s'|s} \left[p^{NS}(s') + (1 - p^{NS}(s')) \tfrac{\Gamma y}{b'+x'} \right], \tag{7}$$

Given the definition of the nonstrategic type, it follows that the nonstrategic household only files in states the strategic types also files in. Specifically, for any state s, either $p^{NS}(s) = p^S(s)$ or $p^{NS}(s) > p^S(s)$. Hence, there exists no state s where $p^{NS}(s) < p^S(s)$. Therefore, $E_{s'|s} p^{NS} \geq E_{s'|s} p^S$. Furthermore, since $\frac{\Gamma y}{b'+x'} < 1$ in equilibrium, this implies that $q^{NS}(s, b') \geq q^S(s, b')$. This reflects that the interest-rate schedule offered to the nonstrategic type is weakly better than that offered to the strategic type.

If, as in Section 3.2, intermediaries cannot identify the type of household, they will offer a single interest-rate schedule $q(\cdot)$, as in (5),

$$q(s, b') = \alpha q^S(s, b') + (1 - \alpha) q^{NS}(s, b'), \tag{8}$$

where $q^S(s, b') \leq q^{NS}(s, b')$. When the market for lending is perfectly competitive, this is the unique nonzero equilibrium $q(\cdot)$ that earns each intermediary zero expected profit. This will be demonstrated below.

Denote the expected profit of an intermediary lending $q^t(s, b')b'$ in state s, $\Pi(s, b'|q^t, \alpha)$, where α is the proportion of strategic households. In equilibrium, since intermediaries earn zero profits, we have the following identity:

$$\Pi(s, b'|q^S, \alpha = 1) = 0 = \Pi(s, b'|q^{NS}, \alpha = 0). \tag{9}$$

Equation (9) simply reflects the fact that when all agents are strategic ($\alpha = 1$) the equilibrium interest-rate schedule that earns zero expected profit is $q^S(\cdot)$, and it is $q^{NS}(\cdot)$ when $\alpha = 0$.

Additionally, we can show that,

$$\Pi(\boldsymbol{s}, b'|q^{NS}, \alpha = 1) \leq 0 \leq \Pi(\boldsymbol{s}, b'|q^{S}, \alpha = 0) \tag{10}$$

Equation (10) reveals that, when all agents are strategic ($\alpha = 1$), the intermediary will earn negative expected profits by choosing $q(\cdot)$ to equal the equilibrium interest rate schedule when all agents are nonstrategic, $q^{NS}(\cdot)$. Conversely, when all agents are nonstrategic ($\alpha = 0$), the intermediary will earn positive expected profits by choosing $q(\cdot)$ to equal the equilibrium interest rate schedule when all agents are strategic, $q^{S}(\cdot)$. The intuition behind this result is that the strategic types likelihood of repaying is insufficient to compensate the lender for the better interest-rate schedule it offers to nonstrategic agents, hence it obtains negative expected profits. Similarly, the nonstrategic types relative willingness to repay is excessive compared to the high interest rate offered to strategic types, hence positive expected profits are obtained. We can demonstrate the inequalities in (10) by explicitly writing the expected profit function of the intermediary. The expected profit (i.e., excess return) for an intermediary lending $q^{t}(\boldsymbol{s}, b')b'$ can be expressed as

$$\Pi(\boldsymbol{s}, b'|q^{t}, \alpha) = E_{\boldsymbol{s}'|\boldsymbol{s}}\left[p^{t}(\boldsymbol{s}') + (1 - p^{t}(\boldsymbol{s}'))\tfrac{\Gamma y}{b'+x'}\right] b' - (R + \tau)q^{t}(\boldsymbol{s}, b')b', \tag{11}$$

where the first term is the expected return, given the possibility of nonrepayment due to bankruptcy, and the latter term is the cost of lending, which is the sum of the intermediation cost, τ, and the opportunity cost, which is equal to the risk-free rate, R. Using (11) together with $q^{NS}(\boldsymbol{s}, b') \geq q^{S}(\boldsymbol{s}, b')$, I will show each inequality in (10).

