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The Introduction of Cost Sharing for Prescription Drugs: Evidence from The Irish Longitudinal Study of Ageing (TILDA)

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Abstract: Ageing populations and age-related morbidity present major challenges for advanced economies in managing rapidly increasing pharmaceutical expenditures. However, older people, particularly those with low incomes, may be susceptible to negative effects from cost sharing for medicines. The impact of introducing prescription drug co-payments for older publicly insured patients (medical cardholders) in Ireland is explored using data from The Irish Longitudinal Study on Ageing. Difference-in-difference analysis revealed that medicines use increased despite the imposition of small co-payments for medical cardholders (the treatment group) relative to a control group of private patients. However, features of the Irish market must be taken into account in interpreting this counterintuitive result.

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I INTRODUCTION

1.1 Background

Ageing populations and age-related morbidity present major challenges for advanced economies in managing rapidly increasing pharmaceutical expenditures. To moderate patient demand for medicines, cost sharing for prescription drugs is widely employed. Co-payments require an insured patient to pay a fixed out-of-pocket charge to obtain a prescribed item. Cost sharing provides an economic incentive for the rational use of medicines and it also generates a source of revenue.

However, where direct costs to patients discourage consumption of necessary medications, cost sharing may be injurious to health. If chronic conditions remain untreated by cost-effective drugs, patients with such conditions may end up requiring more expensive forms of healthcare in the long run, compromising the overall efficiency of healthcare systems (Gemmill *et al*., 2008; Goldman *et al*., 2007; Lexchin and Grootendorst, 2004). Moreover, co-payments may exacerbate inequities in health and healthcare use, particularly among low income households. A large body of empirical evidence has demonstrated that co-payments reduce medicines usage (Aziz *et al*., 2016; Goldman *et al*., 2007; Lexchin and Grootendorst, 2004; Luiza *et al*., 2015; Sinnott *et al*., 2013a; Soumerai *et al*., 1993). In response, countries such as Wales (Cohen *et al*., 2010), Scotland (Williams *et al*., 2018) and Northern Ireland have abolished prescription drug co-payments. In the US, the direction of policy has shifted towards value-based insurance design, to reduce barriers to the use of cost-effective medicines (Chernew *et al*., 2014; Fendrick *et al*., 2012).

By contrast, however, a trebling of expenditure on medicines under the General Medical Services (GMS) scheme in Ireland (the main scheme for public insurance) from 2000-2010 led to the introduction of cost sharing for the first time for publicly insured patients (Barry *et al*., 2010). An initial co-payment was set at €0.50 per prescribed item in October 2010. Subsequent changes saw the levy increase to €2.50 by December 2013, although it has since been reduced to €1.50 per item.

Ireland is the only healthcare system in Europe that does not have universal health coverage for primary care (Thomson *et al*., 2014), and the publicly insured population represents a vulnerable group (Sinnott *et al*., 2013a). Older medical cardholders may be especially susceptible to negative effects from cost sharing for medicines. This paper investigates the impact of the introduction of cost sharing for the older, publicly insured population. While many studies have investigated the effects of cost sharing, reviews show that the bulk of evidence originates from North America, findings from which may have limited applicability to other healthcare systems (Sinnott *et al*., 2017). Furthermore, the methods of analysis typically rely on cross-sectional designs or time series of administrative data. Our study makes an original contribution to the existing literature using multiple waves

from a rich longitudinal survey. The findings diverge from the conventional wisdom that cost sharing reduces medicine usage, providing an alternative discovery among the stock of literature.

1.2 Institutional Setting and Policy Change

The arrangement of healthcare in Ireland is a complex mix of public-private provision across primary and hospital care settings. The majority of Irish residents are private patients and pay the full cost of general practitioner (GP) services at the point of consumption, as well as prescription medicines subject to a monthly deductible.[1] A GP consultation averages at €52.50 (Connolly *et al*., 2018). Under the GMS scheme, medical cardholders are entitled to free GP visits, and prior to the introduction of co-payments they were entitled to free prescription drugs. Medical Card eligibility is income means tested (details of income thresholds are provided in Callan *et al*., 2017), or may be offered on a discretionary basis to patients with exceptional health needs. In 2017, a third of the population held a Medical Card (Department of Health, 2018). A 'GP visit card' also exists, which only provides for free GP consultations, and GP visit cardholders must pay for prescription medicines as private patients. The GP visit card has a higher means tested threshold than the Medical Card, but the uptake of this scheme has been low (Callan *et al*., 2017). Since 2015, the GP visit card became universally available to children under six years, those over 70 years, and from 2018 carers also became eligible.

The annual cost of prescriptions provided for under the GMS (which covers medical cardholders) trebled in the decade 2000-2010, from €328 million to €1.2 billion (Health Service Executive, 2017). Rising costs were attributed to a growth in the number of prescribed items and the prescribing of new, more expensive medicines. To curb this growth, new legislation was implemented, effective from October 2010, where medical cardholders became subject to a €0.50 co-payment for each prescription item. A €10 ceiling on monthly drug expenditures for Medical Card households was also put into effect. The co-payment was then increased in January 2013 to €1.50, and the ceiling rose to €19.50. In December 2013, the co-payment further increased to €2.50; the ceiling to €25. The changes to the cost sharing in prescription medicines is documented in Table 1. According to a report, the introduction of prescription levies generated an income of €0.6 billion for the Health Service Executive between 2010 and 2017 (Health Service Executive, 2018).

[1] A deductible is the amount paid by a service user out-of-pocket before their insurer begins to share in the cost of covered services. For example, where the Drugs Payment Scheme monthly threshold was €132 (from January to December 2012) a private household (i.e. one that was not covered by the Medical Card scheme) would pay the full cost of medicines up to €132 in a month, and expenses beyond €132 would be covered by the Scheme and availed of for free to the user.

Table 1: Cost Sharing Arrangements for Medical Cardholders in Ireland

Date	*Co-pay (€)*	*Monthly cap per family (€)*
Prior to October 2010	Zero	Not applicable
October 2010	0.50	10.00
January 2013	1.50	19.50
December 2013	2.50	25.00
March 2017	2.00 medical cardholders >70 years only	20.00
January 2018	2.00 all medical cardholders	20.00
January 2019	1.50 medical cardholders >70 years only	15.00
November 2020	1.00 medical cardholder >70 years; 1.50 medical cardholders < 70 years	10.00 > 70 years; 15.00 < 70 years

Source: Authors' analysis of Department of Health and HSE information.

Private patients must pay the full cost of prescriptions. Policies have been introduced in Ireland to reduce the price of medicines for the consumer, such as drugs reference pricing and greater generic substitution (Usher and Barry, 2012). Additionally, the Drugs Payment Scheme (DPS) protects households against excessive expenses. DPS claimants pay the full cost of their medicines up to a threshold which has changed over time (outlined in Supplementary Figure S-1). In addition, patients with certain illnesses or disabilities are entitled to obtain medicines for managing that condition free-of-charge under the Long Term Illness (LTI) scheme (Health Service Executive, 2019).

The financing and provision of hospital care is also complex in Ireland, where all residents are entitled to free public hospital care, though co-payments for attendances to Emergency Departments and overnight hospital stays exist for the 'private' population who do not have Medical Cards. Private health insurance is also availed of by 43 per cent of the Irish populace (Department of Health, 2018), the main benefit of which is avoiding public waiting lists for hospital care using a private provider (which may be in a public or private hospital). In Ireland, private health insurance does not usually provide coverage for GP consultations or prescription medicines. All residents, including those who hold Medical Cards, can purchase private health insurance.

1.3 The Impact of Co-Payments for Medicines in the International Literature

The majority of studies evaluating cost sharing for medicines finds that medication use and adherence[2] declines as a result (Aziz *et al*., 2016; Goldman *et al*., 2007; Lexchin and Grootendorst, 2004; Lu *et al*., 2008; Luiza *et al*., 2015; Sinnott *et al*.,

[2] The degree to which patients take medicines as prescribed or continue to take medicines.

2013a; Soumerai *et al*., 1993). Few studies find little impact (Andersson *et al*., 2006; Crown *et al*., 2004; Lee *et al*., 2012; Linnet *et al*., 2013) and a small number of counterintuitive results have been uncovered, where medication use increased (Berndt *et al*., 1997; Hong and Shepherd, 1996; Ong *et al*., 2003; Pilote *et al*., 2002). Quantitative investigations have typically been informed by administrative data, using cross-sectional designs, and have lacked control groups (Aziz *et al*., 2016; Goldman *et al*., 2007). The majority of studies are deficient of individual-level information on claimants, with socio-economic status and health behaviours thought to be important confounders (Goldman *et al*., 2007).

The bulk of evidence originates from the US and Canada, and investigations have focused on impacts in adult and older populations. The most cited study of cost sharing in healthcare is the RAND Health Insurance Experiment (HIE) in the US, which randomised cost sharing via health insurance arrangements for participants who were under the age of 65 across multiple study locations from 1974-1982. Evidence from the RAND HIE found that the number of drug prescriptions purchased per capita was lower for groups which had greater levels of cost sharing, relative to beneficiaries on a free healthcare plan (Leibowitz *et al*., 1985). For the older population in the US, an expansion in drug insurance coverage for older and disabled adults, who could voluntarily enrol under the Medicare Part D policy from 2006, was found to increase medicines use among beneficiaries (Lau *et al*., 2011; Lichtenberg and Sun, 2007; Safran *et al*., 2010; Schneeweiss *et al*., 2009; Zhang *et al*., 2010; 2009). However, Medicare Part D was found to have differential effects across drug therapeutic types, and a net decrease in generic drug utilisation for enrolees was uncovered (Zhang *et al*., 2010). The impact of Medicare Part D also differed according to circumstances, where it was not expected to increase drug use for nursing home residents (Stuart *et al*., 2006), and the level of cost sharing for Part D beneficiaries did not affect prescriptions for those with employer-based drug plans (Goedken *et al*., 2010). A recently published study concerning the RAND experiment notes that intertemporal substitution of healthcare consumption featured strongly (Lin and Sacks, 2019), where those who reached their deductible for healthcare expenditures concentrated their consumption in the years for which they exceeded the threshold, stocking up when they faced an effective price of zero. However, the authors note that drugs spending was not included in the analysis as medicine prescriptions spanned multiple years and could not be reliably dated.

