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More Than Meets The Eye: Has the Eye Care Policy in Scotland Had Wider Health Benefits?

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Abstract

Cardiovascular disease is the leading cause of death, accounting for over a quarter of all deaths both worldwide and in the UK. This study examines the effect of eye examinations in diagnosing hypertension. Eye examinations and hypertension are correlated, since people diagnosed with high blood pressure are advised to have their eyes tested and also eye examinations may lead to the prognosis of potential problems related to blood pressure. The study uses the Scottish eye care policy introduced in 2006 as a quasi-experiment. The analysis is based on the British Household Panel Survey. Difference-in-difference regression analysis was used in the multivariate analysis of the impact of free eye examinations on the diagnosis of hypertension. The eye care policy led to an increase in both blood pressure examinations (around 7 percentage points) and in the reporting of high blood pressure (around 3 percentage points). This is evident only for the people from high-income households. The findings provide evidence of the wider health benefits and cost savings that an eye examination can achieve through the early detection of hypertension. The results also suggest that the disparate uptake of eye examinations across income groups not only widens inequalities in eye health, but may also widen inequalities in other health conditions.

Keywords: Eye Examinations; Hypertension; Preventive Care; Natural Experiment

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More Than Meets The Eye: Has the Eye Care Policy in Scotland Had Wider Health Benefits?

1. Introduction

In 2006 the Scottish Government introduced a subsidised eye examination policy, where all people residing in Scotland are entitled to a free eye examination every two years. The redesign of eye care services in Scotland was introduced on 1st April 2006, with the primary aim of increasing the demand for eye examinations and thereby improving the visual health of the Scottish population through the early detection of eye health problems [15]. This redesign of eye care provision had two main aspects. First, the introduction of free eye examinations to all individuals living in Scotland. Previously individuals in Scotland (similar to the rest of the UK) had to pay for sight tests out of pocket at a private optometrist. Only certain groups of individuals were exempt from the out of pocket fee for sight tests, such as those aged under 16 or over 60 years; full-time students aged 16-18 years; those claiming income support or income-based Job Seekers Allowance; those entitled to a NHS Tax Credit Exemption Certificate or a pension credit guarantee credit; those registered blind or partially sighted; those diagnosed with glaucoma or at risk of glaucoma; diagnosed with diabetes; and those with an HC2 or HC3 Certificate. Since the policy change, patients under 16 or above 60 years, individuals with glaucoma or those aged over 40 years with a close family history of glaucoma, patients with ocular hypertension or with diabetes are entitled to a free eye examination every year. All other individuals are entitled to a free eye examination every two years. The policy redesign introduced a subsidised eye examination that allows anyone living in Scotland to have a 'free' eye examination funded by the NHS and carried out at any high street optometry practice. Second, the new eye examination was also a move away from the previous emphasis on a sight test to the introduction of a more comprehensive eye health examination in order to address wider health aspects, such as diabetes, high cholesterol, thyroid disease, cancer and tumours, and high blood pressure or hypertension [16]. This paper explores whether the subsidised eye care policy in Scotland facilitated the detection of one of these health conditions. Specifically, it investigates the policy impact on detecting hypertension.

Hypertension is often characterised as a "silent killer", since there are rarely any signs or symptoms [10]. Early diagnosis would ensure reliable detection of related end organ damage before hypertension becomes symptomatic. The eye examinations in Scotland,

through the detection of hypertensive retinopathy signs, can help in the early prognosis of hypertension. For example, numerous studies have reported the retinal microvascular abnormalities are related to both the presence and severity of hypertension [16].

Hypertensive retinopathy is strongly associated with blood pressure [17] and coronary heart disease [9]. It is estimated that around 7 million people in the UK are living with cardiovascular disease (CVD) [3]. Cardiovascular (heart and circulatory) disease is the leading cause of death, accounting for over a quarter of all deaths both worldwide [10] and in the UK [3]. In addition, there are important financial implications for the health services. The economic burden of CVD, including indirect costs from premature death and disability, is estimated to be over £15 billion each year in the UK. Healthcare costs alone are estimated at up to £11 billion each year [3].