$$\begin{aligned}
\Pi(\boldsymbol{s}, b'|q^{S}, \alpha = 1) &= 0 \\
&= E_{\boldsymbol{s}'|\boldsymbol{s}}\left[p^{S}(\boldsymbol{s}') + (1 - p^{S}(\boldsymbol{s}'))\tfrac{\Gamma y}{b'+x'}\right] b' - (R + \tau)q^{S}(\boldsymbol{s}, b')b', \\
&\geq E_{\boldsymbol{s}'|\boldsymbol{s}}\left[p^{S}(\boldsymbol{s}') + (1 - p^{S}(\boldsymbol{s}'))\tfrac{\Gamma y}{b'+x'}\right] b' - (R + \tau)q^{NS}(\boldsymbol{s}, b')b', \\
&= \Pi(\boldsymbol{s}, b'|q^{NS}, \alpha = 1)
\end{aligned}$$

$$\begin{aligned}
\Pi(\boldsymbol{s}, b'|q^{NS}, \alpha = 0) &= 0 \\
&= E_{\boldsymbol{s}'|\boldsymbol{s}}\left[p^{NS}(\boldsymbol{s}') + (1 - p^{NS}(\boldsymbol{s}'))\tfrac{\Gamma y}{b'+x'}\right] b' - (R + \tau)q^{NS}(\boldsymbol{s}, b')b', \\
&\leq E_{\boldsymbol{s}'|\boldsymbol{s}}\left[p^{NS}(\boldsymbol{s}') + (1 - p^{NS}(\boldsymbol{s}'))\tfrac{\Gamma y}{b'+x'}\right] b' - (R + \tau)q^{S}(\boldsymbol{s}, b')b', \\
&= \Pi(\boldsymbol{s}, b'|q^{S}, \alpha = 0)
\end{aligned}$$

Suppose now that $0 < \alpha < 1$, and the intermediaries cannot identify the household's type. We can use the above results to infer something about the properties of (8). If intermediaries offer

$q^{NS}(\boldsymbol{s}, b')$, they earn zero expected profit conditional on lending to nonstrategic households, and negative expected profits conditional on lending to strategic households. Hence, unconditional expected profits are negative. Similarly, if intermediaries offer $q^S(\boldsymbol{s}, b')$, they earn zero expected profit conditional on lending to strategic households, and positive expected profits conditional on lending to nonstrategic households. Hence, unconditional expected profits are positive. Therefore, we obtain the following inequality,

$$\Pi(\boldsymbol{s}, b'|q^{NS}, 0 < \alpha < 1) \leq 0 \leq \Pi(\boldsymbol{s}, b'|q^S, 0 < \alpha < 1),$$

which implies that there exists some convex combination of $q^S(\cdot)$ and $q^{NS}(\cdot)$, such that zero expected profits are obtained; i.e., some parameter $\Delta \in (0, 1)$ such that

$$q^S(\boldsymbol{s}, b') < \Delta q^S(\boldsymbol{s}, b') + (1 - \Delta)q^{NS}(\boldsymbol{s}, b') < q^{NS}(\boldsymbol{s}, b').$$

The equilibrium value of Δ is equal to the proportion of strategic types, α. To show this, first I will extend the equation for expected profits in (11) to the case where intermediaries cannot identify household types:

$$\begin{aligned}\Pi(\boldsymbol{s}, b'|q, 0 < \alpha < 1) = {} & \alpha E_{\boldsymbol{s}'|\boldsymbol{s}}\left[p^S(\boldsymbol{s}') + (1 - p^S(\boldsymbol{s}'))\tfrac{\Gamma y}{b' + x'}\right] b' \\ & + (1 - \alpha)E_{\boldsymbol{s}'|\boldsymbol{s}}\left[p^{NS}(\boldsymbol{s}') + (1 - p^{NS}(\boldsymbol{s}'))\tfrac{\Gamma y}{b' + x'}\right] b' - (R + \tau)q(\boldsymbol{s}, b')b'. \quad (12)\end{aligned}$$