More general studies of cost sharing for drugs have been characterised by mixed conclusions as to price sensitivity across patient groups, with some studies finding that older people are less price sensitive (Lexchin and Grootendorst, 2004; Lundberg *et al*., 1998), while others uncover greater price responses among older people (Martin and McMillan, 1996; Soumerai *et al*., 1991; 1987). Chronically ill patients have been found to be price sensitive (Ghosh *et al*., 2019; Goldman *et al*., 2004; 2007). Low income groups may be more sensitive, though there was little empirical support for this theory (Goldman *et al*., 2007).

Several studies distinguish between the use of essential and less-essential drugs (Austvoll-Dahlgren *et al*., 2008). 'Essential' medications are those used in disease management and are not likely to be prescribed in the absence of a definitive diagnosis. 'Discretionary' or 'less-essential' drugs are those that may alleviate symptoms but are unlikely to have an effect on the underlying disease process, or they may also be "drugs that are considered to be over-prescribed or a less cost-effective alternative than other available treatments" (Austvoll-Dahlgren *et al*., 2008, p.5). A review concluded that there was inconsistent evidence on the effect of co-payments across essential and non-essential medicines (Goldman *et al*., 2007). The evidence on the prioritisation of medicines in the treatment of mental health compared to physical health has also been mixed (Norris *et al*., 2016).

1.4 Evidence from Ireland

Upon the introduction of the €0.50 co-payment, the views of 24 GMS patients in Ireland on cost sharing were documented in a qualitative study (Sinnott *et al*., 2013b). Patients were accepting of the levy, identifying waste of prescription drugs as a problem. The interviewees had reservations about increasing the levy, advising that €2-€5 might be prohibitive. From the providers' side, a qualitative study interviewing 19 GPs and pharmacists concluded that experienced healthcare professionals were supportive of the co-payments policy to reduce wastage of medicines which was a considerable issue (Brien *et al*., 2020). However, the practicalities around collection of charges were highlighted as problematic for pharmacists.

Medicine adherence, as measured by the proportion of days covered from Irish prescribing claims data, was compared between GMS and LTI patients, following the introduction of co-payments (Sinnott *et al*., 2016). Declines in adherence were greater for non-essential medicines than essential medicines, including blood pressure lowering, lipid lowering and oral diabetic medications. Anti-depressant use fell. Policy changes had a lasting tempering effect, with long-term adherence continuing at a new lower level.

Responses to increases in co-payments in Ireland were compared with a similar policy change in Massachusetts (Sinnott *et al*., 2017). The dynamic responses to the policies differed. Following a co-payment increase, a gradual, sustained decrease in adherence to antihypertensive medication was observed in Massachusetts. In Ireland, the drop in antihypertensive adherence was immediate, with adherence stabilising at a new lower level. Adherence to lipid modifying agents in both groups was unaffected. However, significant declines in oral diabetic drugs were of a greater magnitude in Massachusetts, compared to Ireland where decreases were not statistically significant. As such, the generalisability of international evidence on cost sharing may be limited across different healthcare systems, meriting context-specific investigations.

In a 2014 telephone survey, 30 per cent of GMS patients aged 65 years and older reported a financial burden from medication costs (Dillon *et al*., 2018). Interviewees were re-contacted after 12 months, and medication-related financial burden was found to be associated with reduced self-reported antihypertensive adherence. However, this was not substantiated in the dispensing records from respondents' community pharmacies.

The Irish evidence to date points to a range of consequences for patients from co-payments. Our study offers an alternative investigation using longitudinal data, comparing GMS patients with a group of private patients who do not have a Medical Card. To the best of our knowledge, a quantitative comparison using private patients has not been carried out to date, since administrative data on medicines use for private patients are not centrally recorded in Ireland.

II METHODS

2.1 Data

Four waves of data from The Irish Longitudinal Study on Ageing (TILDA), a nationally representative survey of community-dwelling over 50s, were used for this investigation. The first wave of TILDA was collected between October 2009 and February 2011, when 8,174 over 50s were interviewed in their homes using computer assisted personal interviews. Interviewers recorded the number of *regular* medicines used by interviewees (the exact wording of the question is documented in the Supplementary File), and medication details were transcribed from the packets during the interview. As the Wave 1 data spanned before and after the introduction of the cost sharing policy, the Wave 1 sample was split into two groups: 6,328 pre-policy interviewees, interviewed before October 2010 when prescription medicines were free for medical cardholders, and 1,134 post-policy interviewees (those which occurred from November 2010 onwards) when prescriptions were subject to the 50 cent co-payment. Interviews which were conducted in the month of October 2010 were dropped as medicines are typically supplied as a 28-day supply. The timing of the TILDA data collection periods and the co-payment policy changes are depicted graphically in Supplementary File Figure S-2, and the arrangement of the TILDA samples across the policy time periods is documented in Table 2.

Data collection for TILDA Wave 2 was carried out between April 2012 and January 2013, capturing 7,281 of the cohort. The co-payment for medical cardholders was €0.50 for most of this period, except for January 2013 when the co-payment charge increased to €1.50. Fourteen Wave 2 interviews that occurred in January 2013 were dropped as a result.

Wave 3 data were collected between March 2014 and October 2015, with 6,618 of the cohort, and the Wave 4 sweep occurred from January to December 2016, with 5,942 of the cohort. The co-payment during both Waves 3 and 4 was €2.50.

For the purposes of clarity, we note that there were no changes to the cost of GP consultations for medical cardholders over the period of investigation, which remained free.

Table 2: Arrangement of TILDA Interviews into Pre- and Post-Policy Groups

Wave	*Data Collection Period*	*Medical Cardholders Co-payment*	*TILDA over 50s*	*Sample Notes*	*Policy*
1	October 2009–February 2011	Free ↓ €0.50 co-payment introduced in October 2010	8,174	Wave 1 split into 2 groups: Zero co-payment before policy: 6,328 interviews (up to September 2010)	Pre-policy
				Interviewed where 50c charge in place: October 2010 interviews excluded due to 28-day supply of medicines 1,134 interviews occurred from November 2010 onwards (post-policy)	€0.50 post-policy
2	April 2012–January 2013	€0.50 ↓ January 2013 charge increased to €1.50	7,281	Wave 2 split: Majority of interviews occur during 50c charge in 2012: 7,267 (up to December 2012)	€0.50 post-policy
				Exclude 14 interviews occurred January 2013 due to the €1.50 charge in place	(Excluded)
3	March 2014 – October 2015	€2.50	6,618		€2.50 post-policy
4	January 2016–December 2016	€2.50	5,942		€2.50 post-policy

Source: Authors' analysis of TILDA data.

2.2 Estimation Methodology

Using a difference-in-difference (DID) framework, medical cardholders are the group that become subject to a co-payment, and as such, they represent the 'treatment group'. Respondents without Medical Cards are exposed to the full cost

of medicines and thus form the control group. Obtaining a 'like for like' control group is not possible for this analysis since medical cardholders are a particularly distinctive group, though one of the main advantages of DID is that it does not require random assignment of individuals to a treatment group. DID also controls for time-invariant unobserved differences in characteristics between a treatment and control group. There are three time periods: the pre-policy period; the €0.50 period; and the €2.50 period.

The linear DID estimated is formalised as:

$$Y_{it} = \beta_1(MC_{it} * Copay_{it}) + \beta_2 X_{it} + \gamma_i + \tau_t + \varepsilon_{it} \quad (1)$$

$$MC_{it} = \begin{cases} 0 \textit{ Do not have a Medical Card} \\ 1 \textit{ Medical cardholder} \end{cases}$$

$$Copay_{it} = \begin{cases} 0 \textit{ Prescriptions free} \text{ (pre – October 2010)} \\ 1 \textit{ Copayment per prescription item} \\ \textit{(post – October 2010: €0.50 or €2.50)} \end{cases}$$

Y_{it} represents the outcomes of interest, which include the number of regular medicines used, polypharmacy (defined as the use of five or more medicines; Masnoon *et al*., 2017) and the use of specific types of medication by Anatomic Therapeutic Classification. The medicine types/classes were categorised into 'essential' and 'discretionary' medicines[3] guided by the definitions and classifications used in previous studies documented in a Cochrane Review (Austvoll-Dahlgren *et al*., 2008).

Whether an interviewee had a Medical Card or not when they were interviewed is represented as MC_{it}. Whether the survey response was given before or after the introduction of prescription charges (€0.50 or €2.50) is represented as the dummy $Copay_{it}$. The coefficient on the interaction of MC_{it} and $Copay_{it}$, β_1, is the DID estimate of the effect of co-payments for medical cardholders. Individual fixed effects are given as γ_i, time fixed effects (wave dummies) are τ_t and ε_{it} is the error term. Controlling for unobserved heterogeneity across individuals in the panel by employing panel fixed effects may be important since unobserved personal characteristics may be associated with use of medicines (e.g. time preferences, attitudes towards drug therapy, organisational skills).

A basic unadjusted model is first estimated (Model 1), with further models adjusting for potential confounders such as demographic, socioeconomic and health characteristics, represented by X_{it}. Gender is time invariant and education is

[3] There are no national guidelines in Ireland applying to these essential medicines, however there were no substantive changes in prescribing recommendations in European hypertension and cardiovascular prevention guidelines during the study time period. The major relevant temporal change was that 'discretionary' supplements of Omega-3 and Glucosamine were de-listed as reimbursable under State schemes.

minimally variable for the over 50s, so these variables drop out from the fixed effects model; age, marital and employment status, equivalised household income, private health insurance, self-rated health, any difficulties in instrumental activities in daily living (IADLs), mental health score, smoking, problematic alcohol consumption and physical activity remain as covariates in Model 2. A third model (Model 3), in addition to the covariates already listed, also controls for a number of chronic conditions, specifically hypertension, diabetes, had a heart attack, had a stroke, had a transient ischemic attack (TIA – mini stroke), heart failure, lung disease, osteoporosis, arthritis and 'often troubled by pain'. It must be acknowledged these variables are more susceptible to endogeneity, since medicines use could remedy or control these conditions.

Respondents whose Medical Card status changed over the time period of investigation were dropped for the analytical sample to ensure a changing composition of the treatment and control groups did not explain the findings. The sample for analysis also comprises complete cases, where respondents have complete information on all variables. For the complete case analysis 1,867 observations were dropped due to missingness on variables of interest – Medical Card status, medicines use, demographic, socio-economic and health information (the specific variables for which there is complete information are listed in Supplementary File Table S-1).