People with high blood pressure are advised to have their eyes tested, but also through eye examinations high blood pressure problems can be detected. In order to disentangle this bi-directional relationship, this study uses the Scottish eye care reform as a quasi-experiment. This policy provided an exogenous increase in eye examinations, although evident only in the high-income households [7, 8], which provides us with a rare opportunity to assess the unintended spill-over effects of such a policy intervention and to identify the causal effect of eye examinations on detecting high blood pressure. Indeed, the analysis using the British Household Panel Survey (BHPS), suggests that the eye care policy led to an increase in blood pressure examinations by around 7 percentage points and an increase in the reported incidence of high blood pressure by around 3 percentage points. However, this is evident only for the people from high-income households, who are also the people that responded positively to the eye care policy by increasing their eye examinations [7, 8].

2. Materials and methods

The paper utilises the British Household Panel Survey to investigate the effect of the introduction of free eye exams on the detection of high blood pressure and the incidence of blood pressure exams. The BHPS is a nationally representative annual survey of adults, covering over 5,000 households in the UK from 1991-2008. It is an appropriate dataset for this study as it collects a wide range of information on both personal and household characteristics as well as health care utilisation. For households included in the survey, all members of the household are usually interviewed and are followed when they leave the household to form new households. The BHPS is an anonymised data set available in the

public domain; therefore no ethics approval was required for this study. Since the BHPS is a panel dataset, there is potential for health-related attrition to be an issue; however, evidence suggests that this does not distort the estimates of the effect of socio-economic status on health outcomes [5].

2.1 Impact of the policy on diagnosing hypertension

In the BHPS there are two questions that are related to blood pressure. One asks the respondents whether they had blood pressure health checkups and tests since last September, and the second question asks whether the respondents have a heart or blood pressure health problem. People who are diagnosed with high blood pressure are advised to have their eyes tested since high blood pressure can damage blood vessels in the retina. Also, people through their eye examinations may be diagnosed with hypertensive retinopathy, a risk indicator of blood pressure and coronary heart disease. Thus, we test the hypothesis that the detection of problems related to high blood pressure will increase after the policy's introduction in 2006.

In order to identify the potential beneficial outcome that eye examinations can have in detecting problems related to high blood pressure and referring the patient for further exams, an exogenous variation in eye examinations is required. The subsidised eye examinations policy introduced in Scotland in 2006 provides such an exogenous variation and can be used as a quasi-experiment. Prior to the policy, all UK countries had the same eye care policy, namely, that most people who wanted or needed an eye test would pay for this out of pocket at a private optometrist. The policy changes in Scotland introduced an exogenous variation in the cost of eye examinations (natural experiment) that affected only Scotland [8]. This enables us to investigate the treatment/policy effect on the detection of problems related to high blood pressure, where Scotland is regarded the treatment group and England the control group.

2.2 Socio-economic differences in the impact of free eye exams on diagnosing hypertension

The impact of the eyecare reform in Scotland will depend on the uptake of eye exams across different socio-economic groups. An earlier study on the effect of free eye exams on the demand for eyecare services found that, on average, the policy did not increase demand for eye exams across the whole population, but only among high income households [7, 8]. Based on these findings, we expect that the detection of high blood pressure and the incidence of blood pressure exams will increase only for individuals from

high income households. This is based on the hypothesis that the group of people more likely to exhibit a greater incidence of blood pressure exams and high blood pressure will be the same group who responded more positively to the eye care reform by having a higher uptake of eye exams.

2.3 Method

The empirical analysis uses a difference-in-difference (DD) estimator that enables us to examine the policy's impact, while isolating the effects of confounding factors at the time of the policy's introduction. The policy treatment group are the people residing in Scotland, while the control group, those not affected by the policy, consists of people living in England. One key assumption for the DD method is the common trend assumption that requires that both treatment and control groups would follow a similar trend in the absence of the policy. The policy provides an exogenous variation that makes the treatment group to deviate from this common trend.