Imposing the equilibrium zero-expected-profit condition in (12), $\Pi(\boldsymbol{s}, b'|q, 0 < \alpha < 1) = 0$, yields the equilibrium interest-rate schedule offered by intermediaries when types cannot be identified,

$$\begin{aligned}q(\boldsymbol{s}, b') &= \frac{\alpha}{R + \tau}E_{\boldsymbol{s}'|\boldsymbol{s}}\left[p^S(\boldsymbol{s}') + (1 - p^S(\boldsymbol{s}'))\tfrac{\Gamma y}{b' + x'}\right] + \frac{1 - \alpha}{R + \tau}E_{\boldsymbol{s}'|\boldsymbol{s}}\left[p^{NS}(\boldsymbol{s}') + (1 - p^{NS}(\boldsymbol{s}'))\tfrac{\Gamma y}{b' + x'}\right] \\ &= \alpha q^S(\boldsymbol{s}, b') + (1 - \alpha)q^{NS}(\boldsymbol{s}, b'),\end{aligned}$$

where the final equality follows from the definitions of $q^S(\boldsymbol{s}, b')$ and $q^{NS}(\boldsymbol{s}, b')$ in (6) and (7), respectively. At this equilibrium value of $q(\boldsymbol{s}, b')$, intermediaries are earning (weakly) positive expected profits from lending to nonstrategic households, and (weakly) negative expected profits from lending to strategic households. The information asymmetry generates an adverse selection problem for intermediaries, which benefits the strategic agents at the expense of the nonstrategic agents. Finally, if the market for credit was not perfectly competitive, there would potentially be scope for lenders to price-discriminate and induce a certain type of households to select a particular interest-rate schedule.

Appendix B PSID Data

This section contains details for the estimation of income processes and the regression used to obtain the data moments, both using household-level data from the Panel Study of Income Dynamics (PSID).

B.1 Income processes

The process for estimating the exogenous income process outlined in Section 4 will be described here. Log labour earnings for household i at age j, $\ln y_{i,j}$, is comprised of a deterministic component, $Z_{i,j}$, and persistent and transitory components, $z_{i,j}$ and $u_{i,j}$, respectively, such that:

$$\ln y_{i,j} = Z_{i,j}\beta + z_{i,j} + u_{i,j}, \tag{13}$$

where $z_{i,j}$ follows an AR(1) process,

$$z_{i,j} = \rho z_{i,j-1} + \eta_{i,j},$$

with $\rho \leq 1$, $\eta_{i,j} \sim \text{iid } \mathcal{N}(0, \sigma_\eta^2)$, $u_{i,j} \sim \text{iid } \mathcal{N}(0, \sigma_u^2)$, $\eta_{i,j} \perp\!\!\!\perp u_{i,j}$.

The PSID range of years used is 1984-1995, to match the period studied in Fay, Hurst, and White (2002). Net earnings is used for the regression in (13), where **Z** is comprised of age dummies, a race dummy, and year fixed-effects. Household earnings is defined as the sum of head and wife labour earnings, while age and race refer to that of the household head. The SEO sample is excluded to ensure the sample is representative of the population. The NBER Tax Sim is used to generate estimates of federal and state taxes. Variables used in the Tax Sim procedure include: year, age of taxpayer (head) secondary taxpayer (spouse, if applicable), state of residence, marital status (for joint filings), number of dependants, taxable and non-taxable transfers to the household (gross social security benefits, workers comp, unemployment compensation). $\hat{\beta}$ is used to generate the life-cycle (deterministic) profile of household earnings. The parameters of the stochastic component contained in Table 2 are estimated using residual earnings, following Guvenen (2009).

B.2 Data moments

The PSID moments referred to in Sections 4 and 5 are a set of coefficients estimated in the following regression,

$$BR_t = W_t\alpha + X_t\beta + Y_t\gamma + Z_t\delta + \epsilon_t, \tag{14}$$

where BR_t is an indicator for a household bankruptcy filing, W_t represents wealth variables, X_t demographics (in the model), Y_t income, Z_t household characteristics (not in the model). The strategy here is to use the parameter estimates (α, β, γ) as target moments. The covariates, Z_t, are included here to control for sources of variation not present in the model. This approach follows that of Fay, Hurst, and White (2002), however, I use a linear specification. Since we are including covariates not present in the model, a linear model is preferred to non-linear alternatives, such as the probit or logit model. If we were to choose a non-linear model, but not have an identical set of covariates in the regression used to obtain the target moments and the model moments, the marginal effects will differ. This means that, even if we estimate model parameters such that the model moments precisely match the target moments, the marginal effect of some variable, e.g., X_t on BR_t, will not be equal in the model and the data.