Medical Card status changed for some TILDA respondents over the four waves of the data. In order to carry out analysis for only individuals for which there was no change in Medical Card status, 3,668 observations over four waves were dropped (as the Medical Card status associated with these had changed at some point over the four waves). The final sample for analysis across the TILDA waves and Medical Card status is documented in Table 3. We note also that the DID model sample sizes vary, since there are two different sets of co-payment policies compared: the first is no co-payment (free medicines for medical cardholders) with a €0.50 charge; the second is no co-payment with a €2.50 charge. The comparison of the pre-policy period with the €0.50 period compares the pre-policy Wave 1 sample with the post-policy Wave 1 sample and Wave 2 follow-up. The second comparison of the pre-policy period with the €2.50 co-payment timeframe compares the pre-policy Wave 1 sample with the post-policy Wave 3 and 4 follow-up.

The validity of DID relies on the 'parallel trends' assumption, which assumes that in the absence of treatment, any difference in outcomes between the 'treatment' and 'control' groups is constant over time. To examine this, the predicted number of medicines, polypharmacy and use of medicines by anatomic type for the group with Medical Cards and the group without Medical Cards by month in the pre-policy period was plotted (Walsh *et al*., 2019). Supplementary File Figure S-3 demonstrates that the trends between the groups on the outcomes of interest were broadly similar. Due to having only one pre-policy period, it was not possible to conduct further statistical investigations of parallel trends for this study.

Table 3: Medical Card Status across the TILDA Waves (Sample Used for Analysis)

Wave	*Medical Cardholders*	*Non-Medical Cardholders*	*Total Sample*
1 (pre-policy period only) [1]2009/10/11 Free prescription medicines for medical cardholders	1,991 (52.2%)	1,822	3,813
2[1] 2012/13 €0.50 co-payment per prescription item for medical cardholders	2,348 (48.8%)	2,463	4,811
3 2014/15 €2.50 co-payment per prescription item for medical cardholders	1,971 (46.2%)	2,294	4,265
4 2016 €2.50 co-payment per prescription item for medical cardholders	1,559 (43.2%)	2,054	3,613

Source: Authors' analysis of TILDA data.
Note: [1] The Wave 1 sample size is smaller than that for Wave 2 since the Wave 1 sample contains only the interviews for the pre-policy only period (i.e. Wave 1 interviews before October 2010 – the remainder of the Wave 1 interviews, those from October 2010 onwards, are excluded). The sample sizes across the waves are described fully in Table 2.

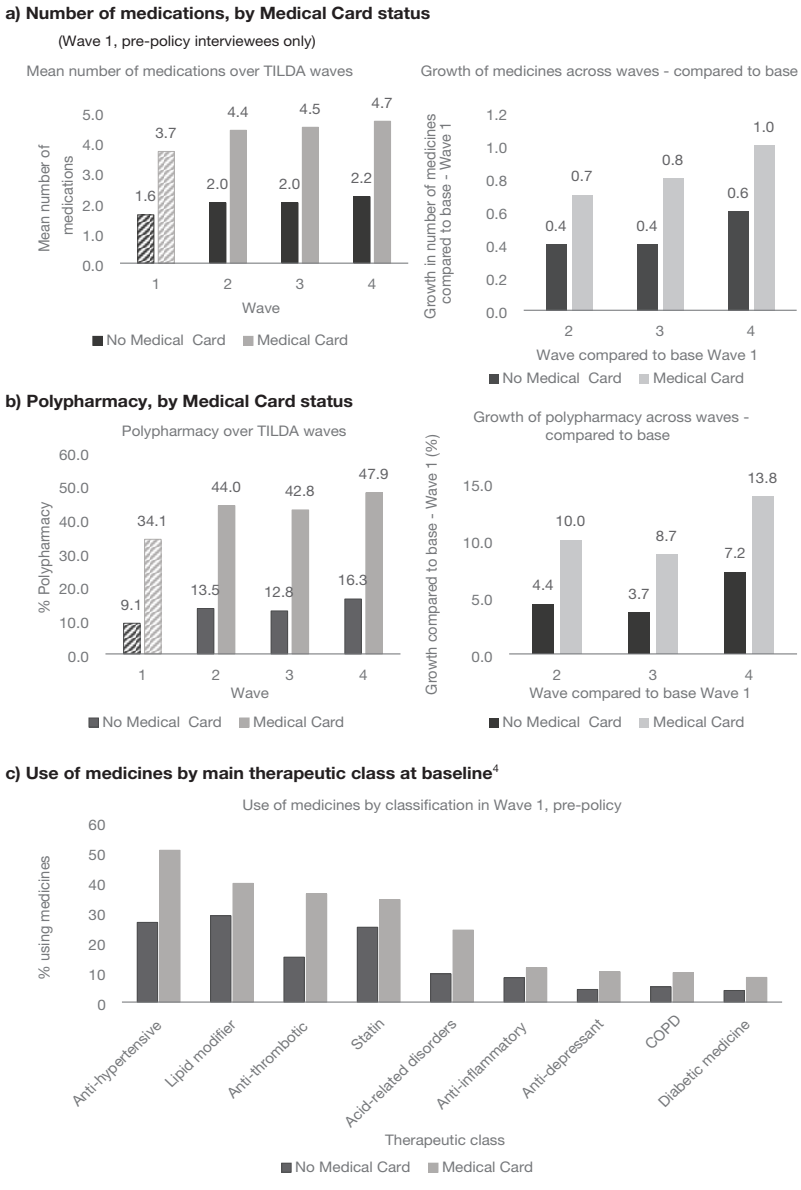
III RESULTS

3.1 Summary Statistics

Medical cardholders had higher utilisation of medicines across all waves of the data, as shown in Figure 1a. The growth in the number of medicines over the waves, relative to the pre-policy base, was greater for medical cardholders than for those without a Medical Card. In Wave 1, polypharmacy was over three times higher among medical cardholders than for those without public insurance (Figure 1b). Polypharmacy also increased during the policy period. Half (51.6 per cent) of medical cardholders were taking an antihypertensive before the co-payments were introduced (Figure 1c), compared to 24.4 per cent of private patients. As the waves of TILDA progressed, Table 4 shows that the proportion of respondents using medicines from most therapeutic categories grew, observed for both groups. Some exceptions were antihypertensives in the C02 group (comprising anti-hypertensive drugs not categorising in the five named anti-hypertensive drug classes), diuretics

and anti-inflammatory drugs. Omega-3 and Glucosamine use reduced over the waves. Descriptive statistics for the characteristics of the sample (covariates) are documented in Supplementary Table S-1.

Figure 1: Summary Statistics on Outcomes Across Waves



Source: Authors' analysis of TILDA data.

[4] Charts of the growth of medicines over the TILDA by therapeutic class are provided in Supplementary File Figure S-4.

Table 4: Summary Statistics on Outcomes Across Waves and Medical Card Status

*Outcome**	*Medical Cardholders*				*Private Group – No Medical Card*			
	W1: pre-policy:[1] *2009/10/11 Zero Co-pay*	*W2: 2012/13 Co-pay €0.50*	*W3: 2014/15 Co-pay €2.50*	*W4: 2016 Co-pay €2.50*	*W1: pre-policy:*[1] *2009/10/11 Full payment*	*W2: 2012/13 Full Payment*	*W3: 2014/15 Full payment*	*W4: 2016 Full payment*
Number of medicines	3.7	4.4	4.5	4.7	1.6	2.0	2.0	2.2
Polypharmacy (%)	34.1	44.0	42.8	47.9	9.1	13.5	12.8	16.3
Essential medicines (% respondents using)								
Lipid modifiers	39.6	47.2	47.3	48.2	27.0	33.8	31.4	34.2
Lipid modifiers exc. Omega-3	36.8	41.0	44.7	45.5	23.2	24.0	27.9	30.2
Statins	37.4	42.3	44.6	44.8	23.2	26.3	27.9	30.6
Anti-psychotic	2.2	2.3	3.0	2.9	1.0	1.0	1.1	1.2
Antidepressant	10.3	12.6	14.2	15.0	4.0	5.2	5.5	6.4
Antihypertensive	51.6	57.8	58.5	59.9	24.4	29.0	31.3	34.1
C02 group antihypertensive	2.8	2.9	2.7	2.6	0.9	1.0	1.0	1.0
Diuretic	14.6	14.6	14.1	14.6	2.9	3.7	3.6	4.2
Beta blocker	20.7	24.0	24.4	26.0	8.4	9.3	9.6	10.9
Calcium channel blocker	14.1	15.9	17.1	18.9	5.5	7.5	7.8	8.7
ACE Inhibitor	19.6	20.8	19.6	19.9	8.2	8.9	10.2	11.5
Angiotensin 2 Antagonists	15.3	18.9	19.8	20.3	7.9	10.2	12.2	12.5
Diabetic medication	8.5	10.2	12.1	12.0	3.4	3.9	4.5	5.0
Diabetes type 1 (insulin)	0.8	1.5	1.6	2.0	0.4	0.6	0.8	1.0
Diabetes type 2 (non-insulin)	8.0	9.6	11.7	11.2	3.1	3.5	4.1	4.4
Obstructive airway (COPD)	10.5	10.3	10.3	11.8	5.2	5.4	5.6	6.3
Anti-thrombotic	36.6	39.4	40.5	40.7	13.0	14.3	15.9	18.4
Antiplatelet	32.1	33.4	32.9	33.2	12.1	13.2	14.3	15.4

Table 4: Summary Statistics on Outcomes Across Waves and Medical Card Status (Contd.)

*Outcome**	*Medical Cardholders*				*Private Group – No Medical Card*			
	W1: pre-policy:[1] *2009/10/11 Zero Co-pay*	*W2: 2012/13 Co-pay €0.50*	*W3: 2014/15 Co-pay €2.50*	*W4: 2016 Co-pay €2.50*	*W1: pre-policy:*[1] *2009/10/11 Full payment*	*W2: 2012/13 Full Payment*	*W3: 2014/15 Full payment*	*W4: 2016 Full payment*
Anti-platelet exc. aspirin	5.2	5.0	4.3	4.4	1.5	1.2	1.7	1.8
Aspirin	29.9	30.3	30.8	31.0	11.5	12.6	13.4	14.4
Anticoagulant	4.8	7.1	8.4	9.0	0.9	1.2	1.9	3.5
Discretionary medicines (% respondents using)								
Anxiolytic/hypnotic	9.9	11.6	11.3	11.0	2.3	2.5	2.7	3.1
Omega-3	3.1	7.1	2.9	2.9	3.8	10.1	3.8	4.1
Anti-inflammatory	11.7	13.2	9.3	8.0	7.9	8.5	6.0	5.9
Anti-infl. exc. Glucosamine	8.8	9.8	8.2	7.1	4.9	4.6	4.2	4.7
Glucosamine	3.3	3.8	1.1	1.0	3.1	4.1	1.8	1.4
Analgesic	11.0	15.6	15.9	15.3	2.7	3.7	3.8	3.6
Acid related disorders	25.0	29.0	31.6	33.1	8.5	8.7	9.7	11.7
n[1]	1,991	2,348	1,971	1,559	1,822	2,463	2,294	2,054

Source: Authors' analysis of TILDA data.