This assumption can be visually verified by examining Figure I. The sample used in the plots excludes year 2006. A potential identification issue arises for the cases where the interviews took place between April and December in the year 2006, since the reference period in the related questions includes both a pre and post policy period [8]. It is only for 172 observations that we can positively confirm this information in the year 2006. The top part of the figure plots the average proportion of the Scottish and English sample that had a blood pressure examination before and after the policy. Similarly, the bottom part plots the percentage of the sample population who reported having problems related to high blood pressure. Both plots suggest that in the absence of a policy intervention the two groups are expected to follow a similar trend, although it is more evident in the case of blood pressure examinations.

The regression equation for the DD analysis is given by the following equation:

$$Outcome_i = \beta_0 + \beta_1 Scotland_i + \beta_2 Policy_i + \beta_3 Scotland_i \cdot Policy_i + \varepsilon_i \quad (1)$$

where $Scotland_i$ is a binary variable for the treatment group, $Policy_i$ is a binary variable indicating the time period after the introduction of the policy. β_1 is a measure of the difference in outcome between the treatment and control groups prior to the policy; β_2 is a measure of aggregate factors that cause changes in the outcome irrespective of the policy; β_3 is a measure of the treatment effect, while holding all other confounding factors constant; ε_i is the error term, while β_0 is the usual intercept.

There are two outcomes considered, one indicates whether the respondent had a blood pressure examination and the other whether the respondent reported having high blood pressure. Equation (1) is estimated separately for these two outcomes, while including controls for gender, age, number of children, marital status, education, two indicators of overall health, binary variable indicators for individuals whose equivalised household income is either in the top or bottom 25% of the income distribution and year trends. The regression equations are estimated using a linear probability model with standard errors clustered by individuals.

In order to test our second hypothesis and explore whether there are heterogeneous treatment effects across different income groups, a difference-in-difference-in-difference model (DDD) is employed. This is similar to the DD estimator but it considers three dimensions: the policy period, the treatment group and position on income distribution; and it includes a full set of dummies and all pairwise interactions.

$$Outcome_i = \beta_0 + \beta_1 Scotland_i + \beta_2 Policy_i + \beta_3 Income_i + \beta_4 Scotland_i \cdot Policy_i +$$

$$\beta_5 Scotland_i \cdot Income_i + \beta_6 Policy_i \cdot Income_i + \beta_7 Scotland_i \cdot Policy_i \cdot Income_i + \varepsilon_i \qquad (2)$$

The coefficient of interest is that of the triple interaction term (β_7). The income groups we consider are the individuals whose equivalised household income is in the top or bottom 10%, with the reference group being the individuals at the mid of the income distribution, 10-90%. Alternatively, we also focus on the top and bottom 25% of the income distribution. Figure II plots the average uptake of blood pressure examinations (top part) and the average incidence of reporting problems related to high blood pressure (bottom part), separately for the two income groups for England and Scotland. The high and low income group reflect the individuals whose equivalised household income is at the top or bottom 25% of the income distribution. The common trend assumption appears to be supported in both cases. Specifically, high income people from England and Scotland appear to follow a similar trend in both the uptake of blood pressure examinations and in reporting high blood pressure problems. The common trend assumption is also confirmed for the people at the bottom 25% of the income distribution.

3. Results

Table I, panel A, reports summary statistics on the eye exams, blood pressure exams, and high blood pressure problems for the sample of individuals living in Scotland and

England for the period 2001-2008. The overall sample consists of 51,984 observations, with roughly 26 percent of the sample from Scotland and the remaining 74 percent from England. In the sample used, 36.4 percent had an eye examination and 42.2 percent had a blood pressure examination, while 8.7 reported having high blood pressure. People who had their eyes tested have both a higher uptake of blood pressure examinations and incidence of high blood pressure (50.5 percent and 11.2 percent, respectively), compared to those who did not have an eye examination (37.5 percent and 7.2 percent, respectively). The correlation between eye examinations and blood pressure examinations and health problems is reported in Table I, panel B. We find evidence that eye examinations are statistically significantly correlated with both blood pressure examinations (correlation coefficient of 0.127, statistically significant at the 1% level) and reporting high blood pressure problems (correlation coefficient of 0.068, also statistically significant at the 1% level).