The specific PSID variables used are: BR_t: bankruptcy (dummy); W_t: debt, debt-squared – these are zero or positive; X_t: age, age-squared; Y_t: income, income-squared – household labor earnings, i.e., sum of labor earnings for head and wife; Z_t: education (in years), self-employed (dummy), state of residence (dummy), year (dummy). The coefficient estimates, standard errors and t-statistics for the regression of these variables on an indicator for a bankruptcy filing are contained in Table 10.

Table 10: PSID bankruptcy filing regression estimates.

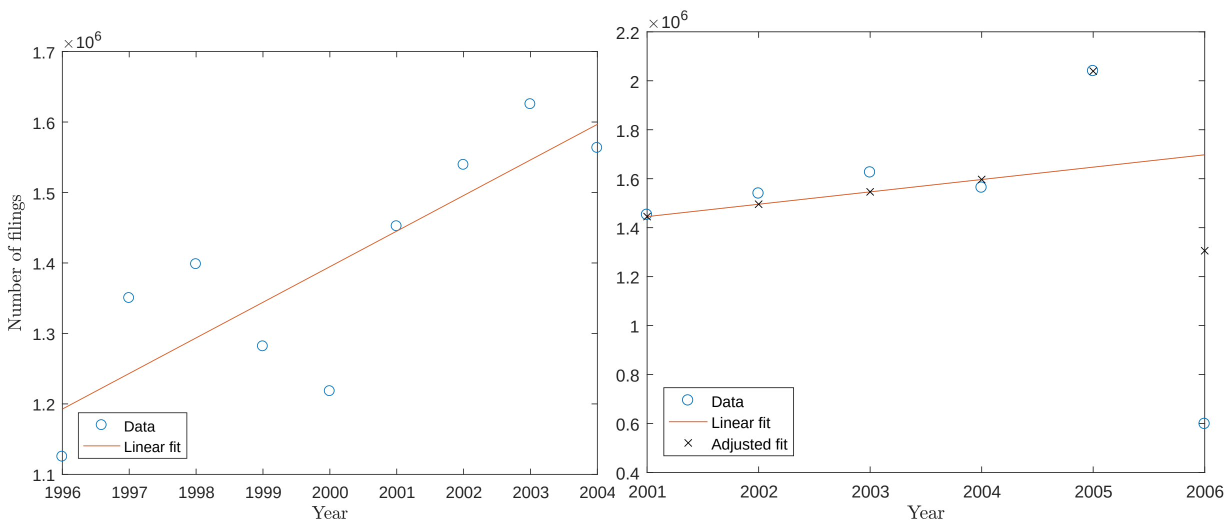
	Est. Coefficient	Std. Error	T-Stat.
Covariates (in model):			
Debt	1.43×10^{-07}	1.43×10^{-07}	3.59
Debt-sq.	-2.77×10^{-13}	-2.77×10^{-13}	-3.29
Income	-3.86×10^{-08}	-3.86×10^{-08}	-5.13
Income-sq.	3.32×10^{-14}	3.32×10^{-14}	4.05
Income drop	-3.55×10^{-08}	-3.55×10^{-08}	-2.06
Covariates (not in model):			
Age	-9.26×10^{-05}	1.02×10^{-04}	-0.90
Age-sq.	-2.87×10^{-07}	9.41×10^{-07}	-0.30
Education	-8.81×10^{-04}	2.94×10^{-04}	-3.00
Self-employed	4.93×10^{-04}	8.62×10^{-04}	0.57
Constant	1.07×10^{-02}	4.61×10^{-03}	2.32

Note: The year range for the PSID is 1984–1996, with variables in 1996 dollars, which yielded a sample size of $N = 61{,}735$. Includes state and year fixed-effects, PSID sample weights and utilises robust standard errors.

Finally, it should be noted that I use precisely the same dataset as that of Fay, Hurst, and White (2002). This means that, in addition to using standard variables provided by the PSID, I use their series for debt, which interpolates the value of debt and wealth for the intervening years when debt and wealth data were not collected.