Notes: *Descriptive statistics for characteristics of sample reported in Supplementary File Table S-1. W1/W2/W3/W4: Wave 1/2/3/4.

[1] The pre-policy Wave 1 sample size for the group with Medical Cards and those without Medical Cards is smaller than that for Wave 2 since the pre-policy Wave 1 sample contains only the interviews for the pre-policy only period (i.e. Wave 1 interviews before October 2010; the remainder of the Wave 1 interviews, those from October 2010 onwards, are excluded for the purposes of displaying the descriptive statistics). The final sample sizes for analysis across the waves and the groups are described fully in Table 3.

3.2 Main DID Results

A statistically significant higher relative growth in medicines use among medical cardholders compared to the 'private' group who did not have a Medical Card was confirmed in the DID estimates in Table 5 (full set of results available in Supplementary Table S-2). Adjusting for age, demographic and socioeconomic characteristics, private health insurance, health behaviours and health, the positive DID estimate is slightly attenuated, but remains highly statistically significant. This is also the case when the model is further adjusted for the list of chronic conditions. Using the estimates of Model 3, between the periods of free prescriptions and that of a €0.50 levy, medicines use increased by more than one-third of a medication.

Table 5: DID Estimate on Number of Medicines and Polypharmacy

	€0 to €0.50			€0 to €2.50		
	(1)	(2)	(3)	(1)	(2)	(3)
Number of medicines	**0.419*** **	**0.421*** **	**0.367*** **	**0.598*** **	**0.606*** **	**0.533*** **
	(0.072)	**0.073)**	**(0.071)**	**(0.083)**	**(0.082)**	**(0.080)**
Constant	2.593***	–3.428	–1.913	2.462***	–3.412	–3.577
	(0.022)	(3.959)	(4.488)	(0.419)	(3.007)	(2.974)
R^2	0.049	0.236	0.404	0.073	0.260	0.394
No. observations	9,355	9,355	9,355	11,691	11,691	11,691
No. individuals	6,110	6,110	6,110	5,938	5,938	5,938
Polypharmacy	**0.074*** **	**0.076*** **	**0.069*** **	**0.085*** **	**0.088*** **	**0.077*** **
	(0.015)	**(0.015)**	**(0.015)**	**(0.015)**	**(0.015)**	**(0.015)**
Constant	0.211	–1.598	–1.378	0.114	–0.676	–0.653
R^2	0.047	0.128	0.197	0.109	0.177	0.252
No. observations	9,355	9,355	9,355	11,691	11,691	11,691
No. individuals	6,110	6,110	6,110	5,938	5,938	5,938

Source: Authors' analysis of TILDA data.

Notes: Statistical significance: + p<0.1, *p<0.05, **p<0.01, ***p<0.001. Robust standard errors in parentheses.

Outcomes – number of medicines and binary variable of polypharmacy – are modelled as ordinary least square regression (linear probability model in case of polypharmacy).

Model 1: Basic DID.

Model 2: Model 1 adjusted for age, marital status, employment status, equivalised household income, private health insurance, self-rated health, any difficulties with instrumental activities in daily living (IADLs), mental health score, smoking, problematic alcohol, physical activity – full results in Supplementary File Table S-2.

Model 3: Model 2 further adjusting for chronic conditions: hypertension, diabetes, had a heart attack, had a stroke, had a transient ischemic attack (TIA – mini stroke), heart failure, lung disease, osteoporosis, arthritis and 'often troubled by pain'.

Full results for number of medicines displayed in Table S-2 in Supplementary File. All results available on request from authors.

The average treatment effect on the treated was a 9.9 per cent increase in medicines (based on an average of 3.7 medicines for medical cardholders in the pre-policy period). Between the periods of free prescriptions and that of the €2.50 charge, the number of medicines increased by approximately half a medication, representing a 14.4 per cent increase for the treatment group.

An upward trend was also estimated for polypharmacy, with a 6.9 percentage point (p.p.) growth in polypharmacy estimated between the €0 to €0.50 periods, and a 7.7 p.p. increase for the €0 to €2.50 periods.

Table 6 shows that for the majority of 'essential' medicines, cost sharing did not affect use. However, a positive, statistically significant effect on the use of mental health-related drugs was estimated – a 1.7 p.p. increase in anti-psychotics and a 3.1 p.p. increase in anti-depressants. For 'discretionary' medicines, a small relative reduction in anti-inflammatories was estimated, while there was a positive, statistically significant growth in analgesics and acid-related drugs. Discretionary drugs used in the management of mental health conditions, such as anti-anxiety medicines, were estimated to increase by 2.0 percentage points.

Table 6: DID estimates on Medicines by Therapeutic Class – Split by Essential and Discretionary (Fully Adjusted Model 3 Estimates)

'Essential' medicines			*'Discretionary' medicines*		
	€0 to €0.50	*€0 to €2.50*		*€0 to €0.50*	*€0 to €2.50*
Lipid modifiers	–0.021	–0.003	Anxiolytic/hypnotic	0.018*	0.020**
	(0.016)	(0.017)		(0.009)	(0.008)
[Lipid modifiers excluding Omega-3]	0.003	0.001	Omega-3	–0.019	0.004
	(0.014)	(0.016)		(0.012)	–(0.009)
Statins	–0.010	–0.012	Anti-inflammatory	–0.014	**–0.038****
	(0.013)	(0.016)		(0.013)	**(0.013)**
Anti-psychotic	0.011*	**0.017*****	[Anti-inf. exc.	–0.006	**–0.032****
	(0.004)	**(0.005)**	Glucosamine]	(0.011)	**(0.011)**
Antidepressant	0.004	**0.031****	[Glucosamine]	–0.007	–0.009
	(0.009)	**(0.010)**		(0.008)	(0.008)
Antihypertensive	0.009	–0.003	Analgesic	**0.054*****	**0.039****
	(0.012)	(0.014)		**(0.012)**	**(0.011)**
[Antihypertensive in the C02 group]	–0.002	0.001	Drugs for acid related disorders	**0.047*****	**0.070*****
	(0.004)	(0.005)		**(0.012)**	**(0.014)**
[Diuretic]	–0.001	0.013			
	(0.008)	(0.010)		–	–

Table 6: DID estimates on Medicines by Therapeutic Class – Split by Essential and Discretionary (Fully Adjusted Model 3 Estimates) (Contd.)

'Essential' medicines			*'Discretionary' medicines*		
	€0 to €0.50	*€0 to €2.50*		*€0 to €0.50*	*€0 to €2.50*
[Beta blocker]	0.021*	0.013			
	(0.009)	(0.012)		–	–
[Calcium channel blocker]	0.000 (0.010)	0.020 (0.012)		–	–
[ACE Inhibitor]	–0.006	–0.030*			
	(0.010)	(0.012)		–	–
[Angiotensin 2 Antagonists]	0.017+ (0.009)	0.004 (0.011)		–	–
Diabetic medication	0.006 (0.005)	0.002 (0.006)		–	–
[Diabetes type 1 (insulin)]	0.002 (0.003)	–0.002 (0.003)		–	–
[Diabetes type 2 (non-insulin)]	0.006 (0.005)	0.005 (0.006)		–	–
Obstructive airway disease (COPD)	0.015+ (0.008)	0.019* (0.009)		–	–
Anti-thrombotic	0.026*	0.028+			
	(0.013)	(0.014)		–	–
[Anti-platelet]	0.010	–0.005			
	(0.013)	(0.014)		–	–
[Anti-platelet exc. Aspirin]	–0.007 (0.007)	–0.022** (0.008)		–	–
[Aspirin]	0.009	0.005			
	(0.012)	(0.014)		–	–
[Anticoagulant]	**0.021*** (0.006)**	**0.035*** (0.008)**		–	–
No. observations	9,355	11,691	No. observations	9,355	11,691
No. individuals	6,110	5,938	No. individuals	6,110	5,938

Source: Authors' analysis of TILDA data.

Notes: Statistical significance: + p<0.1, *p<0.05, **p<0.01, ***p<0.001. Robust standard errors in parentheses. Since there are 28 outcomes, an alpha value of p<0.002 was used as the threshold to account for multiple hypothesis testing; the outcomes which survive multiple hypothesis testing are highlighted in bold.

Covariate adjustment for Model 3. Outcomes modelled as linear probability models (ordinary least square regression).

All results available on request from authors.

3.3 Sensitivity Analyses

A number of alternative analyses were performed to verify robustness of the results (see Supplementary File Table S-3). First, the analysis was carried out including those whose Medical Card status had changed; the estimated results were similar to the main analysis. Second, a number of sub-group analyses were conducted: the analysis was carried out separately for under 70-year-olds and those aged 70 and over (as over 70s faced lower payments and monthly thresholds after March 2017; see also Table 1 and Supplementary File Figure S-1), with little difference found from the main analysis. The estimates from the age groups 50-60 and 60-70 years were also similar. Third, an investigation was conducted for the household level; couples, and those living in the same household were identified. The household level analysis carried a positive, statistically significant DID coefficient, with slightly larger magnitudes to those estimated at the individual level. Fourth, an alternate control group consisting of respondents who were GP visit cardholders – entitled to free GP visits, but subject to the full cost of medicines – was used to check results. However, this control group is impaired by a lack of power since only a small proportion of the Irish population claim GP visit cards (Callan *et al*., 2017); 1.7 per cent of pre-policy TILDA respondents fell in this group. This yielded positive but statistically non-significant estimates.

A falsification analysis was also performed on an alternative outcome, the number of medicines which are not reimbursed by State schemes (i.e. over the counter medicines not subject to a co-payment), which should be unaffected by cost sharing. There was no evidence of an impact on these medicines (Supplementary Table S-3).