Table II provides the estimated treatment effects (β_3) for the DD estimation, where the upper half of the table refers to blood pressure examinations and the bottom half to high blood pressure problems. The results reported in Column 1 do not provide any evidence that the subsidised eye care policy in Scotland led to a higher uptake of blood pressure examinations or detection of high blood pressure problems. Thus, for the whole sample, we do not find evidence to support our first hypothesis.

This is in line with the findings of recent studies [7, 8], where no policy impact was found on the uptake of eye examinations when considering the whole sample. The policy effect on eye examinations was evident only when allowing a heterogeneous response based on individuals' position in the income distribution. Specifically, the evidence suggested that individuals only from the upper part of the income distribution responded positively to the eye care policy, by increasing the uptake of eye examinations by around 5 percent [8]. The implications of this is that if the eye care policy led to more blood pressure examinations and detection of high blood pressure problems, this should be evident only for the group of people who responded positively to the policy and had a higher uptake of eye examinations.

The results from the DDD analysis are presented in Table II, columns 2 and 3. Individuals are distinguished based on their relative position in the income distribution. The results presented in column 2 identify individuals whose equivalised household income is either at the top or bottom 10 percent of the distribution. Alternatively, the top

and bottom 25 percent of the income distribution is considered in the results presented in column 3.

The results suggest that since the eye care policy reform in Scotland there is an increase in the uptake of blood pressure examinations of 5.5 to 7.2 percentage points but only for the individuals at the top of the income distribution. These findings are also verified when considering the incidence of reporting problems related to high blood pressure. There is an increase in the level of reported high blood pressure problems by 2.5 to 3.6 percentage points. The findings are consistent with the evidence on how people's uptake of eye examinations changed since the policy was introduced. Eye examinations increased only for the individuals from the upper part of the income distribution [7, 8], and it is a similar group of people that are also found to have a higher uptake of blood pressure examinations and to be more likely to report health problems related to high blood pressure.

We also performed a sensitivity analysis where we re-estimated the DD and DDD regression equations by excluding the 172 observations of year 2006. As expected the results remained fairly unchanged both qualitatively and quantitatively, confirming the previous estimates. It is only for the people at the top 25% of the income distribution where the policy effect on reporting high blood pressure problems that loses its statistical significance.

4. Discussion

The findings provide evidence of the wider impact that the eye care policy in Scotland may have had. The results also highlight the wider health benefits and cost-savings that an eye examination can achieve through the early detection of hypertension. Our results suggest that the disparate uptake of eye examinations across income groups not only widens inequalities in eye health [7, 8], but may also widen inequalities in other health conditions. This contributes to a strand in the literature where other universal health promotion policies in Scotland have also been found to inadvertently widen health inequalities [6, 14].

This study highlights the scope of further research on the subject. Specifically research is needed to understand why people from lower income households do not avail themselves of free eye-examinations. Furthermore, attention should be focused on those at the lower end of the socio-economic ladder and explore what can be done to alleviate inequalities in uptake.

The DD methodology is quite commonly used in policy evaluation studies. However, like all empirical approaches, it also has its limitations. The DD methodology relies on the assumption that there is a random, exogenous, intervention, conditional on time and group fixed effects. Much of the debate in the literature typically revolves around the validity of this assumption and the potential endogeneity of the policy interventions [2]. In addition, there have been arguments about the extent to which the DD estimation can isolate a specific behavioural parameter [4, 12]. Finally, the linearity assumptions used in DD estimation has also been assessed [1].

5. Conclusion

Cardiovascular disease is the number one cause of death in the UK. In addition, it has important financial implications for the National Health Services. Eye examinations and hypertension are correlated, since people diagnosed with high blood pressure are advised to have their eyes tested for the presence of hypertensive retinopathy [13], and also eye examinations may lead to the prognosis of potential problems related to high blood pressure.