Appendix C Bankruptcy filings and BAPCPA reforms

We can perform a simple accounting exercise to obtain an approximate reduction in the number of bankruptcy filings caused by the BAPCPA amendments. This approximation is used to infer a value of ψ consistent with the reduction in filings observed when BAPCPA was implemented. Unfortunately this goal is complicated by the fact that households anticipated the BAPCPA amendments, and hence we observe a large spike in filings in 2005, followed by a substantial drop in 2006. See Figure 10, panel (b). To obtain an approximation for the reduction in bankruptcy filings caused by BAPCPA, we therefore have to account for the proportion of filings that filed 'early' for fear they may not have been eligible following the amendments.



(a) Trend in annual filings (b) Adjusted fit for strategic response to BAPCPA

Figure 10: Actual and forecast filings at the time of the BAPCPA reforms.

The procedure to obtain the estimate is as follows. First, I use the number of annual filings for the years 1996-2004 (see panel (a) of Figure 10) to obtain a linear trend for filings, which provides a predicted estimate for annual filings 1,647,200 in 2005 and 1,697,700 in 2006. These estimates are well below the 2,039,214 filings observed in 2005, and well above the 597,965 filings observed in 2006. I assume the difference between these values is due to strategic agents filing in 2005, which, in the absence of the policy change, would have filed in 2006. Shifting these 392,014 bankruptcies from the predicted value in 2006 to 2005 reduces the 2006 predicted value to 1,305,686. The observed value of 597,965 is approximately 46% of the predicted value.

Appendix D Additional results

D.1 Homogeneous Agents

This section contains additional results from the model with strategic agents only ($\alpha = 1$).

Table 11: Calibration results (homogeneous strategic agents, $\alpha = 1$).

Moments	Target	Model(Γ)	Model(ψ)	Data
Filing rate	Y	0.496%	0.184%	0.493%
Interest rate	N	11.3%	9.9%	10.9 – 12.8%
Debt/income	N	0.40	0.78	1.87 – 2.33
Debt coef.	N	3.32×10^{-06}	-3.60×10^{-06}	1.43×10^{-07}
Debt-sq. coef.	N	-3.32×10^{-12}	2.86×10^{-10}	-2.77×10^{-13}
Income coef.	N	-7.36×10^{-07}	-2.04×10^{-07}	-3.86×10^{-08}
Income-sq. coef.	N	5.54×10^{-12}	1.13×10^{-12}	3.32×10^{-14}
Income drop coef.	N	6.81×10^{-08}	3.45×10^{-08}	-3.55×10^{-08}
Strategic	–	89.24%	71.62%	–
Nonstrategic	–	10.76%	28.38%	–
Av. Discharge	–	$5,816	$11,950	–
Av. Earnings (Filers)	–	$14,381	$19,237	–
Av. Earnings	–	$30,397	$30,397	–

Note: Model(Γ) refers to the model with the transfer to the lender under bankruptcy calibrated ($\Gamma = 0.049629$) to equate the filing rate in the model with the corresponding data moment, with no stigma cost ($\psi = 0$). Model(ψ) refers to the model with no transfers to the lender ($\Gamma = 0$), and the stigma cost calibrated ($\psi = 0$) to match the filing rate with the data moment – $\psi = 0$ minimises the distance between the model and data moment, since the filing rate is decreasing in ψ.

Table 11 reveals that, when $\beta = 0.95$ and $\gamma = 2.00$, the model with Γ outperforms the model with ψ. Furthermore, these costs are not substitutes. The additional role played by Γ – transfering income to the lender under bankruptcy – leads to a smoother interest-rate schedule for the borrower. The borrow has access to better rates with $\Gamma > 0$, however it does not necessarily ensure the average borrowing rate is lower; in fact, Table 11 demonstrates the opposite is true. $\Gamma > 0$ ensures that a higher $q(\cdot)$ is offered to the agent, and consequently, in equilibrium, the agent chooses to borrowing more and a worse rate, thus reducing the average borrowing rate.

Table 12: Parameter estimates and model moments for homogeneous strategic agents ($\alpha = 1$).