In addition, a DID propensity score matching (PSM) exercise was conducted. The set-up of the treatment and control groups was different to that of the main DID. One PSM DID compared TILDA respondents who gained a Medical Card between Waves 1 and 2 with respondents who remained without a Medical Card. A second analysis compared respondents who lost their Medical Card, with respondents who always had a Medical Card (Ma and Nolan, 2017). As demonstrated in Supplementary File Tables S-4 to S-6, the result on the PSM DID for those who gained Medical Card status also found a positive effect, but the results were less statistically robust. The loss of a Medical Card, resulting in former medical cardholders paying the full cost of prescriptions, was estimated to reduce the relative use of medicines, but the estimated effects were largely non-significant.

IV DISCUSSION

4.1 Explaining the Result

The descriptive evidence and the DID analysis presented in this paper suggests that medical cardholders experienced a relative increase in medicines use despite the

cost sharing policy. The growth in medicines for the medical cardholder group over time, relative to the base, was greater than that for the private group without a Medical Card.

The size of the co-payments at €0.50, increased to €2.50, is modest and appears not to present a barrier to access in this analysis. The provision of a ceiling on monthly medication costs may be protective for households with high volumes of prescriptions. A question included only in Wave 4 of TILDA (when a €2.50 co-payment was in place) asked whether respondents did not fill their prescriptions because medications were too expensive. Only 1.7 per cent reported this problem, with the rate slightly lower for medical cardholders (1.6 per cent). The discount on medicines for medical cardholders is substantial even with a co-payment. It may be that the relatively larger cost of drugs for private patients is tempering their growth of medicines, while the small relative price for medical cardholders does not discourage medicines use.

The findings of this study are supportive of qualitative evidence concerning cost sharing in Ireland (Sinnott *et al*., 2013b). Participants held a belief that medicines were too important to discontinue, with some reporting they would sacrifice other things before foregoing medicines. A reported financial burden of medicines was not found to affect prescriptions filled for antihypertensive drugs despite a €2.50 co-payment (Dillon *et al*., 2018). Other international studies attribute a lack of effect of co-payments to patients' high personal valuation of drugs, modest levies, the absence of substitutes and the prioritisation of medicines relative to other expenditures (Linnet *et al*., 2013; Ong *et al*., 2003; Pilote *et al*., 2002).

There is some debate as to whether charging a price for a good causes consumers to place a higher value on that good and use it more (Gourville and Souman, 2002; Hoffmann *et al*., 2009; Shampanier *et al*., 2007; Thomas *et al*., 2004). Price acts as a signal for value, and consumers may value items more highly if they are more expensive or costly to procure (Cialdini, 2009; Norton *et al*., 2012; Thomas *et al*., 2004). It could be that where medical cardholders face a charge for prescriptions they previously obtained for free, their perceived value may increase, resulting in greater use. In a qualitative study from Ireland, pharmacists commented that some patients subject to co-payments for medicines felt they were getting good value for their money (Brien *et al*., 2020).

Another explanation of the positive direction of 'effect' may be that of accumulating stressors. Since Medical Card eligibility is means tested, this group represents individuals from lower socio-economic positions. Medical cardholders had more health problems throughout TILDA, with poorer self-rated health, higher mental distress scores and more chronic conditions (as seen in Supplementary File Table S-1). They had poorer health behaviours as evidenced by greater levels of smoking, lower physical activity and more problematic alcohol use. It is possible that such influences along with other unobserved aspects of deprivation, culture,

location and access may combine as a cocktail of 'accumulating stressors'. The progression of similar health conditions may be more severe for medical cardholders than for the group who do not have a Medical Card, requiring greater medicalisation. Owing to this, the expected tempering effect of cost sharing may be crowded out. Accumulating stressors have been used to explain the persistence of poorer health in Scotland (Cowley *et al*., 2016) and the US (Barker *et al*., 2010).

The ability to obtain free-of-charge access to primary care itself may increase treatment among medical cardholders, compared to private patients. Previous TILDA research demonstrated that Medical Cards increased the propensity of receiving treatment among those with high blood pressure or cholesterol (Murphy *et al*., 2016). In one study of the TILDA cohort, proximity to death was found to be associated with prescription medicine expenditure (Moore *et al*., 2017). Proximity to death is unobserved in the study presented in this paper, but it may be that TILDA medical cardholders are closer to death than their private patient counterparts (regardless of age), resulting in higher relative growth in medicines.

The increase in medicines may also be attributable to changes in prescribing behaviour (Lundin, 2000). The monthly ceiling may provide an incentive to prescribers and patients with high volumes of medicines to load additional medications onto prescriptions since, after the threshold is reached, additional items would be free-of-charge. To explore this possibility, we examined tertiles and quintiles of medicines use. The growth in medicines was concentrated among the quantiles with lower volumes of medicines, and for those with higher volumes the growth was small. Therefore, it was not evident that greater medicines use was due to an incentive to add extra items where the monthly limit may have been reached.

In terms of medications use by therapeutic type, reductions in lipid modifying drugs, statins, antihypertensive drugs or anti-depressants were not found, which differs from previous research using prescribing claims data (Sinnott *et al*., 2017; 2013a). The relative use of mental health drugs intensified, lending support to the accumulating stressors theory. A study of patients treated for depression found that higher cost sharing was associated with higher use of selective serotonin reuptake inhibitor drugs (Berndt *et al*., 1997). The reduction in the use of Omega-3 and Glucosamine may be explained by the delisting of these medicines from State schemes in September 2012.

4.2 Strengths and Limitations

TILDA offered a large sample size with a panel structure. The number of medicines used regularly, and the name of medicines (permitting classification) held in the home of respondents was recorded, providing outcomes that were expected to be directly affected by cost sharing.

However, since TILDA is used as a secondary source of data to inform this research, other information which would have been useful for the purposes of this research was not collected, for example, details on payments made for medicines

on an out-of-pocket basis, and the costs of medicines experienced by private patients (those without a Medical Card). Furthermore, TILDA only collected data for one pre-policy period; thus, the investigation of trends in medicines use between medical cardholders and those without Medical Cards was limited to the pre-policy months in Wave 1. Another limitation of our study is that physician-prescribing practices (Lundin, 2000) were unobserved.

4.3 Implications for Research and Policy

In contrast to the majority of existing studies, we did not discover a drop in medicines use arising from the introduction of small co-payments on prescription items for an 'at risk' group of older people. From a policy perspective, this is an encouraging result. While a growth in medicines use was observed for the medical cardholder group, we do not believe that co-payments in themselves are causing this uplift, rather the positive effect arises from the greater intensity of usage of medicines among older people with Medical Cards.

Mindful of the large body of evidence that finds undesirable effects, cost sharing must continue to be approached prudently. Co-payments must not present a barrier to the use of cheap, cost-effective medicines (Dillon *et al*., 2018). Efforts to contain costs on the supply side should be pursued to minimise patient burden. On the patient-physician and dispensary side, patients must be sufficiently informed as to the importance of medicines adherence, particularly for asymptomatic conditions.

This study does not suggest an optimal co-payment size, though it may be noted that GPs and pharmacists in Ireland appeared to favour the lower €0.50 fee in a qualitative study (Brien *et al*., 2020).

In terms of the research agenda going forward, we note the differential increase in medicines use over the timeframe of the TILDA cohort between the Medical Card group and that of the group of private patients, which would suggest that these groups are experiencing differentially increasing medical need. Future research could assess these trends for other healthcare services such as the use of GP services, Emergency Department attendances and nights spent in hospital. Such investigations could help better understand the variance in medical need between the groups, as well as relationships between medicines use and the use of healthcare services.

Furthermore, as outlined in Table 1, from March 2017 the Irish Government has made a series of policy changes to reduce co-payments for medical cardholders. The reductions have been implemented as part of political commitments outlined in the *Programme for Government* (Irish Government, 2016; 2020). The most recent co-payment change announced as part of the budget for the financial year 2020/2021 reduces co-payments to €1 for over 70s with a monthly cap of €10, and for those under 70 the co-payment is €1.50 with a cap of €15 a month. The threshold for DPS was also lowered to €114. The future availability of TILDA data

collected for years which coincide with reductions in the co-payments and the impacts of this on medicines use also merit examination in future research.

4.4 Conclusion

The results provide the research and policymaking community with alternative evidence concerning the impact of cost sharing in medicines for older people in a European country. Drug use increased notwithstanding the introduction of cost sharing for an older, low income population. It would appear that the modest pecuniary size of two different iterations of the levy, €0.50 and €2.50, was not a deterrent. Given the strong growth in medicines use among the treatment group over time (Figure 1a), the findings suggest that the increasing trends for medicines use in the TILDA cohort outweigh any disincentive effect the introduction of co-payment on prescription drugs may have. The continued rise in the use of medicines for treating mental health conditions may also indicate that older, publicly insured individuals may have experienced accumulating stressors. These findings highlight the importance of considering specific contexts and healthcare systems in interpreting existing evidence. This work aims to inform healthcare policymakers on this specific pharmaceutical policy as Ireland is currently in the process of attempting to deliver whole system reform and universal healthcare known as Sláintecare for all its citizens.

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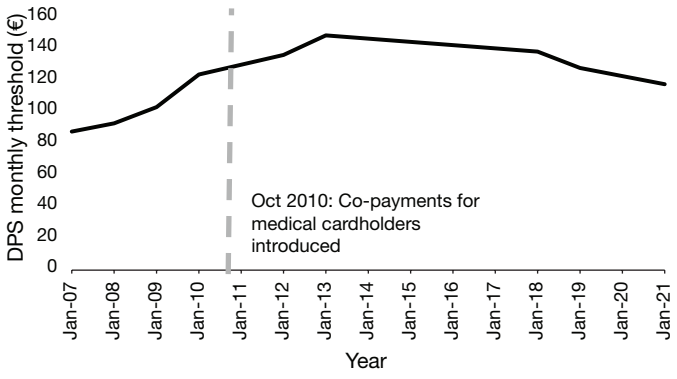
The Introduction of Cost Sharing for Prescription Drugs: Evidence from The Irish Longitudinal Study of Ageing (TILDA)

Supplementary File

Additional background information

1. Changes to the Drugs Payment Scheme (DPS)

Figure S-1: Changes to the DPS Threshold Over Time



Year	DPS monthly threshold (€)
Jan-07	85
Jan-08	90
Jan-09	100
Jan-10	120
Jan-12	132
Jan-13	144
Jan-18	134
Jan-19	124
Nov-20	114

Source: Authors' analysis of Department of Health and HSE information.