This study examines the effect of eye examinations in diagnosing hypertension, both measured by the number of high blood pressure examinations and reported incidences of high blood pressure. The identification strategy employed to estimate the causal effect of eye examinations on the diagnosis of hypertension is based on DD analysis, using the eye care policy that was introduced in Scotland in 2006 as a quasi-experiment.

The eyecare reform in Scotland introduced a subsidised eye examination that provided examinations at no out of pocket cost to all people in Scotland. According to recent studies [7, 8], people from different socio-economic groups responded differently to the eye care policy. Their evidence suggests that the individuals only from the upper part of the income distribution responded positively to the eye care policy.

Our study investigates two related hypotheses: (i) whether the free eye exams led to an increase in the detection of hypertension through a higher uptake of eye exams, and (ii) whether the group of people who are likely to respond positively to the eye care policy and have a higher uptake of eye examinations is the same group of people who had more blood pressure examinations and consequently reported more high blood pressure problems.

This paper using the BHPS suggests that the eye care policy led to an increase in blood pressure examinations by around 7 percentage points and an increase in the

reporting of high blood pressure by around 3 percentage points. However, this is evident only for the people from high-income households.

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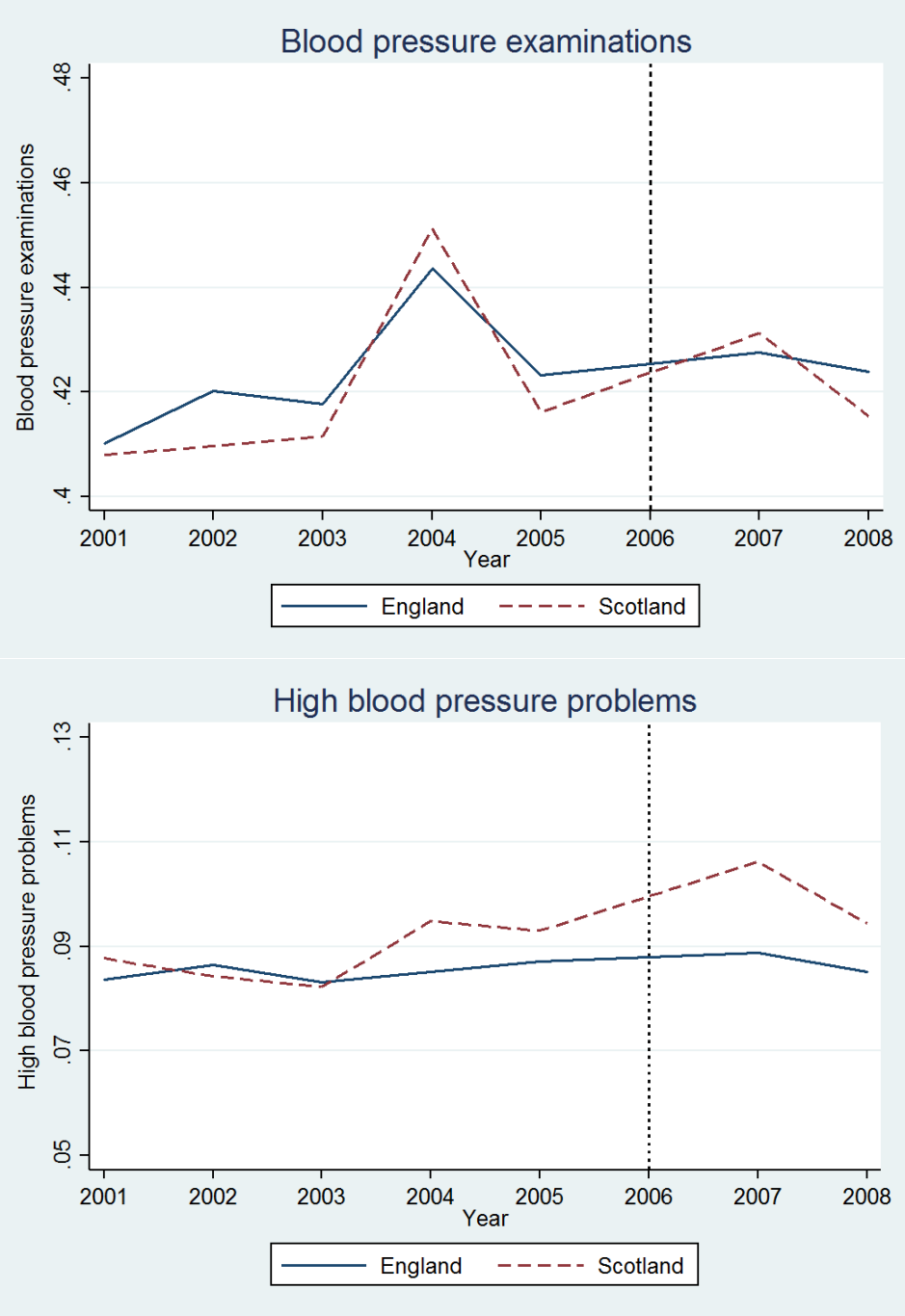
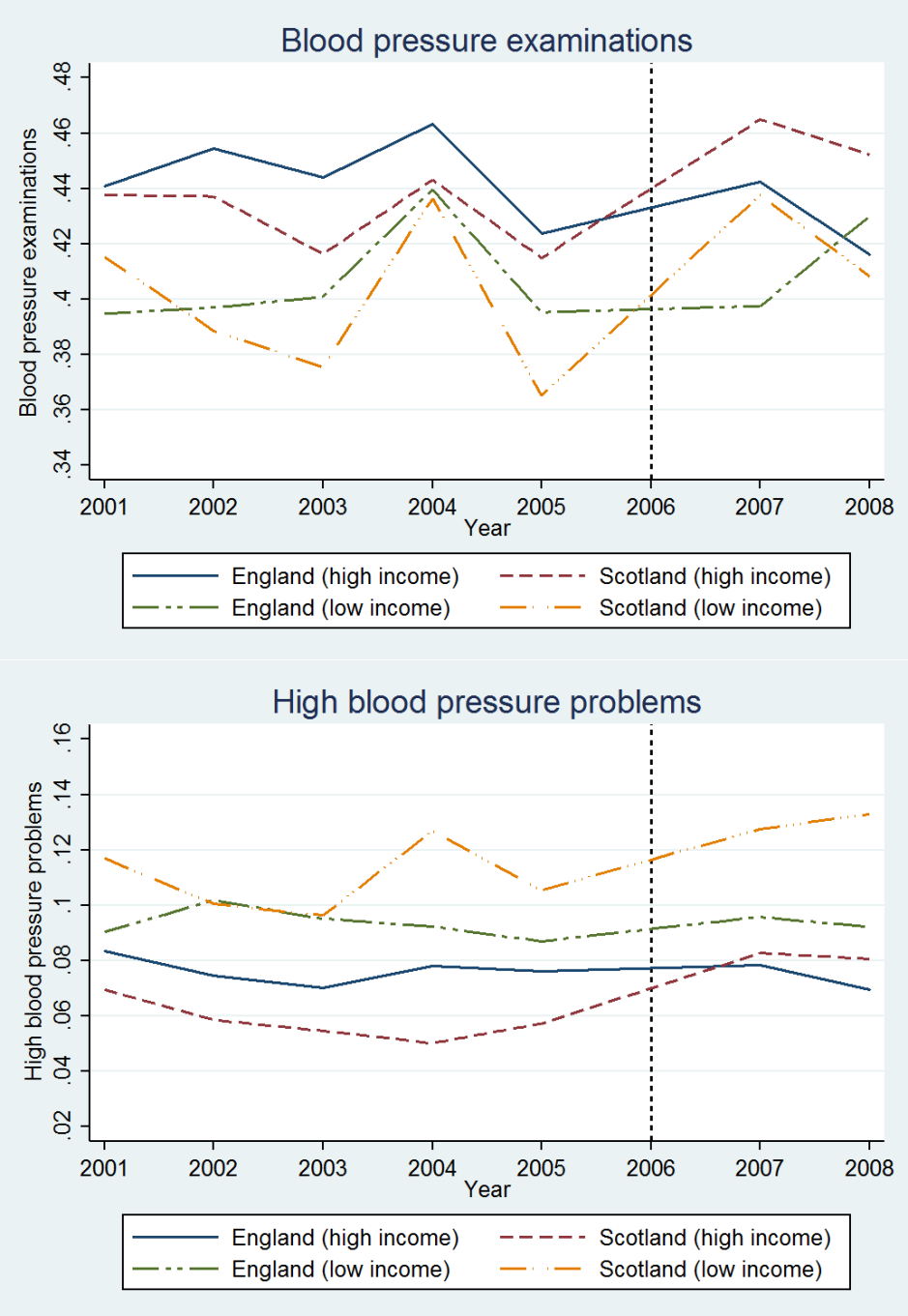
Figures