Estimated Parameter(s)	β	γ	Γ	ψ	Filing rate	Debt/ income	Borrowing rate
Γ	0.950	2.000	**0.050**	0.00000	**0.496**%	0.40	11.3%
β, Γ	**0.841**	2.000	**0.512**	0.00000	**0.493**%	**1.87**	7.9%
γ, Γ	0.950	**1.763**	**0.444**	0.00000	**0.097**%	**1.87**	7.6%
β, Γ, ψ	**0.854**	2.000	**0.008**	**0.00008**	**0.493**%	**1.87**	**8.1**%
β, γ, ψ	**0.854**	**2.000**	0.000	**0.00008**	**0.493**%	**1.87**	**8.1**%
Data targets	–	–	–	–	0.493%	1.87	11.5%

Note: Estimated parameters and moments targeted are indicated by **bold** entries.

Table 12 contains additional estimation results for the homogeneous agents model ($\alpha = 1$). First, we note that the target moments are much more responsive to changes in β than γ. We do observe an improvement in the fit by reducing β, however, we still cannot match all three target moments. Additionally, by lowering β the increase in borrowing introduces a role for the stigma cost, ψ. Finally, we could use the parameterization in the final row, and raise the charge set by the intermediaries to match the interest rate. This would entail almost doubling the intermediation cost from 4% to 7%. This seems unreasonably high – it is approximately three times larger than the calibrated value in Livshits, MacGee, and Tertilt (2010).

D.2 Heterogeneous agents

D.2.1 NS.1: Income type

Table 13 contains parameter estimates of the proportion of types (α) and bankruptcy costs (Γ and ψ), and model moments for the nonstrategic income type (NS.1), with fixed values of β, γ and the cutoff value ($\underline{y}$). The range of values for the cutoff are $5,000, $7,000 and $10,000.

Table 13: Estimation results (heterogeneous agents – NS.1).

–	$\underline{y} = 5{,}000$	$\underline{y} = 7{,}000$	$\underline{y} = 10{,}000$	Data
Parameters				
α	0.330449	0.332711	0.077675	–
Γ	0.019467	0.096830	0.262078	–
ψ	0.000043	0.000042	0.000024	–
Target moments				
Filing rate	0.494%	0.487%	0.497%	0.493%
Interest rate	10.06%	11.50%	11.50%	11.50%
Debt/income	1.88	1.86	2.57	1.87
Regression coef.				
Debt	7.88×10^{-06}	8.60×10^{-06}	6.76×10^{-06}	1.43×10^{-07}
Debt-sq.	-7.43×10^{-12}	-8.73×10^{-12}	8.49×10^{-10}	-2.77×10^{-13}
Income	1.18×10^{-07}	-3.63×10^{-07}	-5.50×10^{-07}	-3.86×10^{-08}
Income-sq.	2.26×10^{-12}	1.30×10^{-12}	4.63×10^{-12}	3.32×10^{-14}
Income drop	-2.38×10^{-08}	-3.14×10^{-08}	-1.82×10^{-08}	-3.55×10^{-08}
Statistics				
Prop. BR (S)	0.946	0.875	0.625	–
Borrowing rate (S)	15.39%	18.43%	32.33%	–
Debt/income (S)	1.82	1.88	3.08	–
Discharge (S)	$27,165	$27,779	$70,966	–
Earnings|File (S)	$15,628	$15,479	$30,683	–
Prop. BR (NS)	0.054	0.125	0.375	–
Borrowing rate (NS)	7.65%	7.85%	8.77%	–
Debt/income (NS)	2.82	1.76	1.72	–
Discharge (NS)	$32,696	$17,308	$15,478	–
Earnings|File (NS)	$11,757	$8,536	$9,104	–
Prop. Involuntary BR	0.150	0.220	0.452	–

Note: In this estimation, only the filing rate, interest rate and debt-income moment are targeted. The regression coefficients not targeted. (S) refers to strategic types and (NS) refers to nonstrategic types.

D.2.2 NS.2: Disposable income type

Table 14 contains parameter estimates of the proportion of types (α) and bankruptcy costs (Γ and ψ), and model moments for the nonstrategic disposable income type (NS.2), with fixed values of β, γ and the cutoff value ($\underline{b}$). The range of values for the cutoff are $-\$15,000$, $-\$10,000$ and $-\$5,000$.

Table 14: Estimation results (heterogeneous agents – NS.2).