Wording on Question Which Informs Outcome Variable 'Number of Medicines Used' in TILDA

Number of medicines:
Wave 1,2,3,4:

"Now I would like to record all medications that [you/Rname] [take/takes] on a regular basis, like every day or every week. This will include prescription and non-prescription medications, over-the-counter medicines, vitamins, and herbal and alternative medicines."

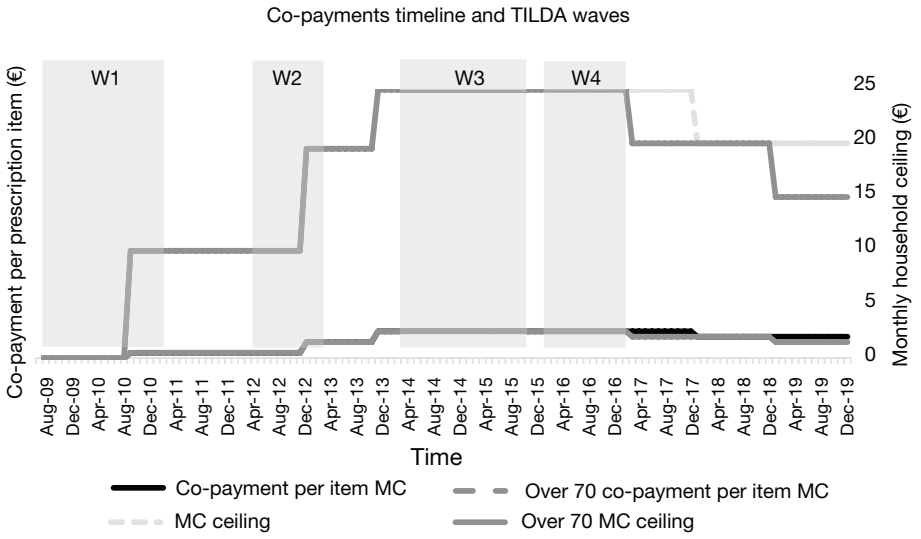
Question prescription or over the counter asked only in Waves 2, 3 and 4.

Was this medication prescribed by a doctor or did you get it over the counter?

1. Prescribed by a doctor
2. Over the counter

Figure S-2 outlines the periods of collection of TILDA data (e.g. W1 – Wave 1) and the changes to co-payments per prescription item and the household monthly ceiling for medical cardholders (MC).

Figure S-2: Changes to the Co-payments Policy and TILDA Timeline



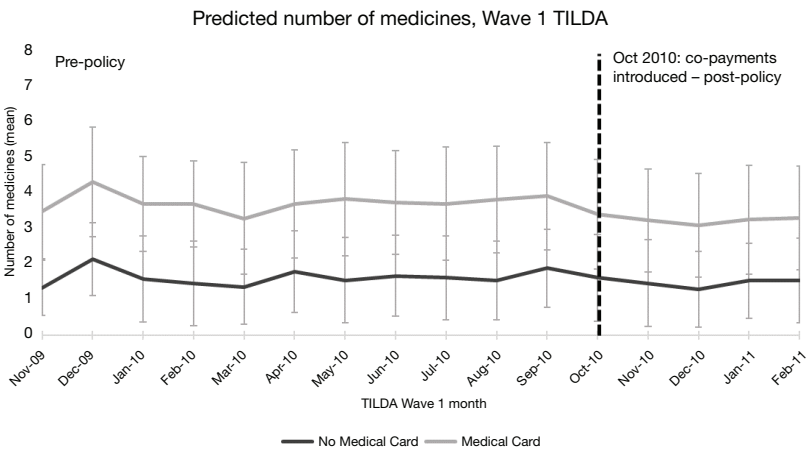
Source: Authors' analysis of TILDA data.

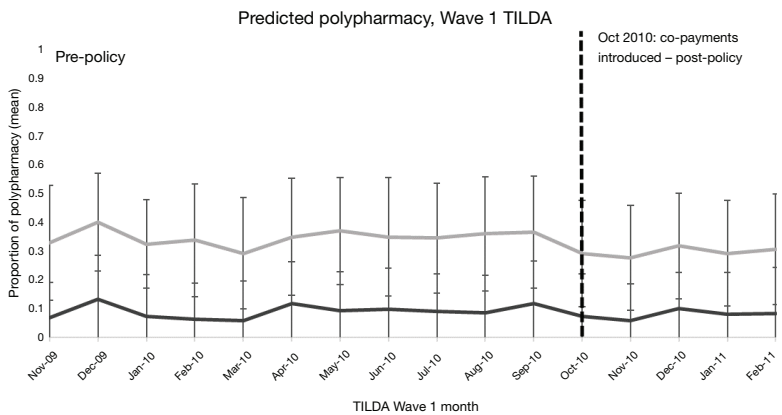
2. Parallel trends investigation

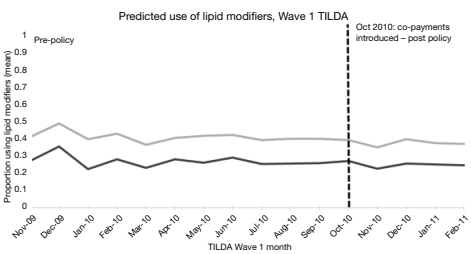
The validity of DID relies on the 'parallel trends' assumption, which assumes that in the absence of treatment, the difference between the 'treatment' and 'control' groups is constant over time. Observing the trends between the groups before a policy change provides an indication as to the likelihood of parallel trends between the groups (Walsh *et al.*, 2019). Since the TILDA dataset only has a single wave of pre-policy data, it is challenging to assess parallel trends. However, we exploit the data collected for 12 months pre-policy within the first wave, for the period October 2009 to September 2011, and we plot the predicted number of medicines in the medical cardholder groups and that for the group without Medical Cards, to examine parallel trends in Figure S-3.

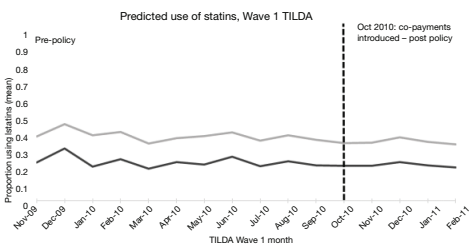
The predicted outcomes, number of medicines, polypharmacy and the main medications types were obtained from a regression on the treatment variable, the months of data collection, and the individual-level demographic, socioeconomic and health covariates used in the main DID estimation. The remaining post-policy months in Wave 1 of TILDA were also plotted. Figure 1 (a) and (b) in the main manuscript shows that the predicted number of medicines and polypharmacy was higher for medical cardholders prior to the policy and remained so following the policy. Figure S-3 demonstrates that the trends between medical cardholders and non-medical cardholders were broadly similar pre-policy for the outcome variables of interest.

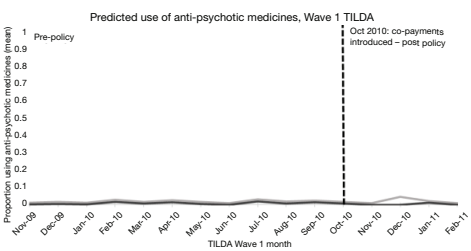
Figure S-3: Predicted Number of Medicines, Polypharmacy and Medications by Type in Wave 1 of TILDA, Pre- and Post-Policy











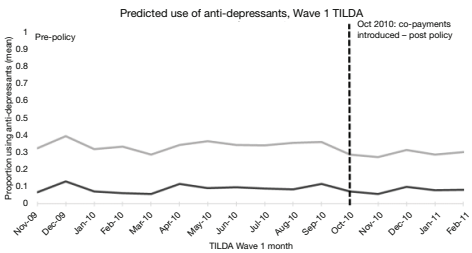
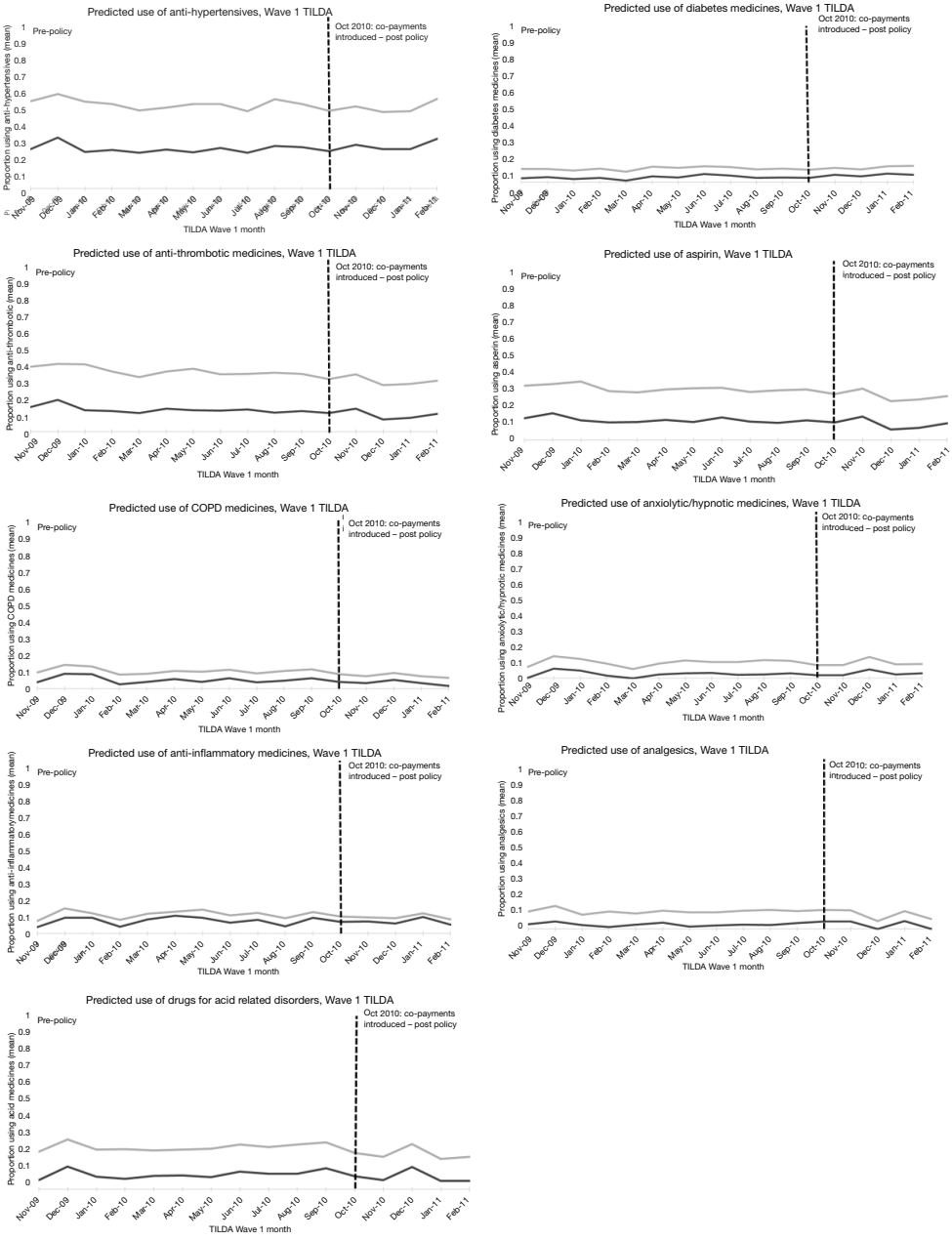


Figure S-3: Predicted Number of Medicines, Polypharmacy and Medications by Type in Wave 1 of TILDA, Pre- and Post-Policy (Contd.)