Figure I



Notes: Percentage of people in Scotland and England, before and after the eye care policy, who (i) had a blood pressure examination (top part), and (ii) reported having problems related to high blood pressure (bottom part). Based on authors' calculations, using the BHPS sample for the period 2001-2008 (year 2006 is excluded, due to small sample size).

Figure II



Notes: Percentage of people in Scotland and England, before and after the eye care policy, who (i) had a blood pressure examination (top part), and (ii) reported having problems related to high blood pressure (bottom part). High income group refers to the top 25% of the income distribution, low income refers to the bottom 25% of the income distribution. Based on authors' calculations, using the BHPS sample for the period 2001-2008 (year 2006 is excluded, due to small sample size).

Tables

Table I: Summary statistics

Panel A: Means[i]

	All	Had eye examination		
		Yes	No	t-test[ii]
Eye examination	0.364 (0.481)			
Blood pressure examination	0.422 (0.494)	0.505 (0.500)	0.375 (0.484)	***
High blood pressure problems	0.087 (0.282)	0.112 (0.316)	0.072 (0.259)	***
Observations	51,984	18,906	33,078	

Panel B: Correlation coefficients[iii]

	Eye examination	Blood pressure examination	High blood pressure problems
Eye examination	1		
Blood pressure examination	0.127***	1	
High blood pressure problems	0.068***	0.289***	1

Notes: i: Means with standard deviations reported in brackets. ii: *** p<0.01 from a means differences t-test between people who had an eye examination and people who did not. iii: Correlation coefficients reported with the level of statistical significance denoted by *** for p<0.01.

Table II: Eye care policy effect on blood pressure examinations and outcomes

Outcome: Blood pressure examination			
Scotland×Policy	-0.002		
	(-0.15)		
Scotland×Policy×HH income: top 10%		0.055*	
		(1.71)	
Scotland×Policy×HH income: bottom 10%		0.050	
		(1.31)	
Scotland×Policy×HH income: top 25%			0.072***
			(2.97)
Scotland×Policy×HH income: bottom 25%			0.046
			(1.60)
Observations	51,984	51,984	51,984
Outcome: High blood pressure problems			
Scotland×Policy	0.008		
	(1.21)		
Scotland×Policy×HH income: top 10%		0.036**	
		(1.89)	
Scotland×Policy×HH income: bottom 10%		-0.004	
		(-0.18)	
Scotland×Policy×HH income: top 25%			0.025**
			(1.70)
Scotland×Policy×HH income: bottom 25%			0.019
			(0.99)
Observations	51,984	51,984	51,984

Notes: OLS estimates. Coefficients reported with *t*-statistic in parentheses. The level of statistical significance is denoted by: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Other explanatory variables included are controls for gender, age, number of children, marital status, education, equivalised household income (position in distribution) and year trends.