–	$\underline{b} = -15{,}000$	$\underline{b} = -10{,}000$	$\underline{b} = -5{,}000$	Data
Parameters				
α	0.298347	0.415514	0.537424	–
Γ	0.030224	0.043168	0.043299	–
ψ	0.000038	0.000032	0.000023	–
Target moments				
Filing rate	0.494%	0.493%	0.493%	0.493%
Interest rate	8.50%	9.18%	10.35%	11.50%
Debt/income	1.87	1.62	1.32	1.87
Regression coef.				
Debt	9.17×10^{-06}	1.22×10^{-05}	1.52×10^{-05}	1.43×10^{-07}
Debt-sq.	-8.83×10^{-12}	-1.36×10^{-11}	-1.62×10^{-11}	-2.77×10^{-13}
Income	6.16×10^{-07}	2.77×10^{-07}	-1.65×10^{-07}	-3.86×10^{-08}
Income-sq.	-3.22×10^{-13}	-6.30×10^{-13}	2.50×10^{-12}	3.32×10^{-14}
Income drop	-4.93×10^{-07}	-4.63×10^{-07}	-3.53×10^{-07}	-3.55×10^{-08}
Statistics				
Prop. BR (S)	0.942	0.946	0.954	–
Borrowing rate (S)	11.25%	11.95%	13.27%	–
Debt/income (S)	1.79	1.55	1.25	–
Discharge (S)	$25,851	$20,326	$15,510	–
Earnings|File (S)	$15,525	$13,988	$13,136	–
Prop. BR (NS)	0.059	0.054	0.046	–
Borrowing rate (NS)	7.61%	7.66%	7.73%	–
Debt/income (NS)	3.10	2.85	2.68	–
Discharge (NS)	$42,645	$40,650	$39,108	–
Earnings|File (NS)	$16,185	$16,940	$17,495	–
Prop. Involuntary BR	0.132	0.151	0.131	–

Note: In this estimation, only the filing rate, interest rate and debt-income moment are targeted. The regression coefficients not targeted. (S) refers to strategic types and (NS) refers to nonstrategic types.

D.2.3 NS.3: Consumption type

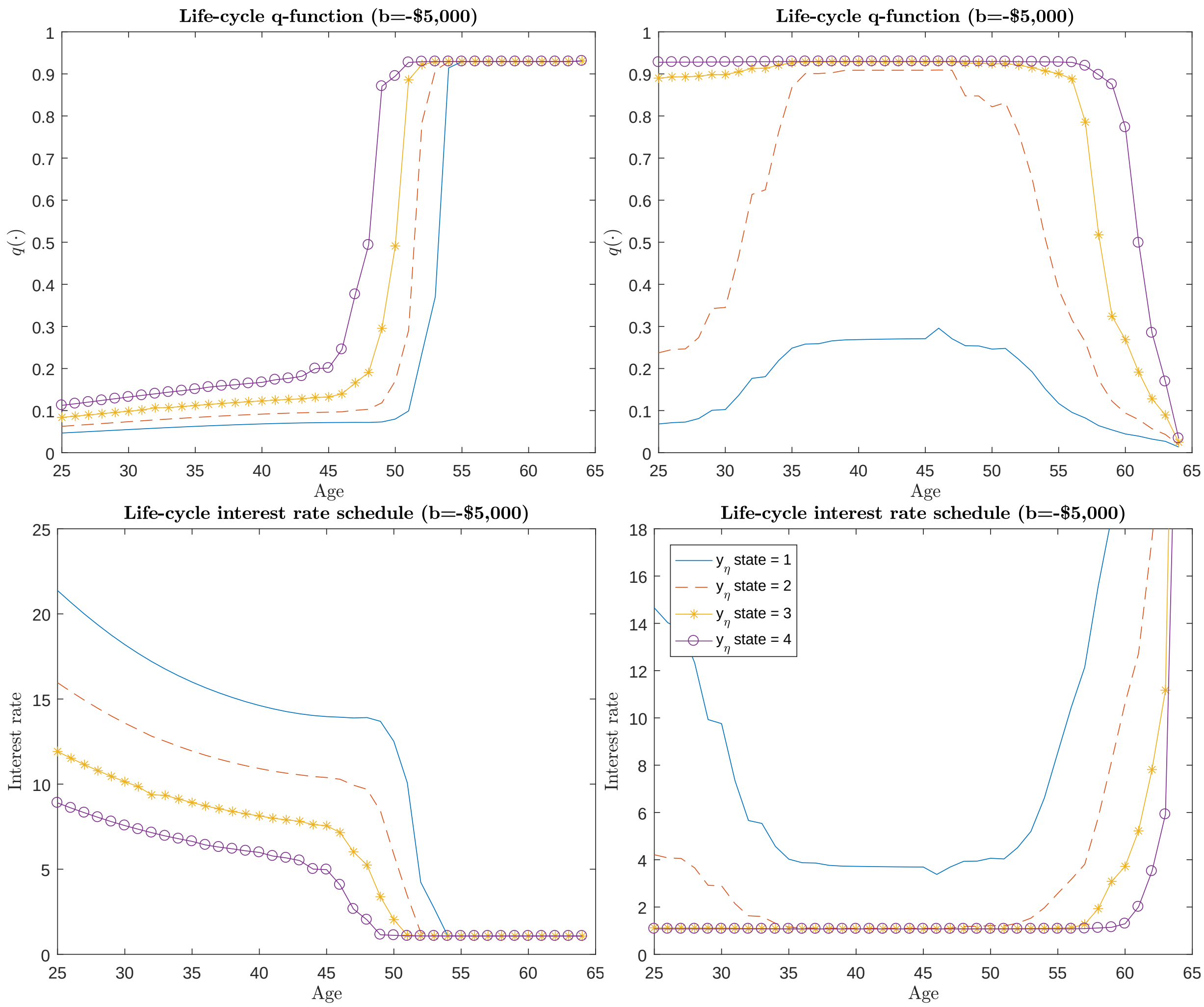
Table 15 contains parameter estimates of the proportion of types (α) and bankruptcy costs (Γ and ψ), and model moments for the nonstrategic consumption type (NS.3), with fixed values of β, γ and the cutoff value ($\underline{c}$). The range of values for the cutoff are \$2,500, \$5,000 and \$7,500.