Source: Authors' analysis of TILDA data.

3. Descriptive Statistics of Sample Used for analysis Across Waves of TILDA – Disaggregated by Medical Card Status

Table S-1: Characteristics of the TILDA Sample Across Four Waves of TILDA – Broken Down by Medical Card Status

Sample broken down by Medical Card status	*Wave*							
	1 *(pre-policy)*		*2*		*3*		*4*	
Covariate characteristic	MC	No-MC	MC	No-MC	MC	No-MC	MC	No-MC
Female (%)	55.3	45.5	55.8	51.6	57.4	51.7	57.7	51.9
Age (mean)	69.1	58.1	70.4	58.9	71.8	62.0	73.2	64.1
Married (%)	54.1	77.8	54.5	78.8	53.2	78.1	52.0	77.6
Never married (%)	12.0	10.0	11.7	8.2	11.6	7.9	11.6	8.1
Separated/Divorced (%)	8.4	6.5	9.2	6.3	9.8	6.4	9.7	6.6
Widow (%)	25.5	5.8	24.6	6.7	25.4	7.7	26.8	7.7
Primary education (%)	50.5	11.1	48.2	10.8	46.5	9.9	44.0	9.2
Secondary education (%)	36.1	41.8	37.1	39.8	37.6	39.4	39.1	39.1
Tertiary education (%)	13.5	47.2	14.7	49.4	15.9	50.7	16.9	51.8
Employment (%)	10.8	64.5	10.8	58.6	9.9	55.1	9.8	50.7
Retired (%)	52.4	22.3	53.6	27.7	58.0	33.2	59.3	39.5
Unemployed (%)	6.0	3.4	5.1	2.4	5.1	1.7	3.9	1.1
All other employment states (%)	30.8	9.8	30.5	11.3	26.7	9.8	27.0	8.7
Equivalised household income (mean)	15,109	35,038	16,617	33,795	16,043	34,408	16,009	34,031
Private health insurance (%)	30.1	81.2	29.1	81.8	27.3	82.1	27.6	82.9
Self-rated health excellent (%)	8.8	23.8	7.7	22.1	7.3	20.5	6.9	19.8
Self-rated health very good (%)	21.4	34.7	24.8	39.7	23.9	40.2	25.9	41.9
Self-rated health good (%)	33.9	30.6	37.4	30.2	39.6	30.4	41.1	30.2

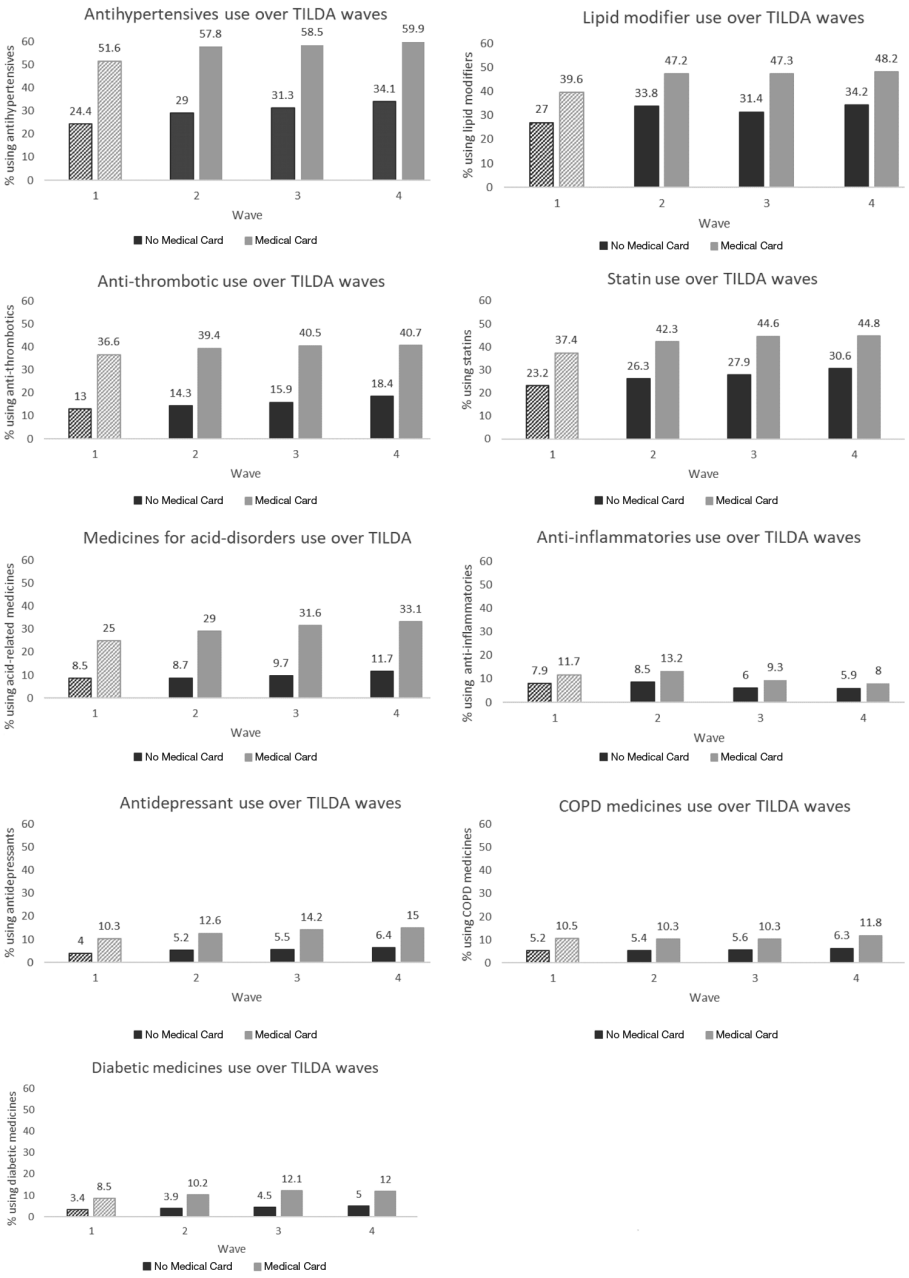
Table S-1: Characteristics of the TILDA Sample Across Four Waves of TILDA – Broken Down by Medical Card Status (Contd.)

Sample broken down by Medical Card status	*Wave*							
	1 (pre-policy)		*2*		*3*		*4*	
Self-rated health fair/poor (%)	35.9	11.0	30.1	8.0	29.2	8.9	26.1	
8.1Long term health problem (%)	50.7	70.8	47.3	69.3	46.3	68.2	48.8	67.3
Any (I)ADL (%)	21.3	5.3	16.1	3.3	15.7	3.1	16.7	4.2
Mental health score (mean)	3.7	2.2	3.4	2.3	4.0	2.6	3.8	2.6
Currently smoking (%)	21.4	14.6	19.8	12.0	16.4	9.2	16.2	8.6
Problematic alcohol (%)	8.5	16.4	10.0	16.4	9.0	16.3	8.6	15.5
Moderate/high physical activity (%)	61.0	75.5	60.7	77.4	52.1	72.0	53.1	71.0
Hypertension (%)	45.4	26.6	46.0	26.6	42.9	25.7	45.4	27.7
Diabetes (%)	10.3	4.7	12.3	5.0	13.1	5.5	13.8	5.7
Had a heart attack (%)	7.9	2.2	8.1	2.4	7.7	3.1	8.1	2.9
Had a stroke (%)	2.9	0.4	3.5	0.3	3.5	0.6	3.1	0.8
Had a TIA (mini stoke) (%)	3.1	1.2	4.5	1.3	5.3	1.6	5.7	2.0
Heart failure (%)	1.7	0.6	1.9	0.5	1.3	0.4	1.1	0.5
Lung disease (%)	6.5	2.3	6.7	2.3	6.2	2.8	5.4	2.7
Osteoporosis (%)	11.8	6.2	17.0	11.2	17.3	11.7	19.3	12.6
Arthritis (%)	36.7	16.9	43.2	21.9	45.8	23.9	48.1	25.3
Often troubled by pain (%)	43.9	27.2	41.7	27.1	44.0	27.9	42.9	26.5
No. individuals	1,911	1,822	2,348	2,463	1,971	2,294	1,559	2,054

Source: Authors' analysis of TILDA data.

4. Growth of Use of Medicines by Main Therapeutic Class

Figure S-4: Growth of Use of Medicines by Main Therapeutic Class Across TILDA Waves



Source: Authors' analysis of TILDA data.

5. Full DID Results

Table S-2: Results from DID Modelling on Number of Medicines

	€0 to €0.50			€0 to €2.50		
	(1)	*(2)*	*(3)*	*(1)*	*(2)*	*(3)*
Co-payment period	–0.087	–0.142^{+}	–0.154^{+}	0.381***	0.001	–0.054
	(0.090)	(0.093)	(0.093)	(0.046)	(0.217)	(0.214)
DID: Medical card*	0.419***	0.421***	0.367***	0.598***	0.606***	0.533***
Co-payment period	(0.072)	(0.073)	(0.071)	(0.083)	(0.082)	(0.080)
Wave	0.530***	0.403**	0.426**	0.328***	0.153	0.153
	(0.080)	(0.146)	(0.144)	(0.032)	(0.107)	(0.107)
Male	/	/	/	/	/	/
Age		0.084	0.053		0.080^{+}	0.077
		(0.072)	(0.071)		(0.047)	(0.047)
Base – Married						
Single		–0.785^{+}	–0.767^{+}		0.073	0.177
		(0.442)	(0.449)		(0.394)	(0.384)
Separated/divorced		–0.484	–0.488		–0.019	0.037
		(0.410)	(0.410)		(0.263)	(0.262)
Widowed		0.023	0.025		–0.010	0.034
		(2.252)	(0.250)		(0.190)	(0.187)
Base – Employed/self employed						
Retired		0.076	0.104		0.070	0.073
		(0.107)	(0.105)		(0.076)	(0.073)
Unemployed		0.133	0.110		0.189	0.180
		(0.147)	(0.143)		(0.123)	(0.117)
All other employed		0.190	0.197		0.217**	0.223*
states		(0.119)	(0.117)		(0.098)	(0.097)

Table S-2: Results from DID Modelling on Number of Medicines (Contd.)

	€0 to €0.50			*€0 to €2.50*		
	(1)	*(2)*	*(3)*	*(1)*	*(2)*	*(3)*
Log of equivalised household income		0.049 (0.031)	0.050 (0.030)		0.053* (0.025)	0.050* (0.025)
Health insurance		–0.0201 (0.168)	–0.184 (0.163)		–0.020 (0.140)	–0.046 (0.135)
Base – Self-rated health excellent						
Very good health		0.080 (0.066)	0.063 (0.064)		0.095 (0.059)	0.057 (0.055)
Good health		0.119* (0.085)	0.148* 0.083)		0.322*** (0.072)	0.233*** (0.068)
Fair/poor health		0.538*** (0.123)	0.424*** (0.121)		0.711*** (0.111)	0.565*** (0.105)
Any ADL		0.169 (0.130)	0.145 (0.128)		0.206^{+} (0.112)	0.242^{+} (0.113)
Depression score		0.011 (0.012)	0.011 (0.012)		0.001 (0.009)	0.001 (0.009)
Current smoker		0.085 (0.494)	0.132 (0.488)		–0.367** (0.150)	–0.323** (0.146)
Problematic alcohol		0.186^{+} (0.098)	0.194^{+} (0.096)		0.049 (0.087)	0.028 (0.083)
Physically active		0.113^{+} (0.065)	$–0.110^{+}$ (0.065)		–0.005 (0.054)	0.004 (0.052)
Hypertension			0.571*** (0.099)			0.566*** (0.082)
Diabetes			0.686** (0.226)			1.137*** (0.185)

Table S-2: Results from DID Modelling on Number of Medicines (Contd.)

	€0 to €0.50			€0 to €2.50		
	(1)	*(2)*	*(3)*	*(1)*	*(2)*	*(3)*
Heart attack			0.581			2.447***
			(0.574)			(0.328)
Stroke			0.666			0.284
			(0.615)			(0.491)
TIA – mini stroke			1.364			0.521^{+}
			(0.658)			(0.315)
Heart failure			1.119**			0.400
			(0.400)			(0.509)
Osteoporosis			0.417**			0.415***
			(0.131)			(0.114)
Arthritis			0.296*			0.041
			(0.119)			(0.098)
Lung disease			0.227			0.513*
			(0.257)			(0.216)
Often troubled by pain			0.039			0.092
			(0.066)			(0.056)
Constant	2.593***	–2.199	–1.913	2.462***	–3.412	–3.577
	(0.022)	(3.959)	(4.488)	(0.419)	(3.007)	(2.974)
R^2	0.049	0.336	0.404	0.073	0.260	0.394
No. observations	9,355	9,355	9,355	11,691	11,691	11,691
No. individuals	6,110	6,110	6,110	5,938	5,938	5,938

Source: Authors' analysis of TILDA data.
Statistical significance + p < 0.1, * p < 0.05, ** p < 0.01, *** p <0 .001. Robust standard errors.

6. Sensitivity Analyses Results

Table S-3: DID Coefficient Estimates from Sensitivity Analyses (Full Model Specification -Model (3))

Alternate sample			*Subgroups*							
	Keeping respondents whose Medicl Card status changes		*Under 70s*		*50–60*		*60–70*		*Over 70s*	
			Main analysis sample (i.e. dropping those whose Medical Card status changes)							
	€0 to €0.50	*€0 to €2.50*	*€0 to €0.50*	*€0 to €2.50*	*€0 to €0.50*	*€0 to €2.50*	*€0 to €0.50*	*€0 to €2.50*	*€0 to €0.50*	*€0 to €2.50*
Number of medicines	0.370*** (0.067)	0.514*** (0.076)	0.443*** (0.096)	0.412*** (0.114)	0.390** (0.138)	0.549** (0.178)	0.406** (0.147)	0.597** (0.196)	0.392*** (0.094)	0.486** (0.112)
Polypharmacy	0.067*** (0.014)	0.081*** (0.014)	0.079*** (0.019)	0.062*** (0.021)	0.061* (0.026)	0.0648 (0.032)	0.079* (0.029)	0.077* (0.034)	0.076*** (0.019)	0.069** (0.020)
No. observations	11,203	14,211	6,481	7,705	3,935	3,940	3,129	4,604	6,723	8,058
No. individuals	7,273	7,106	4,313	4,123	2,693	2,445	2,244	2,901	4,473	4,297

Statistical significance: + p<0.1, *p<0.05, **p<0.01, ***p<0.001. Robust standard errors.
Outcomes – number of medicines and binary of polypharmacy – are modelled as ordinary least square regression (linear probability model in case of polypharmacy).

Table S-3: DID Coefficient Estimates from Sensitivity Analyses (Full Model Specification -Model (3)) (Contd.)

	Alternative unit of		*Alternative control group*			*Alternative outcome*	
	Household		*GP visit cardholders as the control group*			*Main analysis sample*	
	€0 to €0.50	*€0 to €2.50*	*€0 to €0.50*	*€0 to €2.50*		*€0 to €0.50*	*€0 to €2.50*
Number of medicines	0.507*** (0.101)	0.625*** (0.115)	0.381 (0.336)	–0.234 (0.340)	Number of non-reimbursable medicines	–0.001 (0.029)	0.014 (0.026)
Polypharmacy	/	/	0.109 0.084	0.010 (0.077)			
No. observations	11,586	14,475	5,804	7,642	No. observations	9,355	11,691
No. individuals	7,415	7,184	3,921	4,301	No. individuals	6,110	5,938

Source: Authors' analysis of TILDA data.

7. Propensity Score Matching

A DID propensity score matching (PSM) exercise was also conducted to check the sensitivity of the results generated from the main DID analysis. The set-up of the treatment and control groups was different under the PSM DID arrangement. One PSM DID analysis compared TILDA respondents who gained a Medical Card between Waves 1 and 2, with TILDA respondents who remained without a Medical Card over the same period. A second analysis compared TILDA respondents who lost their Medical Card status between Waves 1 and 2, with respondents who always had a Medical Card in the two periods (Ma and Nolan, 2017).

For both DID PSM analyses, a probit regression was used to estimate a propensity score for TILDA participants to the treatment group based on a set of control variables (measured at Wave 1). Then, observations in the treatment group were matched with observations in the control group according to their estimated propensity scores. Nearest neighbour one-to-one matching was used to match, computing the average treatment effect on the treated (ATT) by selecting the one comparison unit whose propensity score is the nearest to the treated unit in question. Kernel matching was also used, which matched all the treated units with a weighted average of all controls. The difference in average changes in medicines use for the two matched groups was estimated. This gives estimates of the average treatment effect of changing Medical Card status on medicines use. The summary statistics for the PSM DID (Supplementary File Table S-4 to Table S-6) indicate that for those who gained a Medical Card, their growth in medicines between Waves 1 and 2 was greater than the control of those who never had Medical Card eligibility. For those who lost their Medical Card status, their growth in medicines was smaller between the waves, than the control group of those who always had Medical Card status. A positive effect of the co-payments policy was estimated in Table S-6 comparing those who gained relative to the control, while a negative effect was estimated for those who lost their Medical Card eligibility, relative to the control.

The result on the PSM DID for those who gained Medical Card status corroborates the findings of the main DID results. The loss of a Medical Card, which results in former medical cardholders paying the full cost of prescriptions, was estimated to reduce the relative use of medicines under PSM DID.

Table S-4: PSM Treatment and Control Groups

1. Gaining a Medical Card	*Wave 1 (Zero co-pay)*	*Wave 2 (€0.50 co-pay)*	*N*
Treatment Group	Private	Public	302
Control Group	Private	Private	2,204
2. Losing a Medical Card	*Wave 1 (Zero co-pay)*	*Wave 2 (€0.50 co-pay)*	*N*
Treatment Group	Public	Private	79
Control Group	Public	Public	1,944

Table S-5: Average Number of Medicines, Treatment and Controls

1. Gaining a Medical Card	*Wave 1 (Zero co-pay)*	*Wave 2 (€0.50 co-pay)*	*Outcome*	*T-statistic (p-value)*
Treatment Group	2.42	3.30	0.88	6.52 (0.000)
Control Group	1.69	2.13	0.44	11.35 (0.000)
2. Losing a Medical Card	*Wave 1 (Zero co-pay)*	*Wave 2 (€0.50 co-pay)*		
Treatment Group	2.22	2.97	0.25	1.82 (0.073)
Control Group	3.56	4.44	0.87	15.45 (0.000)

Source: Authors' analysis of TILDA data.

Table S-6: DID Propensity Score Matching Estimates on Number of Medicines – No Co-Payment jto €0.50 Co-Payment

	Treatment 1 (Gaining Medical Card)	*Treatment 2 (Gaining Medical Card)*
Nearest neighbour	0.086	–0.421
	(0.246)	(0.357)
Nearest neighbour (n=5)	0.301	–0.418
	(0.199)	(0.288)
Nearest neighbour (n=10)	0.332*	–0.432
	(0.163)	(0.250)
Kernel	0.320*	–0.492*
	(0.165)	(0.209)
N	1,770	1,570
Treatment N	222	63
Control N	1,548	1,507

Source: Authors' analysis of TILDA data.
Notes: All specifications were estimated on the common support.
Sample size for modelling reduces because of missingness on household income, which is matching on in Wave 1.
Kernel matching reports bootstrap standard errors (50 replications) in parentheses. *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, +$p < 0.1$.

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