Table 15: Estimation results (heterogeneous agents – NS.3).

–	$\underline{c}$ = 2,500	$\underline{c}$ = 5,000	$\underline{c}$ = 7,500	Data
Parameters				
α	0.256417	0.175633	0.156491	–
Γ	0.048020	0.020086	0.019503	–
ψ	0.000038	0.000036	0.000035	–
Target moments				
Filing rate	0.493%	0.493%	0.493%	0.493%
Interest rate	8.53%	11.50%	14.85%	11.50%
Debt/income	1.82	1.76	1.37	1.87
Regression coef.				
Debt	8.92×10^{-06}	8.58×10^{-06}	8.60×10^{-06}	1.43×10^{-07}
Debt-sq.	-8.25×10^{-12}	-8.51×10^{-12}	-8.79×10^{-10}	-2.77×10^{-13}
Income	3.92×10^{-07}	3.77×10^{-07}	-1.72×10^{-07}	-3.86×10^{-08}
Income-sq.	-1.67×10^{-13}	-1.43×10^{-12}	2.55×10^{-12}	3.32×10^{-14}
Income drop	-4.18×10^{-07}	-4.76×10^{-08}	-4.29×10^{-08}	-3.55×10^{-08}
Statistics				
Prop. BR (S)	0.952	0.852	0.642	–
Borrowing rate (S)	11.73%	31.96%	51.71%	–
Debt/income (S)	1.74	1.72	1.46	–
Discharge (S)	\$29,639	\$32,280	\$28,384	–
Earnings|File (S)	\$17,473	\$19,046	\$19,287	–
Prop. BR (NS)	0.048	0.148	0.358	–
Borrowing rate (NS)	7.62%	7.86%	8.49%	–
Debt/income (NS)	3.34	2.01	1.22	–
Discharge (NS)	\$40,704	\$21,249	\$13,691	–
Earnings|File (NS)	\$13,769	\$9,814	\$10,125	–
Prop. Involuntary BR	0.122	0.218	0.412	–

Note: In this estimation, only the filing rate, interest rate and debt-income moment are targeted. The regression coefficients not targeted. (S) refers to strategic types and (NS) refers to nonstrategic types.

D.3 Interest rates



(a) Homogeneous agents (b) Heterogeneous agents

Figure 11: Comparison of life-cycle interest-rate schedules across models.